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Disertační práce

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**ANTONINSKÝ LIMES: SROVNÁNÍ ANTONINOVA VALU A
ODENWALDSKO-NECKARSKÉ SEKCE HORNOGERMÁNSKÉHO
LIMITU**

**THE ANTONINE LIMES: THE COMPARISON OF THE ANTONINE
WALL AND THE ODENWALD-NECKAR SECTION OF THE UPPER-
GERMAN LIMES**

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Abstrakt

Přestože je Limes Romanus archeologicky zkoumán již téměř 150 let, jeho výstavba, postupné modifikace a funkce samotná jsou stále předmětem odborné debaty. Na základě antických pramenů lze předpokládat, že klíčovou úlohu při jeho vyměrování a výstavbě hráli tzv. *agrimensores*, kteří k ní používali jednoduchý geodetický nástroj zvaný *groma*. Z toho lze usuzovat, že prostorové vztahy mezi jednotlivými prvky limitu byly diktovány vzájemnou viditelností mezi klíčovými lokalitami na bázi přímek.

Meritem prezentované práce jsou výsledky komplexní studie viditelnosti na Odenwaldském Limitu (SRN) a Antoninově valu (UK). Na jejich základě jsou v kombinaci s dalšími prostorovými analýzami v prostředí GIS určeny klíčové lokality z pohledu vyměrování limitu, které pak někdy sloužily i jako centra správy hraničního pásma. Sledovány jsou prostorové vztahy mezi vybranými lokalitami, distribuce jednotek v kontextu krajinného reliéfu a vztah jednotlivých prvků limitu ke krajinným dominantám a komunikačním uzlům (nejen) v období vlády císaře Antonine Pia v provinciích *Britannia* a *Germania Superior*. Dále jsou v práci řešena témata jako signální komunikace nebo definice krajinného umístění jednotlivých prvků limitu – věží, pevností, pevnůstek, limitních cest a lineárních bariér.

Cílem prezentované práce je zasadit výsledky zmíněných analýz do kontextu dostupného archeologického poznání a poodhalit tak odpovědi na obecné otázky: jak měl systém Limes Romanus fungovat a za jakým účelem byl vybudován. V závěru práce je nabídnuto srovnání obou zkoumaných příkladů systému Limes Romanus.

Klíčová slova: Limes, prostorové analýzy, Antoninův val, Odenwaldský limes

Abstract

Despite the Limes Romanus has already been studied for more than 150 years, fundamental questions such as its construction, later modifications and primary function itself are still a matter of dynamic debate. From the historical sources it is currently known that a major role during the construction and planning of the whole system performed so called *agrimensores* using the simple geodetic tools like *groma*. Therefore, the essential role during the construction of the Limes had the direct visibility between individual sites of the future frontier.

The core of this thesis is the presentation of the results of the so called viewshed analysis of individual sites on the Odenwald Limes (Germany) and on the Antonine Wall (Scotland). Based on combination of this method with results of the other spatial analyses in GIS, the nodal sites for both the surveying and operation of the Limes are detected in each studied sector. The thesis is also dealing with the distribution of the units in the landscape, terrain definition of the positioning of individual parts of the Limes as well as with the possibility of mutual signal communication between individual parts of the frontier.

The main goal of the thesis is to shed a bit more light on the fundamental questions: how the Limes Romanus was supposed to operate and what purpose it was constructed for in the first place? Except of the already mentioned spatial analyses, a comparison of both frontiers is offered at the end of the thesis in order to answer the aforementioned fundamental questions.

Key words: Limes, spatial analyses, Antonine Wall, Odenwald Limes

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1. Introduction

1.1 The Antonine Limes

The idea of writing this thesis came to the author when reading one of the papers offered to Professor David J. Breeze on the occasion of his retirement from Historic Scotland, a paper called *The Odenwald Limes and its relation to the Antonine Wall* (THIEL 2009, 134–141). The main points of Dr Andreas Thiel's were in accordance with the then-general approach to the Roman frontiers, an approach which was looking for similarities in the deployment of units, distances between the individual frontier features, phases of construction and reconstructions, and similarities in the decoration of various inscriptions and distance slabs on these linear barriers.

The idea of the comparability of the Roman Empire's frontier system in different part of the Empire was reinforced at the time by the ongoing nomination of different parts of the Limes as World Heritage sites – it was a view that we were dealing with one system, applied in various places and conditions, sometimes even tremendously differently, but always with a few general goals such as the control of movement, prevention of raiding, collection of customs and dues from trans-Limes goods exchange etc. (BREEZE – JILEK 2005, 141–146). This view was very influential, especially with the younger generation of scholars, and I felt an urge to move the interpretation via comparison even further – to compare not only the general layout of the Limes and its archaeological remains, but also the fundamental conditions for the organisation of any frontier– the landscape in which the frontiers existed and the way the Roman army adapted to it or used it for its advantage. The initial choice of the topic for this thesis was thus to compare the Antonine Wall and Odenwald Limes from an archaeological and a landscape point of view.

1.2 Study area

The study area of presented thesis is not strictly limited to the sections of frontier as they are traditionally defined. From the Odenwald-Neckar section of ORL (Strecke 10) only the mountainous section (roughly the part of Limes in the modern Geo-Naturpark Bergstrasse-Odenwald) between the forts at Wörth and Schlossau is examined, since the line of the frontier south of Schlossau was evidently adapted to the flatland near the Neckar river, and was not as comparable with the Antonine Wall as with other sections of the ORL (Fig. 114). Although the author hoped on several occasions to widen the study area in current Germany, especially

towards the fort at Obernburg, the inaccessibility of LIDAR data for this stretch of current State of Hesse emerged as a fundamental problem (see p. 238, 242).

For the Antonine Wall, not only was the turf rampart and string of forts and fortlets studied, but also the adjacent seaside military installations, since neither of these features would make sense on their own (Fig. 3). The author also occasionally struggled with the acquisition of data during the interpretation of the Scottish Limes via spatial analyses, which will be further discussed below (see p. 148–152), and a different problem eventually emerged when widening the area of research – the author was simply unable to offer a comparison between the Antonine Wall peripheries and those of the Odenwald Limes. As a result, the peripheral areas of the Antonine Wall are only discussed in a limited manner.

Since the Odenwald Limes was originally surveyed and built in the Trajanic period, the presented study is not strictly limited to the Antonine period either, despite both frontiers existed simultaneously for a while. Both examples of Limes are compared the way they were originally surveyed and their later alternations are discussed separately.

1.3 Questions

The main set of questions discussed in this thesis involve why the frontiers and their individual features were built in that particular form. What were the builders trying to achieve; what they were preventing? Can we find connections between the positioning and purpose of individual sites on the Limes? What did the Antonine Wall and Odenwald Limes have in common, and what kind of qualities they did not share? Many of these issues have been the focus of archaeological and indeed also historical research for decades (KRISTOF 1959, 269–282, WHITTAKER 1994, 60–98, BREEZE 2011, 184–189, LUTTWAK 2016, 67–125) and sadly, much of the discussion is still largely theoretical, or looking for abstract or social explanations. Instead of questioning these approaches, the author would like to contribute to this discussion with a comparison of two frontiers, studied exclusively via the correlation of archaeological knowledge gained over more than 100 years, and modern methods such as spatial analyses in an artificial environment.

Many subjects are not included in the following pages, mainly the assessment of pottery and other material culture that is not specifically relevant to the dating or stratigraphic sequences. The material evidence is not discussed in detail since the main goals of this thesis involve the interpretation of the physical remains of the frontiers, rather than their re-dating or, for example, the (re)interpretation of consumption and coin circulation in the Roman Army.

The main goal of this thesis is to study two frontiers and offer a comparison. Much has been published about both frontiers, and so a certain summary is first presented in the following pages. The Antonine Wall and the Odenwald Limes are thus initially presented separately. The following is authors interpretation of these frontiers via spatial analyses, which usage is justified in the preface of the respective chapters, where more detailed questions relating to the individual frontiers are also discussed. The final synthesis involves a comparison of the studied frontiers and an assessment of whether they were even comparable, followed by brief concluding remarks and suggestions about the nature of Roman frontiers in the chapter called *Modus operandi of the Antonine Wall and Odenwald Limes* (see p. 255–268).

Several topics that were originally planned for this thesis have been in the end omitted. One was the relationship of *Numeri Brittonum* on ORL to Roman Britain. This topic was discussed comprehensively already in 1999 (REUTER 1999, 385–389) and then summarised in 2012 by Dr Tatiana Ivleva (IVLEVA 2012, 170–211), and author could not find anything to add to the debate. Similarly, a comparison of the predecessors of the Antonine Wall and the Odenwald Limes in their respective regions was presented already in 2005, in a comprehensive manner, by Erik Dobat (DOBAT 2004), so that again, there was nothing for the author of this thesis to add. The surveying of the Antonine Wall was extensively explored by MSc John Poulter (POULTER 2009, POULTER 2018), and his conclusions and suggestions are in many cases fundamental for the presented research.

1.4 Methodology of the thesis

The archaeological and historical terminology used in this thesis is largely based on the standards used in the *Proceedings of Roman Frontier Studies*, *Journal of Roman Studies* and *Britannia*. Many German academic terms are transformed into English in order to keep the structure and results cohesive. When needed, the association or translation is provided. Similarly, description of the spatial analyses is based on the terminology used in the *Journal of Computer Applications in Archaeology* and on standards used in practical handbooks for this topic (mainly CONOLLY – LAKE 2006).

The author of this thesis has always tried to quote the primary sources of information whenever that was possible, and so excavation reports are primarily cited, if accessible to the public. All the spatial analyses were calculated in several versions of the ArcGIS 10 programme, for which the author was kindly provided with a license by Goethe University.

All the plans and figures are of the author's design, made either in CorelDRAW X8 and higher, AutoCAD 2014 or ArcGIS. The originals, on which the plans are based, are always quoted. The inscriptions mentioned in text are not represented in any figures or plans, since such reproduction would offer no further information relevant to the topic of the thesis. All can be found in the respective epigraphic fascicles under the standard shortcuts used in this thesis.

When miles, paces or feet are mentioned in the thesis, these are always Roman miles, Roman paces and Roman feet – 0,001 Roman mile (*mille passuum*) = 1 Roman pace (*passus*) = 5 feet (*pedes*) = 1,48 m.

2. The Antonine Wall

2.1 History of research

Shortly after its definitive abandonment in 162 AD, knowledge regarding the Antonine Wall was more or less lost. Despite the names of several forts along the structure being mentioned in the *Ravenna Cosmography* (FRERE 2001, 286–292), information about the true purpose and origin of the Antonine Wall quickly faded away, together with the Empire responsible for its construction. Thus, the oldest remarks about its existence tell the tale of Britons actually building the Wall on Roman orders (BEDE 1910, *Historia Ecclesiastica gentis Anglorum* 1, XII), or attribute its erection to Septimius Severus (NENNIUS 1848, *Historia Brittonum* 23). Given that the mound was still present and must have looked artificial even to a common observer, the existence of a certain mythology about its construction or emergence was only logical, especially if knowledge about its true origins had been lost. Soon the Wall received a new name, Grimisdike or Graham's Dyke, a Wall of Graeme, a mythical figure merely described as the son of the mythological king of Scotland, Eugenius (JOHN OF FORDUN, *Chronica Gentis Scotorum* III, 3).

The visible structure of the Antonine Wall became an object of interest for medieval and early modern scholars and antiquaries, like George Buchanan, Alexander Gordon and John Horsley, to mention the most important examples, who frequently wrote short testimonies about the Antonine Wall or salvaged some of the inscribed stones. However, the first scholar to actually study the Antonine Wall scientifically was Timothy Pont. This Scottish topographer and cartographer was the first one who attempted to survey the location of both the former rampart and the nearby lying ditch of the Antonine Wall, while creating a detailed map of 16th century Scotland for King James VI. Interestingly, his work was largely either forgotten or later reused by other scholars like Johan Blaeu (BLAEU 1654) and Robert Sibald (SIBALD 1707). His map was not entirely exact, as some of the recorded alignments of the Wall were imprecise and the map was generally executed on a large scale (KEPPIE 2012, 40–41). Unfortunately, Pont died before completing his task, but the significance of his work extends beyond basic mapping: in one of his sketches accompanying the main map the structure of the wall is recorded as a linear barrier and features like fortlets and expansions are postulated here, nearly 400 years before they were actually proven to exist via archaeology (CAMDEN 1722, 1287–1288).

In the early modern era, interest in the remains of the Roman presence in *Britannia* grew. William Stukeley, while composing a treatise about Arthur's O'on, published another map of the Antonine Wall with some corrections to Sibald's work (STUKELEY 1720, 1–27).

Another important account from the same period was provided by Alexander Gordon, who personally inspected the course of the Antonine Wall in 1725 (KEPPIE 2012, 75) and published a comprehensive study (GORDON 1726, 46–69) about the visible and known remains of the Roman presence in the north of Britain, including a redesigned map of the Antonine Wall. His work is especially important because he was one of the last people to document the course of the structure before the start of the construction of the Forth-Clyde Canal (built between 1768–1790), which intersected the Antonine Wall several times and significantly altered the nature of the landscape.

Shortly before the completion of works on the Forth-Clyde Canal, the most important pre-modern treatise about the Antonine Wall was published. This was William Roy's *Military Antiquities of the Romans in North Britain* (ROY 1793), for which more advanced geodetical methods were first used and thus the more or less exact line of the Antonine Wall was documented for the first time (BREEZE 2008, 27). Roy was the last person to record the Antonine Wall before the construction of the Forth-Clyde Canal and the subsequent change in land ownership, followed by alterations to the demarcation of field boundaries, which in combination dramatically transformed the Scottish landscape (KEPPIE 2012, 92). The Roy's military background and his cartographic and geodetic skills allowed him to additionally create a valuable description of many individual Roman sites on the Antonine Wall, even though Roy's sole authorship of the maps and plans themselves was later questioned (HODSON 2011, 117–132). Until precise measurements were made by the Ordnance Survey in 19th century, Roy's map was unparalleled in both precision and detail and served as a vital basis for later scholars like John Buchanan and Robert Stuart in the early 19th century (KEPPIE 2012, 117–118).

In Scotland, the second half of the 19th century was marked by intensive agricultural, industrial and intellectual developments, which deeply affected the Antonine Wall as well as the scientific approach to it. Increasing antiquarian interest in the ancient remains stimulated members of the Glasgow Archaeological Society to lead tours and visits to the line of the Wall from which accounts survived (KEPPIE 2012, 118–120). The Society of Antiquaries of Scotland published their first proceedings in 1852 and despite there was initially only limited amount of space dedicated to Roman archaeology or the Antonine Wall itself, since the beginning of the 20th century numerous important excavations reports have been published in this journal. Moreover, a detailed Ordnance Survey map was made between 1854–1861 and ultimately published in 1890 (JONES 2011, 147).

Increased public and scientific interest in the past manifested itself in the eventual commencement of excavations of Roman sites all over Scotland. Most of the principal Roman forts on the Antonine Wall were excavated for the first time at the start of the 20th century, beginning with the nearby lying fort at Camelton (BUCHANAN 1901, 350–379). Castlecary soon followed (CHRISTISON – BUCHANAN 1903, 286–330), together with Rough Castle (BUCHANAN – CHRISTISON – ANDERSON 1905, 442–499) and Bar Hill (MACDONALD – PARK 1906, 1–150). The last major site excavated before the First World War was the fort at Balmuildy, but the report was published after the conflict (MILLER 1922, 1–120).

A cornerstone for these actions had already been laid in the late 19th century by the publication of *The Antonine Wall Report* (Glasgow Archaeological Society 1899), which summarised the endeavours of the Glasgow Archaeological society in the late 19th century. In this report, the Wall was placed in the spotlight and it was effectively proved that it was indeed made of layers of turf built on stone foundations. In this study, the Antonine Wall was rightly examined together with the nearby lying Military Way, which was for the first time comprehensively measured and studied (see p. 21–22). Furthermore, the existence of expansions near Croy Hill was mentioned and it was demonstrated that they were secondary to the construction of the foundations of the Wall itself (Glasgow Archaeological Society 1899, 80–85).

These archaeological excavations also provided an exceptional context for many antiquarian and historical finds from previous centuries, especially for recovered distance and dedication slabs as well as for altars from both the forts and the course of the Antonine Wall itself. The majority of these were finally put on public display in the Hunterian Museum in 1810 (KEPPIE 1998, 33), despite the collection being in the possession of Glasgow College since the 18th century. The first epigraphical catalogue of them was published in 1897 (MACDONALD 1897), but statements about finds of Roman inscribed stones from the area of the Antonine Wall can be traced back to the mid-16th century (KEPPIE 1998, 3) and many antiquarians did their best to document these unique finds over the years, particularly Alexander Gordon (GORDON 1726, 46–69), John Horsley (HORSLEY 1732, 194–205) and William Stukeley (STUKELEY 1720, 1–27).

Combining this antiquarian knowledge with the results of completed (and sometimes still pending) archaeological excavations as part of a comprehensive study became the key task of George Macdonald in his 1911 treatise *The Roman Wall in Scotland* (MACDONALD 1911). This book proved pivotal for all subsequent studies of the Antonine Wall and it was only

replaced later by its revised and improved second edition in 1934 (MACDONALD 1934). Macdonald was connected with most of the work undertaken on the Antonine Wall in the first half of the 20th century and it was him who came with first comprehensive summary of the Antonine frontier in Scotland and its probable function (see p. 260). He took charge (together with Alexander Park) of the excavations of the forts at Bar Hill (MACDONALD – PARK 1906, 1–150), Mumrills (MACDONALD – CURLE 1929, 396–575), Old Kilpatrick, Croy Hill (MACDONALD 1932, 219–42), Rough Castle and Westerwood (MACDONALD 1933, 243–77).

The last large-scale excavations on the Antonine Wall before the Second World War took place at Cadder (CLARKE 1933). The successive post-war period was marked by the rapid development of the whole of Scotland, which naturally created pressure on archaeologists to excavate the Roman sites prior to their destruction. This new urge to excavate was also backed by knowledge gained via a new method of prospection – aerial photography (ST. JOSEPH 1945, 47–59) – which brought a whole range of potential new sites to the attention of the wider scientific public. Consequently, a fort at Carriden was identified (ST. JOSEPH 1951a, 167–174) as well as a fortlet at Wilderness Plantation (ST. JOSEPH 1951b, 52–65), which proved especially important because it had previously been believed that the fortlet at Watling Lodge, already partially explored in 1894 (CHRISTISON 1901, 337), was an exception. Instead, it became clear that fortlets like this were relatively common features on the Antonine Wall. Two more forts were excavated in the 1950s: Duntocher between 1947 and 1957 (ROBERTSON 1957) and Kirkintilloch between 1953 and 1960 (ROBERTSON 1960a, 27), before another comprehensive summary of the Antonine Wall was published in 1960 by Professor Anne S. Robertson (ROBERTSON 1960b). This book effectively summarised all the generally accepted knowledge about the frontier to the time of its publication and has been three times revised, edited and published again. Robertson together with Professor Lawrence Keppie and Margaret Scott also published an extensive report about the excavations at Bar Hill (ROBERTSON 1975), which proved to be one of the most important excavation reports from the whole Antonine Wall.

During the 1970s and 1980s, excavations and extensive research of the fortlets at Watling Lodge (BREEZE 1975, 166–175), Croy Hill (HANSON – KEPPIE 1978, 91–94), Seabegs Wood, Kinneil, Cleddans (KEPPIE – WALKER 1981, 143–162) and Summerston (MAXWELL – HANSON 1981, 87–88) were conducted, while long-term excavations of the fort at Bearsden were performed between 1973 and 1982 (BREEZE 2016). Given that all of these excavations yielded enormous amounts of data, the time has come to interpret the frontier in a new light. The structural evolution of the whole frontier became suggestable, especially thanks to the

fortlet discoveries and further studies into smaller features like expansions (STEER 1959, 161-169) and minor enclosures (HANSON – MAXWELL 1983, 227–243).

Despite the fact that Macdonald was the first to propose a theory concerning the sequence of construction of the Antonine Wall (MACDONALD 1934, 359–400), it was John Gillam who observed that the frontier in its preserved state underwent several major modifications (GILLAM 1975, 51–56). Gillam’s observations and prediction of more fortlet sites actually led to many discoveries mentioned above. His perspective has been critiqued in some details, but in reality it has been enhanced by Professors William Hanson and George Maxwell (HANSON – MAXWELL 1986, 104–136), who brought to wider attention the correlation between the construction of the curtain Wall and the positions of forts and newly discovered temporary camps. In particular, they suggested that the distances between the individual features on the frontier may have been based on a mathematical formula (see p. 73–79, 143).

Another approach to the Antonine Wall was an attempt to compare it with other Roman frontiers, particularly Hadrian’s Wall, no doubt due to its historical and topographical proximity (BREEZE – DOBSON 1976, 79–148). This approach has also been followed in this thesis, inspired by similar comparisons from the past (DOBAT 2004, THIEL 2009, 134–141).

Finally, the 1980s and 1990s represented a golden era for new theories about the construction, meaning and operation of the Antonine Wall, and numerous respectful scholars like Professors Geoff Bailey (BAILEY 1994, 299–314), David J. Breeze (BREEZE 1985, 223–228; BREEZE 1986, 185–189), William Hanson (HANSON – MAXWELL 1986), Mark Hassall (HASSALL 1983, 262–264), Nick Hodgson (HODGSON, 1995, 29–49), Lawrence Keppie (KEPPIE 1998), Gordon S. Maxwell (MAXWELL 1989) and Vivien Swan (SWAN 1999, 399–480) published their principal works about the frontier at this time. The results of their studies will be considered in the following chapter.

One important issue concerning how the Roman frontiers were able to operate was signalling (DONALDSON 1985, 19-24), with the Antonine Wall quickly becoming the subject of such research (WOOLLISCROFT 1996, 153–178). This inevitably led to the analysis of the Antonine Wall in terms of the landscape and the degree to which it was adapted to it (POULTER 2009). Nevertheless, one should not forget that this approach had its origins as early as the 1970s (SKINNER 1973).

The successful nomination of the Antonine Wall as a World Heritage Site in 2008, only three years after the ORL, brought new attention to this frontier (BREEZE 2009). Despite it

seems as if the principal discoveries about the Antonine Wall have already been made in the last thirty or forty years, a great amount of new knowledge could still be gained, such as regarding the current debate about the signalling and the design of the Antonine Wall (DYČKA 2018, 315–323; POULTER 2018, 113–146), or how this frontier could have been surveyed and originally planned (GRAAFSTAL – BREEZE – JONES – SYMONDS, 45–70).

2.2 The frontier

2.2.1 Historical background

The Antonine Wall first appears in the historical record via a simple quotation connected with the deeds of Roman Emperor Antoninus Pius: *Per legatos suos plurima bella gessit. Nam et Britannos per Lollium Urbicum vicit legatum alio muro caespiticio summotis barbaris ducto* (He waged a number of wars, but all of them through his legates. For Lollius Urbicus, his legate, overcame the Britons and built a second wall, one of turf, after driving back the barbarians – SHA, *Historia Augusta*, Antoninus Pius 5.4). The wall in question was no doubt the Antonine Wall and it is almost certain that the man charged with overseeing its construction was the *Legatus Augusti pro praetore* Quintus Lollius Urbicus. The career of this Roman imperial officer is relatively well known, mainly thanks to an inscription found in the place of his origin – the province of *Numidia* (CIL 6706) – as well as inscriptions mentioning him both in the province of *Britannia* (RIB 1276, RIB 1147, RIB 1148) and on its newly established frontier, the Antonine Wall itself (RIB 2191, RIB 2192). He was a person without a noble background, a so-called *Homo Novus* (BIRLEY 2005, 137), but by late in the third decade of the 2nd century AD he was already a proven commander and administrator with experience from relatively quarrelsome provinces like *Judea* and *Germania Inferior* during the reign of Emperor Hadrian (CIL 6706). His presence in Britain can be traced back to 139 AD, as he was mentioned on an inscription from Corbridge during the second consulship of Emperor Antoninus Pius (RIB 1147) in 139 AD. He was still in Britain at the start of the construction of the fort at Balmuildy on the Antonine Wall, being described still as *Legatus Augusti pro praetore* on a dedication slab from there (RIB 2192). There is no certainty about how long Lollius Urbicus served as a governor of Roman Britain, but based on indirect evidence about his successor, who may have already been in the province in 143 or 144 AD (RIB 2313), it has traditionally been believed that his mandate lasted for just four years (BIRLEY 2005, 141–142).

Important sources of evidence for events during the fourth decade of 1st century AD on the northern frontier in Britain are coins commemorating the victory itself and their subsequent correlation with the historical and epigraphical sources. A commemorative issue of *sestertii* with a seated depiction of *Britannia* was distributed across the Roman Empire early in the reign of Emperor Antoninus Pius (RIC 742–745). On the reverse of these coins it was stated that the Emperor received the title *Imperator* for the second time. Thanks to the epigraphical sources, this acclamation can be dated to 142 AD (CIL X, 515). During one of Marcus Fronto's speeches in the Senate, the author mentions the eventual success of the British campaign during

Antoninus Pius' third consulate (Fronto, *Pan Constantio Caes* 14), which can again be dated to 142 AD. This information, together with evidence from coins, suggests that victory in Britain must have been achieved between 140 AD and 142 AD, because it was already being celebrated in 142 AD (BREEZE 1980, 48).

2.2.2 Antonine conquest of Scotland

How exactly was the region of the present-day Scottish Lowlands conquered as far north as the area of the Antonine Wall (or possibly further) remains unknown. Historical sources offer no clues except for the fact that the campaign was relatively brief and probably without significant battles, in contrast to much longer conflicts waged in the region by Gnaeus Julius Agricola (Tacitus, *Agricola* 20–38) or Septimius Severus (Herodian, *History of the Roman Empire* 3.14.4–3.15.7, Cassius Dio, *Roman History* 77.13–15). An actual comparison of the conquest and occupation of the Scottish Lowlands during the Roman period is, however, not the subject of this thesis and there is not much to relate it to in the case of later discussed Odenwald Limes (see p. 156–157).

The only means of evaluating the events preceding the construction of the Antonine Wall is to study the temporary camps between Hadrian's Wall and the Antonine Wall, which were used by the army marching to the north. A plethora of them have been identified, usually grouped close to the Roman forts that were occupied during both the Flavian and the Antonine period (e.g. Cappuck, Crawford, Newstead or Milton). Owing to the scarcity of dating material and the fact that the majority of them were never excavated, Professors Hanson and Maxwell have used the exclusion method to suggest a potential series of 19 camps related to the Antonine conquest, mainly based on their shape and spatial disposition in the landscape (HANSON – MAXWELL 1986, 65–68). Unfortunately, only one of the camps has been positively identified as Antonine (Inveresk – HANSON 2002, 52–61), whereas for another two it is still possible to think about Antonine dating thanks to either the evaluation of finds of stray coins nearby the camp, as in the case of Cleghorn (BATESON 1990, 167), or the identification of a Flavian–Post-Flavian stratigraphic sequence in the case of Beattock camp (JONES 2013, 144–145), whereas another camp was in contrast positively identified as Flavian (Lyne II – JONES 2013, 269). Despite the described flaws in the evidence, it is still helpful to classify these relatively small camps (17–22 ha) as being related to the Antonine conquest of Scotland, because this theory is in line with the absence of major battles or organised hostility against the Romans in the region.

Long ago it was suggested that the whole Antonine campaign in what is today Scotland left limited traces owing to there being very few practical reasons to conduct it from the point

of view of increasing security on the northern frontier. The belief that the Antonine campaign, despite being conducted by experienced commanders (BREEZE 1991, 227–230), was in fact more connected with internal politics in Rome than with the situation on the northern frontier (BIRLEY 1974, 13–25), is in fact currently widely accepted (BREEZE 2008, 13–14, HANSON – MAXWELL 1986, 59–62). One can therefore presume that the Antonine invasion army was divided into smaller groups advancing through the present day Scottish Lowlands relatively peacefully until reaching the Forth-Clyde isthmus (BREEZE 2008, 49–50), as they met no centrally organised resistance from the locals, an encounter that would have undoubtedly forced the Romans to concentrate their troops in one camp prior to a major battle, as the Romans did under the leadership of Agricola in the same region prior to battle near *Mons Graupius* (Tacitus, *Agricola* 35).

After reaching its limits of expansion (which was not necessarily the location of the Forth-Clyde isthmus – see p. 25, 103), the Roman army probably started to secure the new frontier. Agricola, campaigning in the same region some sixty years before, also provided newly conquered regions with garrisons (Tacitus, *Agricola* 22), including the Forth-Clyde isthmus (Tacitus, *Agricola* 23), and although archaeological evidence for these so called *praesidia* is shallow at best (HANSON – MAXWELL 1980, 43–49), this was routine Roman military practice. Archaeological evidence for a relatively brisk erection of another frontier is based on the epigraphical evidence, especially the commemorative slab from Balmuildy, which mentions a governor Lollius Urbicus (RIB 2192) during the construction of the fort (see p. 11, 28).

2.2.3 Construction of the Antonine Wall – the evidence from temporary/labour camps

In its final form, the Antonine Wall consisted of an upcast mound, a ditch, a berm, a rampart or the Wall itself and the Military Way. However, chronologically the first structures constructed during the erection of any frontier are always quarters for the people building the monument. This assumption is supported further by the standard Roman military practice of erecting a camp during a campaign (Livy, *History of Rome* 27.1, Polybius, *Histories* 6.26–6.32, Hyginus, *De munitionibus Castrorum*, Vegetius, *Empitoma Rei Militaris*, 1.21–1.25). In the case of the Antonine Wall, many such temporary or labour camps have been discovered since World War Two, together with camps south of the Wall (see above p. 8). They can be still located in a contemporary landscape, being characteristic by rectangular or semi-rectangular enclosures and boundaries defined by a V-shaped ditch (*fossa fastigata*) as well as entrances that were sometimes (but not usually) protected by *titulum* (JONES 2005, 554). Up to twenty of them have been identified in the vicinity of the Antonine Wall (JONES 2005, 551), namely (east to west)

Murihouses, Kinglass Park, Inveravon 1 and 2, Polmonthill, Little Kerse, Lochlands (several camps can be attributed to the so-called Lochland complex, associated with a multi-period fort at Camelon. At least some of them can be identified as Antonine and therefore as contemporaries of the construction of the Antonine Wall, such as Lochlands IV – JONES 2013, 262), Tamfourhill, Wester Carmuir, Milnquarter, Dalnair, Garnhall 1 and 2, Tollpark, Dullatur, Bar Hill, Twechar, Easter Cadder, Buchley (sometimes also simply called Balmuirdy temporary camp) and Summerston. Initially these camps were divided into four groups based on their size and disposition by Professors Hanson and Maxwell (HANSON – MAXWELL 1986, 118–121), but further research has shown that based on their size, only two groups can be distinguished – Wester Carmuir, Garnhall 1, Dullatur and Buchley), representing large ones of some 4,8 ha, whereas all the others were ca. half the size of the first group, being approximately 2–2.5 ha (JONES 2005, 554).

The temporary or labour camps were presumably distributed in pairs at each end of the designated sector (MAXWELL 1974, 329, MAXWELL 1989, 155). The best-known example of this arrangement was the group of camps between Bridgeness and the River Avon, consisting of Muirhouses (ST. JOSEPH 1961, 122), Kinglass Park (FEACHEM, R. W. 1958, 334–335), Inveravon I (KEPPIE – WALKER 1990, 143) and Inveravon II (ST. JOSEPH 1965, 80). These camps may be identified alongside the long-known Bridgeness Slab (RIB 2139), which documented the construction of 4,652 paces of the Antonine Wall (roughly 4 $\frac{2}{3}$ Roman miles), which is about the distance between the positions of the camps along the course of the Antonine Wall (Fig. 1, see Table 1). The combined area they occupied was enough to accommodate the complete legion (JONES 2005, 552). Unfortunately, to date there is only one documented example of this quadripartite arrangement of camps for the respective sector and therefore it remains questionable whether the same pattern was applied along the whole length of the Antonine Wall (MAXWELL 1989, 155). Especially given that the length of allocated sectors for individual construction gangs varied between 4652 paces (RIB 2139) and 3000 paces (RIB 2173), it can be easily presumed that gangs of builders were not always of the same size and therefore four camps were not always necessary, particularly in the westernmost sector, possibly being constructed separately during the third season of the erection of the frontier (see below p. 16–17), where allocated sectors varied only between 4411 feet (882,2 paces) and 3000 feet (600 paces).

2.2.4 Construction of the Antonine Wall – surveying the frontier

From the group of temporary or labour camps mentioned above, one should exclude the temporary encampments underneath Bar Hill and Croy Hill forts, whose dimensions were of considerably smaller size (respectively 0,28 ha 0,32 ha) and were previously regarded as Flavian (so called Agricolan *preaeidia* – MACDONALD – PARK 1906, 129–130, MACDONALD 1934, 267–268), but were eventually firmly dated to the Antonine period (HANSON 1980, 58–60). These two small installations can relate to actions that the Roman army had to do even before the start of the actual construction of either the forts or the mural barrier of the Antonine Wall – surveying the frontier. One of the major reasons for this interpretation is the fact that the camp on Croy Hill (preceding a fort and lying near a fortlet) is very close to the exact position of the middle or the central point of the Antonine Wall (HANSON – MAXWELL 1986, 121), while from the summit of Bar Hill, the course of a mural barrier can easily be observed in both eastern and western directions (see Fig. 2). As the surveying of the Antonine Wall is one of the subjects for study via spatial analyses in this thesis, immediately below, only a rough summary of current evidence will be presented. The topic is further discussed on p. 82–83.

According to MSc John Poulter, the positions of all the military installations on the Antonine Wall were chosen before the line of the wall itself was demarcated (POULTER 2009, 118). Those locations thus dictated the course of the Wall. Why they were positioned where they were is discussed on p. 248–253 and the correlation with landscape setting and general visibility and intervisibility is also be discussed there.

The positions of the later forts at Croy Hill and especially at Bar Hill were ideal spots for surveying the newly organised frontier. They offered excellent views across most of the area of the Antonine Wall and therefore could have been used as bases for surveyors (JONES 2012, 27). Poulter has recently interpreted these surveyors' camps as nodal installations, used by legionary teams to demarcate both the line of the Antonine Wall and the positions of smaller features like expansions and minor enclosures (POULTER 2018, 124). Poulter's research via 'best field of view test' has also postulated that the zig-zag course of the mural barrier owed to the fact that Roman surveyors did not use any long distance alignment but instead surveyed the line of a wall in relatively short sections between individual forts and fortlets (POULTER 2009, 113–116). The author subsequently altered his point of view slightly, stating that the Romans did indeed use some long-distance alignments while surveying the Antonine Wall, but they did so in order to establish the positions of the forts, fortlets, expansions and minor enclosures in the central sector of the Antonine Wall so that they would accord with several direct lines,

starting from Castle Hill close to the surveyors' camp at Bar Hill. This system of long-distance alignments was according the Poulter's view intended to facilitate signal communications on the Antonine Wall, based on firing alarms or serious alarms from specific pairs of sites – expansions near Rough Castle and Croy Hill forts and minor enclosures in vicinity of Balmuildy. Aligning the multitude of sites was supposed to improve the reliability of the signalling system were one installation to fail or should the enemy attempt to hamper it via false alarms (POULTER 2018, 123–127). The question of alignments is further discussed in separate subchapter (see p. 82–83, 248–253).

2.2.5 Construction of the Antonine Wall – labour division among builders

Once the line of the Antonine Wall had been surveyed between individual forts (either planned or in the process of construction), it was time to build the linear barrier itself. Thanks to the epigraphic evidence it is known that the builders referred to the structure as *opus valli* (RIB 2200, RIB 2205). The very same epigraphic evidence also shows that the task of building the barrier was divided between detachments of individual legions (Second, Sixth and Twentieth Legion), which constructed each section of the frontier (MAXWELL 1974, 326–332) and then commemorated this achievement by erecting distance slabs at the end of their sections in pairs (STEER – CORMACK 1969, 125). The first of these was always set in the northern rampart (although this theory has been questioned due to the lack of general evidence for such positioning and the illogicality of presenting a piece of legionary art on the northern side of the rampart, where nobody can see it – STRANG 2007, 48), while the second was placed in the southern rampart or near the Military Way (MAXWELL 1974, 328–329, MAXWELL 1989, 155). These relatively ornate commemorations of the building process (in comparison with the centurial stones on Hadrian's Wall, for example) typically provided information about the Emperor and his titles, the detachment of the legion responsible for the work undertaken and the exact length of the constructed sector (known examples of distance slabs from the Antonine Wall consists of RIB 2139, RIB 2173, RIB 2184, RIB 2185, RIB 2186, RIB 2193, RIB 2194, RIB 2196, RIB 2197, RIB 2198, RIB 2199, RIB 2200, RIB 2203, RIB 2204, RIB 2205, RIB 2206, RIB 2208, CSIR 84, 149, CIL 1110a – STRANG 2007, 50, Table No. 10).

On the eastern and central sections of the Antonine Wall, the distances were calculated in paces, while on the westernmost sector feet were used as the unit of measurement. Professor MacDonald has suggested that this odd disjuncture may have been linked with changes in the building process (MACDOLAND 1934, 394). What actually happened cannot be reconstructed with certainty, some theories connected it with troop movements or transfers of *vexillatio* of

north Africans to the Antonine Wall after the Mauretanian War of Antoninus Pius (SWAN 1999, 445–446), others interpreted it as the general haste involved in finishing the barrier (HANSON – MAXWELL 1986, 124) or simply as an indication that different parts of the frontier were completed by different *vexillationes* from the same legions but in different seasons or years under different organization of work (MAXWELL 1974, 331–332). The division of labour between individual gangs of builders was relatively regular in the easternmost and central sectors, varying between 4,652 Roman paces and 3000 Roman paces, but differed in the west, varying between 3000 Roman feet and 4411 Roman feet (HANSON – MAXWELL 1986, 116).

Based on the above-mentioned evidence from one of the westernmost fortlets (and successive fort) of Duntocher, together with changes in the division of space west of Castlehill (MACDOLAND 1934, 394), it can be presumed that the Antonine Wall was probably built sector-by-sector from east to west (MAXWELL 1989, 154, POULTER 2009, 119) and was completed in the westernmost sector with a delay. Rough estimates count three years after the work in the eastern section started as the amount of time that elapsed before the westernmost sector was finished (STRANG 2007, 33).

2.2.6 *Construction of the Antonine Wall – the upcast mound*

The northernmost feature of the linear barrier itself was the so-called upcast mound (also outer mound or glacis). It largely consisted of soil and stone rubble thrown immediately north during the digging of the ditch in front of the Antonine Wall itself. Its shape varied (being either rather spread or heaped to form a relatively formidable barrier – Glasgow Archaeological Society 1899, 139–140) and there did not appear to be any general rule as to its intended width and height. Currently it is best preserved to a substantial height in front of the Bonny-side East and Bonny-side West expansions in the vicinity of the Rough Castle (see p. 139).

2.2.7 *Construction of the Antonine Wall – the ditch*

Beyond the upcast mound was the ditch, which aside from being a barrier in its own right, also increased the height of the rampart itself. Its upper lips were sometimes strengthened by large stones or boulders, probably to make the edge more stable. The width and depth of a ditch varied considerably from 4,27 m to 20,73 m (HANSON – MAXWELL 1986, 75–76), but on average was around 12,2 m wide and 3,66 m deep (KEPPIE 1974, 161). It was v-shaped (*fossa fastigata*) and its sides were generally cut to a slope between 26° and 30° (Glasgow Archaeological Society 1899, 135–138). It was generally narrower in the west (5,8 m wide south of Carleith farm, near Old Kilpatrick – WILSON 1970, 274; 7 m wide near Peel Glen Road, New Kilpatrick

– KEPPIE 1982, 24; 6,1 m wide near Balmuildy - HENDERSON 1974, 45), at least in comparison with the eastern (12 m wide near Bantaskin House, Falkirk – FRERE – HASSALL – TOMLIN 1977, 364; 12 m near Westerwood – KEPPIE – BREEZE 1981, 241; 8,5m wide near Nether Kinneil – HENDRY 1971, 107–110) and central sectors (12,2 m wide near Croy Hill, Sections No. II and III - Glasgow Archaeological Society 1899, 50–54; 11,3 m near Bar Hill, Section No. I - Glasgow Archaeological Society 1899, 86–87; 9,1m near Hillhead, Kirkintilloch - GREW – HASSALL – TOMLIN 1981, 320). Whether this western reduction in width owed to haste in finishing the work on the monument (HANSON – MAXWELL 1986, 77) remains in question, because it may have also been related to the different standards of different legions or even construction gangs (see p. 16–17).

Indeed, evidence for the latter can also be seen in the eastern and central sectors of the Antonine Wall, such as Hillhead near Kirkintilloch, where the width of the ditch has been recorded as 9,1 m and 6,15 m in close proximity (SPELLER – LESLIE 2002, 279–284). Same disparity can be observed in the case of Garnhall, where the difference in the width of the ditch was 0,5 m on the junction in one area (GOODBURN – HASSALL – TOMLIN 1978, 415). Sometimes this was on the other hand caused by the poor preservation of original dimensions of the ditch (as in the case of Croy Hill, Section No. II - Glasgow Archaeological Society 1899, 74; or near Bar Hill, Section No. 4 - Glasgow Archaeological Society 1899, 92). Fundamental for the shape and width of the ditch was also presence of such geological conditions, which simply prevented builders from finishing the monument properly (e.g. a ditch only 7,3m wide near Croy Hill, Section No. VIII - Glasgow Archaeological Society 1899, 65–67; but only 5,8 m wide at Carleith – MACDONALD 1934, 99). Roughly summarised, there appears to have been no rigid formula for the width or general shape of the ditch on the Antonine Wall.

2.2.8 Construction of the Antonine Wall – the berm

Between the edge of the ditch and the turf rampart lied the berm. Its width again varied from sector to sector, from some 6 m up to 30 m or more (Glasgow Archaeological Society 1899, 70). The berm was not just interspaced between the ditch and the Wall itself. Evidence shows that in order to block free movement in the frontier area, the builders dug defensive pits in several rows in front of the rampart. These were sometimes called *lilia* and have long been recognised at Rough Castle fort (BUCHANAN – CHRISTISON – ANDERSON 1905, 456–459), but they have also been discovered more recently in Falkirk, Callendar Park (BAILEY 1995, 587–589), Garnhall (BURNHAM – KEPPIE – ESMONDE CLEARY – HASSALL – TOMLIN 1993, 279) and Laurieston, Falkirk (BAILEY 2002, 266–267). These defensive pits were provided with

sharpened stakes (BURNHAM – KEPPIE – ESMONDE CLEARY – HASSALL – TOMLIN 1993, 279) and probably represented the Roman equivalent of barbed wire in that they constituted an obstacle to free movement in chosen stretches of the landscape. It seems very likely, however, that these defensive pits were provided only in the foreground of military installations, minor enclosures and expansions included (HANSON 1999, 46). Similar pits have been found at Hadrian's Wall, although they have not been interpreted as *lilia* here despite being deemed fundamental evidence of the defensive nature of this frontier (BIDWELL 2006, 1119–1125).

2.2.9 Construction of the Antonine Wall – the rampart

The Antonine Wall itself was constructed from turf blocks. This material was sometimes viewed as inferior, especially in comparison with stone-made Hadrian's Wall or Upper-Germanic Teufelsmauer. Nevertheless, the former was an exception to the general practice of the 1st and 2nd century AD, when most forts and fortlets in northern provinces continued to be built largely from wood, earth, clay and turf (JOHNSON 1983, 56–57). The latter represented the general trend of rebuilding military installations in stone, a later development: for example, in the case of the Upper German Limes, the palisade at Vordere Limes was substituted by stone wall at the turn of the 2nd and 3rd century AD (BAATZ 1975, 199–200).

The choice of building material was no doubt a matter of careful consideration by the builders, who already had experience of building the turf sector of Hadrian's Wall, which was eventually converted to stone (BREEZE – DOBSON 2000, 60–61). One of the clear lessons learnt was the extra care that the builders needed to pay to the monument's foundations. Various sections through the rampart revealed that the Wall itself stood (unlike the Hadrian's turf predecessor in what is now northern England) on stone bedding 4,3 m to 4,9 m wide and was additionally provided with drainage culverts (Glasgow Archaeological Society 1899, 89–91, 127–128) at more or less regular intervals (KEPPIE 1976a, 68–73, HANSON – MAXWELL 1983, 229). Nevertheless, not the whole wall was constructed from turf blocks: in particular, the easternmost sectors were located in areas that seemed to lack quality turves and so they were simply built from earth, with either turf or clay cheek revetments in front (KEPPIE 1974, 156–158, Table 1).

The actual height of the rampart can only be estimated. In several sectors up to 22 levels of turves constructed on top of one another have been discovered (STEER 1959, 227–243), but these are exceptions. Excavations at the end of the 19th century demonstrated only 19 layers of successive turves at best (Glasgow Archaeological Society 1899, 76, 88–89, 119), while more recent work on the course of the Antonine Wall has documented the survival of only six (at

Tollpark - GREW – HASSALL – TOMLIN 1980, 352) or eight layers (at Tamfourhill – BAILEY 1988, 9, KEPPIE – BAILEY – DUNWELL – MCBRIEN – SPELLER 1995, 626–629).

If one takes into consideration the 4th century AD military manual, the dimensions of individual turf blocks should have been 0,15 m x 0,3 m x 0,45 m (½ Roman feet x 1 Roman feet 1 ½ Roman feet – Vegetius, *Empitoma Rei Militaris*, III. 8), hence the minimal height of the rampart was 3,3 m. Given that the original turves probably sank over time, the figure may have been lower after several years of the Antonine Wall's existence. Nonetheless, it is almost certain that the upper layers of the rampart were not preserved (and therefore not documented) in sectioned parts and so the original height can conservatively be estimated at between 3 m and 3,5 m (SPELLER – LESLIE 2002, 283). This figure also considers the concerns regarding the quality of Scottish turves, which were proposed to be thicker than those in the Mediterranean (Glasgow Archaeological Society 1899, 128–131). This figure was from practical reasons taken as the minimal height of the observation platforms on the forts adjacent to the Antonine Wall as well as the minimal height of possible observation platforms on minor enclosures and expansions (see p. 96).

The existence of a walkway on the top of the rampart has long been a matter of discussion, not only on the Antonine Wall but also in the case of its southern predecessor, Hadrian's Wall (BIDWELL 2005, 53–76). Although several authors have tried to integrate indirect evidence for the existence of a walkway into a coherent summary (e.g. BIDWELL 2008, 129–143 or FOGLIA 2014, 42), to date there is still no proof of such a walkway's existence on top of any of the linear barriers of the Roman Empire.

In the case of the Antonine Wall, there is no positive evidence for any walkway. Certainly, such walkway on top of the turf superstructure would have required a wooden platform for sentries if it were to be used on a daily or routine basis. Such a superstructure would have left a trace of more or less regular sets of postholes in the rampart's turves. To the present day, nothing of this kind has been found. Taking into consideration the width of the rampart at the base level (which varied, but was always less than 5 m, see p. 19) as well as the fact that excavations from the end of 19th century have proved that the angle between the base and the southern part of the Wall ranged between 58° and 83,5° (Glasgow Archaeological Society 1899, 76, 84, 86) – on the best-documented section being an average of 63,5° (HANSON – MAXWELL 1986, 81) – the platform would have been less than 3 m wide if the height of the Wall was 3 m. Indeed, if it were 1 m higher, it would reduce to less than 2,5 m. These values may even have been lower because the northern side of the Wall was not perpendicular to its

base and an additional smaller wall or palisade would have been needed on top in order to provide some cover for the sentries. Another problem would have been the need for stairs in more or less regular intervals so that the sentries could access the platform. Foundations of none were discovered yet, theoretically these would also have reduced the width of the walkway at certain sectors and would certainly have left a trace in the form of postholes. Again, nothing of this kind has been found.

At present, there is little evidence to dispute general scepticism concerning the existence of a walkway on top of the Antonine Wall (MAXWELL 1989, 139–140 – HANSON – MAXWELL 1986, 83), rendering us uncertain about the exact top of the rampart: there could have been a symbolic palisade or just a last layer of turf. Since there is no evidence for a walkway on the Antonine Wall thus, in the chapter concerned with spatial analyses only the forts, fortlets, expansions, minor enclosures and one potential watchtower are taken in consideration as positions of potential observation / signalling platforms (see p. 95–96)

2.2.10 *Construction of the Antonine Wall – the Military Way*

Based on existing knowledge, the Military Way ran just south of the Antonine Wall and was built more or less simultaneously with the rampart and the ditch, unlike the Military Way behind the Upper Germanic Limes, which actually preceded the erection of the linear barrier by decades (BAATZ 1975, 40–42) or the similar Military Way added to the Hadrian's Wall after the abandonment of the Antonine Wall (BREEZE – DOBSON 2000, 131–133). Poulter has also shown that the Military Way largely followed the direction of the course of the mural barrier (POULTER 2009, 120), usually some 15–45 m to the south (HANSON – MAXWELL 1986, 83). Certainly, it was part of the original plan of the frontier, as it crossed straight through most of the forts on the Antonine Wall, forming their *via principalis* (the most noteworthy exception being Bar Hill – MACDONALD – PARK 1906, 2–3; although the same can be said about Cadder – CLARKE 1933, 7–8 – and Duntocher – ROBERTSON 1957, 44–46, see p. 34–35). The builders of the Military Way thus knew the exact positions of the gates of individual forts, which were already standing or were in the process of construction when the precise line of the road was being planned.

The Military Way was 4,9 m to 5,4 m wide and consisted of large stones at the bottom and a fill of smaller stones and gravel in the upper layers (e.g. Croy Hill, Section No. II - Glasgow Archaeological Society 1899, 50–54 or Croy Hill, Section No. VI – Glasgow Archaeological Society 1899, 57–59). Kerbs were relatively hard to distinguish from other stones in the fundament and only in one example has paving been documented (Glasgow

Archaeological Society 1899, 149). Sometimes the road was accompanied by drainage ditches (e. g. Cleddans Road – STRACHAN 2000, 92 or Nethercroy – KEPPIE – BAILEY – DUNWELL – MCBRIEN – SPELLER 1995, 647–648), but not in all cases (e.g. near Inveravon - DUNWELL – RALSTON 1995, 535 or at Callendar Park, Falkirk – RANKOV – HASSALL – TOMLIN 1982, 338). Variations in the construction of the Military Way were indeed considerable, as in some places the whole stone superstructure of the road was built on layers of turves (e.g. near Rough Castle - KEPPIE 1975, 53), while in others an extra spine in the middle of the road has been identified, consisting of larger stones marking the centre of the road (e.g. in Callendar Park - RANKOV – HASSALL – TOMLIN 1982, 338), or stakes or posts as revetments (e.g. again in Callendar Park – RANKOV – HASSALL – TOMLIN 1982, 338 or KEPPIE – WALKER 1982a, 5). From the above it is evident that Roman builders were highly adaptable to local conditions in the case of the Military Way and the only constant they tried to follow was the sinuous course of the line of the Wall, which they followed with few shortcuts (POULTER 2009, 120). The width of the road mentioned above generally corresponds to the dimensions of similar roads along Roman frontiers (SCHALLMAYER 2010, 39, 128), despite in the case of Odenwald Limes the foundations of the Military Way were less substantial (see p. 158–160, 180).

2.2.11 *Construction of the Antonine Wall – the river and stream crossings*

Significant river crossings on the course of the Antonine Wall were apparently protected by forts on their eastern banks (Inveravon on Avon and Balmuildy on Kelvin, see Fig. 3). Evidence for bridges is much shallower than in the case of Hadrian's Wall (BIDWELL – HOLBROOK 1989). Smaller streams, usually tributaries of the Kelvin or the Carron, did not have any special protection via permanent installations, but the builders at least aligned the Wall towards river crossings in order to traverse them more easily. These smaller streams were canalised and culverted, probably accompanied by a certain form of walkway for a Military Way, as the only known bridge over these smaller streams was located at Polmont (BAILEY 1996, 355–360). It is likely that there were regular bridges over the two larger rivers – the Avon and the Kelvin (ROBERTSON 1974, 94–97, KEPPIE – WALKER 1982b, 29) – although unequivocal evidence for their existence has never been found. The river crossings may have been managed via fords too (BAILEY 1996, 366).

2.2.12 *Construction of the Antonine Wall – the watch/signal towers*

Beyond all the documented parts of the Antonine frontier in present-day Scotland mentioned so far, several more have been expected or postulated but never found. Unlike Hadrian's Wall, the Antonine Wall had no *vallum* and indeed all indications suggest that one was never planned

on this frontier (see p. 68, 133), although some oppose this point of view (BAILEY 1994a, 300). Moreover, no representative Limes gate has ever been discovered and the fortlet at Watling Lodge can hardly be compared with monumental Limes gate in Dalkingen (see p. 70–71).

For a long time, watch/signal towers were expected or postulated as either incorporated into the rampart of the Antonine Wall (as the turrets were incorporated into the turf part of the original Hadrian's Wall – BREEZE – DOBSON 2000, 34–37), or originally located some distance behind the rampart, akin to the watchtowers on the ORL (BAATZ 1975, 40–42) or elsewhere. Currently only one Roman watchtower is known from the Antonine Wall at Garnhall. This watchtower had relatively standard proportions and dimensions (despite being poorly preserved) and was surrounded by a ring ditch, similar to its ORL or Gask Ridge counterparts (WOOLLISCROFT 2008, 164). It was aligned with the course of Antonine Wall and Military Way (lying just 5 m from the southern edge of the rampart and having its ditch cut by the construction of the Military Way, which obviously originally tried to bypass the watchtower – WOOLLISCROFT 2008, 132–133, illus. 4) and therefore it can be postulated that it was built in Antonine period, although exact dating evidence via pottery or coins is missing. Instead, one has to rely only on four fragments of Roman glass, probably of Antonine dating, as the only dating evidence (WOOLLISCROFT 1994, 61). Garnhall is discussed further on p. 110, 114–115, 217, 137 and 266.

Another site of a possible watchtower was Callendar Park, Falkirk, where a structure embedded into the rampart of the Antonine Wall itself has been interpreted as a turret or watchtower (BAILEY 1995, 585–589). Nevertheless, its positioning, the absence of any postholes penetrating underneath the rampart itself, the presence of hearths in the vicinity as well as the existence of defensive pits or *lilia* in front of the rampart on a berm, all indicate that something Roman was present there, but identification as a watchtower should not be assumed on the limited evidence still (HANSON 1999, 47).

Despite in the general terms of the north-western provinces one may roughly divide watchtowers into two subcategories (wooden or timber watchtowers and stone ones – WOOLLISCROFT 2017, 215), there also remain structures standing somewhere in between, like the early watchtowers of the Odenwald Limes (e.g. WP 10/08 – SCHALLMAYER 2010, 81 or WP 10/28 – FABRICIUS 1935, 42). What should we expect on the Antonine Wall? It is reasonable that if ever present on the here, the watchtowers were made of turf or timber, as stones leave a distinctive trace (see p. 161, 179–181), which would undoubtedly have been identified by now. Despite there being stone turrets on the turf section of Hadrian's Wall, no such installations

have ever been found on the Antonine Wall. The study presented below shows that in order to operate as an effective signal post, Garnhall watchtower should have been at least 9 m to be intervisible with its neighbouring installations like the forts at Castlecary or Westerwood (see Fig. 4). This figure is in accordance with the presumed height of Roman watchtowers in general, ranging between 8 m and 12 m in height, depending on the region and the form (or absence) of roofing (WOOLLISCROFT 2017, 216).

To summarize the topic – only one watchtower was positively identified on the Antonine Wall. Despite more were expected, none were positively identified and the probability of finding such structures in immediate vicinity of the Antonine Wall is low with regard to the modus operandi suggested for the Antonine Wall below (see p. 259–267).

2.2.13 *Construction of the Antonine Wall – general discussion*

How exactly the frontier was built nevertheless still remains unclear. It has been suggested that the construction of all the features of the linear barrier may have taken place more or less simultaneously, notably because the construction of the Military Way may have been connected with the establishment of the stone base of the Wall itself, as they were both built from same material (HANSON – MAXWELL 1986, 133).

Certainly, the erection of the Wall itself (not laying the foundations) took place at the same time as the construction of most of the fortlets (HANSON – MAXWELL 1986, 93), while some forts were already built or at least partly finished when the wall builders reached them with the construction of the mural barrier (POULTER 2009, 121). The fact that the forts at Mumrills, Castlecary, Balmuildy and Old Kilpatrick preceded the construction of the Antonine Wall has been known since the excavations of their defences (STEER 1963, 94–96; CHRISTISON – BUCHANAN 1903, 278; MILLER 1922, 6–7; MACDONALD 1932, 220–30). Together with the unexcavated fort at Auchendavy (BREEZE 2008, 81–82), these forts were traditionally considered “primary” because their construction started either before or during the building of the Antonine Wall. To these military installations was traditionally also added Bishopton (or White Moss), Bar Hill, Camelon and Carriden, but because they did not share their northern wall with the Antonine Wall (or were never excavated properly), their stratigraphic relationship to the construction of the barrier across the Forth-Clyde isthmus cannot be examined (see Fig. 3). Recently it has been suggested that the Roman fort at Falkirk may be counted among the primary forts as its walls were of earlier construction than the rampart of the Antonine Wall (BAILEY 2008, 84), although additional verification is still needed since not even the exact proportions of this fort are known yet (see p. 28).

The second group of forts on the Antonine Wall generally consisted of forts whose construction started after the curtain Wall was at least partially finished. Namely, these were Inveravon (DUNWELL – RALSTON 1995, 530), Rough Castle (MACDONALD 1934, 219), Westerwood (MACDONALD 1933, 277–86), Croy Hill (MACDONALD G. 1932, 247), Cadder (CLARKE 1933, 9–10), Bearsden (BREEZE 2016, 16) and the only partially excavated Kirkintilloch (ROBERTSON 1990, 79–80) together with unexcavated Castlehill (HANSON – MAXWELL 1986, 105; see Fig. 3). In last two mentioned cases the stratigraphic relationship between the Antonine Wall and the northern wall of the forts again remains unknown, but it has generally been presumed that they were of later date than the erection of the mural barrier. A special case is the Duntocher site, where the fort was preceded by a fortlet, but both of these structures preceded the construction of the Antonine Wall (ROBERTSON 1957, 11–16, see p. 31, 33).

Recently, however, debate has emerged regarding the increasing amount of evidence suggesting that all the forts on the Antonine Wall (with the exceptions of Croy Hill and Duntocher – HANSON – MAXWELL 1986, 109) were primary in the intention of the builders and secondary only in construction (ROBERTSON 1990, 29–30; HANSON – MAXWELL 1986, 109; POULTER 2018, 123–138). This may be because they were of lower priority (POULTER 2009, 120–121). This topic will be further discussed in relation to the results of the spatial analyses (see p. 144).

2.2.14 *Forts – their sizes and garrisons*

As mentioned above, forts on the Antonine Wall were integral and nodal parts of the frontier, the vast majority being probably planned among the first components of the system, together with the general direction of the frontier line (POULTER 2009, 118, POULTER 2018, 138). Some seventeen installations can be counted among them. They differed not only from other Roman auxiliary forts in the same time period and region of northwestern provinces, but also from Roman auxiliary bases in general (see p. 26, 29–30). The list includes (from east to west) Carriden, Inveravon, Mumrills, Falkirk, Rough Castle, Castlecary, Westerwood, Croy Hill, Bar Hill, Auchendavy, Kirkintilloch, Cadder, Balmuildy, Bearsden, Castlehill, Duntocher and Old Kilpatrick. Fifteen of these shared their northern wall with the Antonine rampart, similarly (but not exactly as some were built at the same time as the Antonine Wall, hence their northern wall was integrated into the rampart itself from the very beginning) to the forts secondarily added to Hadrian's Wall (e.g. Drumburgh, Great Chesters, Carrawburgh and Birdoswald). Those not

sharing their northern wall with the Antonine Wall rampart were Carriden and Bar Hill, lying in the (immediate) vicinity of the barrier.

Some installations were added to the Antonine frontier system for needs of further interpretations via spatial analyses, namely the seaside forts at Bishopton and Cramond and the outpost fort at Camelon. Forts further to the north (namely Ardoch, Strageath and Bertha), which have also been positively identified as Antonine (CHRISTISON – CUNNINGHAM – ANDERSON 1898, 453–468, FRERE 1989, 126–131, WOOLLISCROFT, 1999, 73), are mentioned here only from a strategic or corroborative point of view and are not examined in an archaeological way in this thesis, mainly due to their physical detachment from the Antonine Wall. For the same reasons, the forts at Bothwellhaugh and Inveresk, the first known Antonine forts inland south of the Antonine Wall, are not included, as they were simply too far away from the frontier.

The size of the forts (the interior encompassed by a rampart and a ditch or ditches) varied considerably from some 0,2 ha at Duntocher (ROBERTSON 1957, 33) to 2,6 ha at Mumrills (MACDONALD – CURLE 1929, 406). With such broad variation it is of course tempting to reassess the function of the permanent military base. In light of the evidence from Vindolanda, it has been long time disputed whether the complete auxiliary unit was actually supposed to be positioned as a whole in one place on a long-term basis and at the same time a question has arisen as to whether just one unit was to occupy one fort (BIRLEY 2002, 61). Evidence from the Antonine Wall, a relatively short-lived frontier, suggests fairly large-scale troop movement among the bases, which could not house the whole auxiliary unit (see directly below).

More than one unit occupied at least three forts on the Antonine Wall (Mumrills, Castlecary and Bar Hill), while there is evidence for the long-term presence of legionaries on certain relatively small outpost forts on the Wall (most notably in Castlecary but also at Westerwood, Croy Hill and Auchendavy). These occupations could have been successive (SPEIDEL 1987, 233–237 *contra* HODGSON 1995, 29–49) but the inconclusive evidence also points to a possibility that at least at certain periods of time the garrisons were relatively mixed (KEPPIE 2006, 1136), which was not entirely uncommon in the Roman army in respective period (HASSAL 1998, 36–38). This proposition is reinforced by the fact that some buildings in the forts were constructed by auxiliaries despite the forts being mostly erected by legionaries, just like the Antonine Wall (MAXWELL 1974, 331).

The primary source of evidence about the garrisons of the forts on the Antonine Wall is epigraphy, comprising either altars or tombstones, which were probably located in the vicinity

of respective installations (ANDERSON 1984, 10–14; KEPPIE 1991, 63, 94). Building inscriptions usually referred only to a unit participating in either the construction of the fort or some of its buildings. A certain number of them can be related to repairs, which were conducted both by specialised construction teams of legionaries and soldiers of auxiliary units actually stationed at the forts (KEPPIE 1983, 56, and also p. 244–245).

At Mumrills (fort with its defences occupied 2,9 ha, available internal space was 2,6 ha – Pl. 7) there is evidence of regiments of the *Ala I Tungrorum quingenaria* and the *Cohors II Thracum quingenaria equitata*. The first unit erected there an altar to Hercules Magusanus (RIB 2140), while the second left behind a tombstone of one of their soldiers, Nectovellius, son of Vindex (RIB 2142).

Two inscriptions from Rough Castle (fort with its defences occupied 0,6 ha, available internal space was 0,5 ha – Pl. 5) document the presence of the *Cohors VI Nerviorum quingenaria*, RIB 2144 and RIB 2145, the first of which (an altar to an unknown deity) records that the soldiers deployed here were under the command of Flavius Betto, centurion of the Twentieth Legion, while the second commemorates the construction (or reconstruction) of the *principia*.

From Castlecary (fort with its defences occupied 1,6 ha, available internal space was 1,4 ha – Pl. 8), eleven inscriptions are known, of which only six say anything about the garrison of the fort. Three altars (RIB 2146, RIB 2148, RIB 2151) attest to the presence of a *vexillatio* of soldiers from the Sixth Legion, with one additionally referring to the presence of a *vexillatio* from the Second Legion. One altar to Neptune mentions the *Cohors I Vardullorum milliaria equitata* (RIB 2149), while another, dedicated to an unknown deity, probably refers to the *Cohors I Batavorum quingenaria* (RIB 2154). The last attributable inscription from Castlecary is the dedication slab from some (unknown) building, erected by the *Cohors I Tungrorum milliaria* (RIB 2155).

The single piece of epigraphical evidence about the garrison of the fort at Westerwood (fort with its defences occupied 1 ha, available internal space was 0,8 ha – Pl. 13) consists of an altar to celestial Silvanus and Quadriviae, dedicated by Vibia Pacata, wife of Flavius Verecundus, centurion of the Sixth Legion (RIB 3504).

Similarly, the situation at Croy Hill (fort with its defences occupied 0,8 ha, available internal space was 0,6 ha – Pl. 6) is complicated, as out of the seven inscriptions found, only four say anything about the garrison. The only surviving evidence speaks for the presence of a

legionaries, as all the stones found mention the Sixth Legion (RIB 2160, RIB 2161, RIB 2162, RIB 2163). Legionary presence indicates also the relief stela of a tombstone found nearby the fort (COULSTON 1988, 1–29).

At Bar Hill (fort with its defences occupied 1,4 ha, available internal space was 1,3 ha – Pl. 1), again two units are evidenced: the *Cohors I Hamiorium quingenaria*, of which the altars and one tombstone remain (RIB 2166, RIB 2167 and currently lost RIB 2172) and the *Cohors I Baetasiorum quingenaria*, which erected only one altar there (RIB 2169) and probably participated in the reconstruction of *principia* (KEPPIE 1983, 56), demonstrated through a dedication slab found in the fort well (RIB 2170). A commemorative slab (RIB 2171) also hints that at least for a brief period, the *vexillationes* of the Second and Twentieth Legions were present at this fort. The remaining four inscriptions found at the site or close by have offered no hints about their dedicators (RIB 2165, RIB 2168, RIB 2187 and RIB 2321).

From the ten inscriptions found in the vicinity of a fort at Auchendavy (fort with its defences occupied 1,2 ha, available internal space was 1,1 ha – Pl. 14), seven can be linked with the Second Legion: four altars (RIB 2174, RIB 2175, RIB 2176 and RIB 2177), two tombstones (RIB 2179 and RIB 2181) and one dedication slab (RIB 2180). The remaining three inscribed stones are fragmentary and vital information cannot be obtained from them (RIB 2178, RIB 2182 and RIB 2183).

At Cadder (fort with its defences occupied 1,3 ha, available internal space was 1,1 ha – Pl. 2), the evidence is dubious at best, consisting of a small fragment of a commemorative slab, from which can be deciphered the name of the Second Legion (RIB 2188), although other interpretations are still possible. No other inscription save for one distance slab (RIB 2186) and one altar (RIB 3505) were found in vicinity of fort at Cadder.

At Balmuildy (fort with its defences occupied 1,7 ha, available internal space was 1,6 ha – Pl. 4), two commemorative slabs evidence a *vexillatio* of the Second Legion (RIB 2191, RIB 2192), while at Castlehill (Pl. 16, fort with its defences occupied ca 1,4 ha, available internal space was ca 1,3 ha, based on the limited archaeological evidence – Keppie 1980, 80–84 – and Roy’s plan – ROY 1793, PL. XXXV) an altar dedicated by soldier of *Cohors IV Gallorum quingenaria equitata* was found (RIB 2195). At Bearsden (fort with its defences occupied 1,2 ha, available internal space was 1 ha – Pl. 3), only one building stone hints that at a certain point there were present soldiers of the Twentieth Legion (RIB 3506), despite as a garrison is traditionally suggested cavalry (BREEZE 2016, 330–344).

At the westernmost fort on the Antonine Wall, Old Kilpatrick (fort with its defences occupied 1,9 ha, available internal space was 1,7 ha – Pl. 9), another altar of the *Cohors I Baetasiorum quingenaria* has been discovered (RIB 3509). The forts at Carriden (fort with its defences occupied 1,8 ha, available internal space was 1,6 ha – Pl. 18), Inveravon (fort was apparently small, internal or external dimensions are precisely unknown – see p. 57, 62, 74, 80), Falkirk (internal or external dimensions of this fort are also unknown, the area occupied by it is estimated either to 0,9 ha or 1,4 ha – FRERE, S. S. – HASSALL, M. W. C. – TOMLIN, R. S. O. 1992, 262–263; Pl. 12), Kirkintilloch (fort with its defences occupied 1,4 ha, available internal space was 1,3 ha – Pl. 15) and Duntocher (fort with its defences occupied 0,26 ha, available internal space was 0,2 ha – Pl. 17) have never yielded any inscriptions mentioning particular units. The same can be told about the fort at Bishopton (this fort occupied approximately 1,6 ha – WRIGHT 1953, 87). At Camelon (fort with its defences occupied 2,7 ha, available internal space was 2,4 ha – Pl. 11) only one building inscription has been found, mentioning the construction of an unspecified building by a detachment of the Twentieth Legion (RIB 2210). Another confusing situation can be noted at Cramond (fort with its defences occupied 2,4 ha, available internal space was 1,9 ha – Pl. 10), where there is evidence of building activity by *vexillatio* of both the Second (RIB 2137) and Twentieth (RIB 2210) Legions as well as presence of two auxiliary units, namely the *Cohors V Gallorum quingenaria equitata* (RIB 2134) and the *Cohors II Tungrorum quingenaria equitata* (RIB 2135) via altars.

An interesting link can be made between the size of the forts and their garrisons: forts like Rough Castle, Westerwood and Croy Hill strongly resemble in size the so called Numerikastellen, bountifully evidenced on the Upper-German Limes, mostly on its Odenwald section. However, there is currently no indication that there were any numeri units on the Antonine Wall. Indeed, the conclusion that can be drawn from current evidence is far more simple: certain stretches of the frontier did not require the permanent presence of whole units. Thus, it appears that the division of individual units could have been made and the frontier was still controlled in order to save manpower. As an alternative scenario, extra *vexillationes* were called from the hinterland and legionaries controlled these marginal outposts, either as a few officers commanding unknown units or in small detachments.

The motivation behind such an organisation could have been the scarcity of population to control, although on the other hand this may have created an urge to occupy the region more densely (but without formidable force), as there were no local authorities upon which to rely (BREEZE 1990, 85). At the same time, this can be perceived as a form of rationalisation: there has been a great deal of inspiration transformed to the Antonine Wall from its predecessor in

the south, the Hadrian's Wall, where the forts were placed alongside the wall in more or less regular spacing (BREEZE – DOBSON 2000, 18). Rationalization can be perceived via the fact that distance formula was not much applied on the Antonine Wall, despite it has been looked for quite some time and several theories were offered (GILLAM 1975, 51–6 - HANSON – MAXWELL 1986, 86–87, also see p. 73–79, 143). Instead, in the case of the Antonine Wall, a system of smaller and bigger military installations can be perceived, in which the former were no doubt the outposts of the latter. The flexibility of the Roman approach was further apparent in the addition of annexes, which will be considered further (see p. 62–66). All in all, such a military deployment did not seem to have represented an afterthought. Professor Keppie has presented some evidence that the Antonine Wall garrison was just a reduced version of the original plan (KEPPIE 2006, 1135–1146). A further interpretation and explanation of these motivations are offered below in the context of spatial analyses and conclusions, since it cannot be solely clarified via epigraphy and forts sizes (see p. 87–88, 259–267).

2.2.15 *Forts – the defences*

There is no regularity in the disposition of defensive ditches around the forts on the Antonine Wall. Of the total seventeen forts, only at Inveravon no ditches were found yet (CFA 1992, 11–12). From all the other, none had the standard number of two ditches around the fort, as was typical of an auxiliary fort in the second 2nd century AD (JONES 1975, 104–116).

At Carriden three parallel ditches were discovered east of the fort, but the rest of the fort was never excavated (ST. JOSEPH 1951a, 167–168). Mumrills had only one ditch to the north and to the south, but two to the east and as many as four to the west (MACDONALD – CURLE 1929, 415–420). At Falkirk three ditches east of the fort were discovered in similar spatial disposition as at Rough Castle, but the rest was never investigated (FRERE – HASSALL – TOMLIN 1992, 262–263). Rough Castle and Castlecary possessed two ditches on all sides except for to the east, where they had beside an annexe an extra ditch (CHRISTISON – BUCHANAN 1903, 273–277; BUCHANAN – CHRISTISON – ANDERSON 1905, 444). Almost unexplored fort at Westerwood was circumvented by two ditches on all sides (MACDONALD 1933, 284). Croy Hill fort was separated from the surrounding area to the north and east by just one ditch, while at the same time being protected by three ditches to the west and south (MACDONALD 1937, 36). Especially noteworthy is the case of the free-standing fort at Bar Hill, which was circumvented by two ditches on all sides except for the potentially most vulnerable northern one, directly facing the Antonine Wall, which was protected only by a single ditch (MACDONALD – PARK 1906, 27–33). Fort at Auchendavy was probably originally circumvented by three ditches, but

documented was only briefly the eastern section of defences, while in the west either only one ditch survived, or the other two were never provided there (KEPPIE – WALKER 1985, 29–33). It is possible that fort at Kirkintilloch fort had originally three ditches, but these were somehow confirmed only on the southern side (KEPPIE – BAILEY – DUNWELL – MCBRIEN – SPELLER 1995, 650–654). At Cadder, the interpretation of the original situation is unclear, as the traces of the second western ditch may have been destroyed during the works on the Forth-Clyde Canal. Otherwise, the fort was provided with two ditches to the east and south as well as one in front of the northern wall (CLARKE 1933, 22–34). Balmuildy was generally protected by three ditches to the west and south, while only two divided it from the annexe to the east and in the north the Wall shared with the Antonine rampart was furnished with just one ditch (MILLER 1922, 4-6). The highly atypical fort at Bearsden had three ditches to the west but none to the east if we consider the annexe as a separate feature. Nevertheless, this would be illogical because only the southern ditch encompassed Bearsden without a break between the fort and the annex, only to be divided into two ditches when passing by the south-eastern corner. Again, in front of the northern wall was just one ditch (BREEZE 1973, 63–64). Like in Bearsden, Duntocher's annexe was also comfortably encompassed by the ditches. The southern and eastern sides of the fort were protected by three ditches, while the western wall of the fort was in fact not divided by a ditch from the annexe, but; rather, the annexe itself was divided from the extramural area by a single ditch (ROBERTSON 1957, 39–43), like in the case of Bearsden. At Old Kilpatrick, the number of ditches was again excessive. Four were dug on relatively weak sides, to the north (towards the Military Way) and west (towards the area behind the Antonine Wall), while only two existed in the south and east (MILLER 1928, 4–9). In Cramond fort the limited excavations so far discovered only two ditches on the eastern side of defences of the fort. Nothing is known about the ditches on any other side (HOLMES 2003, 3). At Bishopton the fort at so-called Whitmoss remains largely undocumented. Limited trenching revealed four ditches in front of the southern rampart of the fort but the overall organization of defences on this site remains unknown (STEER 1951, 31). The situation of the free-standing fort at Camelon is difficult to evaluate thanks to the provision of two separate annexes, but if we omit them, the northern and eastern sides of the fort were protected by one ditch, while in the south and west the fort had two ditches (BUCHANAN 1901, 355–357).

Based on the presented evidence, no general coherent pattern can be seen. At first glance, the provision of extra ditches may have been related to drainage, but local topography often does not correspond that point of view (BREEZE 2002, 885). There may have been attempts to divide the forts more extensively from the annexes, as at Mumrills, Castlecary and

Balmuilty, but this stands in sharp contrast to the situation in Bearsden and Duntocher, where the annexes were not divided by a ditch at all. Even if this were the westernmost sector speciality, Rough Castle had two ditches facing the annexe in the east and three ditches in the west facing a small stream and expansion at Bonnyside East. An overall emphasis on defence does not provide the answer either, as the ditches were not located alongside the obvious weak spots (as in the case of Bar Hill) and their irregular distribution around the fort diminished their usefulness as they could have been relatively easily bypassed (if we accept the fact that the existence of four ditches presented significant defensive improvements to the presence of just three). The overall conclusion may therefore be that the number and the distribution of ditches respected no predefined or decipherable formula and were probably affected by the individual decisions of individual fort builders, who were not subjected to obligatory standards in terms of the number and the disposition of camp defences. Interesting is in this topic comparison with ORL, especially with Odenwald Limes, where same number of ditches had all the small forts – only one, with exception of fort at Wörth (see p. 162–176).

The rampart width of individual forts along the Antonine Wall ranged roughly according to their overall size and importance. Only the walls of the forts at Castlecary and Balmuilty were made from stone; all the other forts (like all other installations on the Antonine Wall) were constructed from the same material as the Antonine rampart itself. The width of turf ramparts ranged from 3,7 m to 6 m (HANSON – MAXWELL 1986, 86), although the stone walls of two of these forts were naturally thicker (2,4 m in average in the case of Castlecary - CHRISTISON – BUCHANAN 1903, 291; and 2,3 m on average in the case of Balmuilty - MILLER 1922, 7–8). The absolute height of a fort's walls could not be reasonably reconstructed. From a logical point of view, they could have been either equal or higher than the rampart of the Antonine Wall. For Balmuilty, the height of the stone wall has been reconstructed as almost 5 m above the ground level, with a walkway 3,4 m above the ground (more or less the postulated height of the Antonine Wall rampart). However, these figure are largely conjectural because only two layers of stone have been found, reaching approximately 0,6 m above the original surface (MILLER 1922, 7–8).

The situation is not much better in cases of forts with turf ramparts. Only three layers of turf have been recorded at the western rampart of Bearsden fort (BREEZE 2016, 25) and the situation here was similar to most of the other forts. Only at Rough Castle did the rampart survive to a substantially greater extent, at the western section of the fort being up to 1,37 m above the ground, thus revealing that it was made of at least eighteen layers of laminated turf (MACIVOR – CLARE – BREEZE 1979, 233–236). Due to the similar width of the rampart stone

bases of the Antonine Wall and its forts (see p. 19–21), the same height should be expected for the fort walls as for the Antonine Wall. This compels us to question the existence of any walkways on the walls of forts for the reasons already mentioned in the case of the Antonine Wall: to date there is no direct evidence (as the only was interpreted the thickening of the rampart, related with desire to increase the security of such walkway, which was attested at Cadder and Duntocher forts. This have been already questioned via corroborative evidence from Rough Castle as unrelated to the support of mentioned feature by Hanson and Maxwell – HANSON – MAXWELL 1986, 92). Even though the furnishing of the forts with such a platform makes much more sense than in the case of nearly 60 km of the whole Antonine Wall, so far the only piece of evidence for the existence of a walkway comes from an artistic depiction of a Roman camp at Trajan’s Column (ANTONESCU 2009, 130, Fig. 15 = Scene XXXII).

Fort defences were further strengthened by sentry towers. These are known thanks to the excavations of the south-western corner of Castlecary fort (CHRISTISON – BUCHANAN 1903, 317–320) and the south-eastern corner of Balmuildy fort (MILLER 1922, 16–17), but the only turf-walled fort to yield any evidence of them is Old Kilpatrick, where at the south-eastern and south-western corners of the fort, postholes have been discovered in a cobbled area (Pl. 9), indicating the presence of timber superstructures such as towers (MILLER 1928, 4).

All the forts on the Antonine Wall had four gates, with the possible exception of Bearsden and the known exception of Duntocher, which thanks to its unique evolution from a fortlet was provided only with three gates in the north-eastern, south-eastern and north-western section walls. Instead of a south-western gate inserted into a rampart, only a stone platform covered by burned material, which was unfortunately too narrow to be considered as a tower base, has been found (ROBERTSON 1957, 51–52).

Gates were apparently simply constructed, leaving only shallow traces in the form of postholes and gaps in the sequence of ditches in front of the rampart. That is how they were identified for the needs of analyses in artificial environment, since the gaps in the course of the ditches were frequently visible on the LIDAR still (Table 2). Sometimes, though, not even gaps were provided; exceptions being the southern gates of smaller forts like Westerwood, Croy Hill and Bearsden; the same absence of a gap has also been documented at the western gates of Bar Hill and Cadder. While in the case of the first three examples it can be presumed that the absence of a break in the ditch was connected with the fact that the southern gates were simply not used, it would be strange to propose the same for the *porta principalis sinistra* of a larger fort like Bar Hill. An explanation may be offered in terms of the existence of the Military Way in the

vicinity of the fort. Indeed, in the case of Bar Hill, this cardinal road bypassed the site a long time in advance and therefore did not form its *via principalis*, instead being routed through the gap between the fort's northern rampart and the Antonine Wall (Pl. 1). In the case of Cadder, the explanation is a bit simpler, as the fort was rotated 90° to the position of the other forts alongside the Antonine Wall (CLARKE 1933, 7). The blocked gate was therefore not the *porta principalis sinistra* but the *porta decumana*, the same gate blocked in the cases of the above-mentioned forts and also in the case of similar sized forts on the Odenwald Limes (see p. 162–163). The Military Way again bypassed this fort in advance (Pl. 2). Thus, despite the fact that many forts were originally laid out in line with the general course of the road, at least two were positioned differently. An explanation of this oddity will be offered below (see p. 105).

The gates in the forts of the Antonine Wall were probably provided with at least a bridge above the gap in the defensive rampart or by simple towers, despite only the limited evidence for that exists (HANSON – MAXWELL 1986, 90–93). In fact, the only sites where the fort gates could be reconstructed were again the stone forts at Castlecary and Balmuilty, mainly because the excavations of turf-and-timber forts in late 19th and early 20th century could not detect shallow traces left after the deliberate demolitions of gates by departing Roman soldiers. Relatively simple stone gates were built at Castlecary, projecting only slightly outside but significantly inwards of the fort wall (CHRISTISON – BUCHANAN 1903, 293–294). Much better is the example of Balmuilty, where not only did the *porta praetoria* have a guardhouse in the gatehouse itself (MILLER 1922, 7), but the gate was furnished with a monumental commemorative slab of the Second Legion (RIB 2192), which built the fort (KEPPIE 1976b, 99–102). The roofing and the height of the gate towers can only be estimated. In the case of Balmuilty, it is likely that the walkway was at least 3,7 m above ground level, slightly higher than the surrounding fort walls according to the excavator (MILLER 1922, 19).

2.2.16 Forts – the internal road system

The internal arrangement of all the forts on the Antonine Wall was dictated by the street network. This was to a certain extent even in the relatively small forts like Rough Castle a reflection of the pseudo-Hyginus plan as described in *De Munitionibus Castrorum* (Hyginus, *De munitionibus Castrorum* 12, 14, 18), along with a certain number of modifications, some of which were not entirely common in standard Roman auxiliary forts.

The crossing of the *via principalis* and the *via praetoria* was a cornerstone of establishing the vast majority of Antonine Wall forts and the positions of gates (defined also this way) were cornerstone for surveying of the whole frontier (see p. 124–127). Even if the

roads inside the fort were not detected or explored, the disposition and layout of internal buildings usually corresponded with their existence in relatively standard alignment. This was true even in cases of forts like Bar Hill (Pl. 1) or Cadder (Pl. 2), where the roads going respectively to the *porta decumana* and *porta principalis dextra* did not fulfil their primary function because the passage through them was blocked. The same was true in Bearsden (Pl. 3), where the attested road was laid out towards the *porta decumana* despite no gates was provided in the rear of this fort (BREEZE 2016, 258).

Larger forts like Cadder (Pl. 2) or Balmuildy (Pl. 4) had *retentura* further divided by another road, *via quintana*, into two halves. Smaller forts like Rough Castle (Pl. 5) or Croy Hill (Pl. 6) were, however, formed just by crossing the *via principalis* and *via praetoria*, like Numerikastellen on the Continent. The only other road provided inside was the so-called *via sagularis*, the peripheral road around the inner side of the defences and that should be expected even in the smallest forts

2.2.17 Forts – the headquarters (principia)

In general terms, a *principia* or the headquarters on northern frontiers in the 2nd century AD can be described as a stone building defined by a courtyard with an attached *basilica* in the rear. Its position was defined by a crossing of *via principalis* and *via praetoria* in the very centre of the fort, as it was in the case of all Antonine Wall forts with the exceptions of Bearsden and Duntocher (see Pl. 3 and 17). The courtyard was enclosed with a portico and sometimes in one of its corners a well was dug. The back of the *basilica* was formed by three or five administrative rooms, of which the middle one was called the *aedes* (see also p. 274–277). Aside from the complicated case of Bearsden, all the headquarters buildings on the Antonine Wall had stone-founded walls and were roofed by tiles, unlike on the Odenwald Limes (see p. 164).

All the thoroughly excavated forts except for the already mentioned Bearsden and Duntocher had *principia* in their centre (Mumrills, Rough Castle, Castlecary, Croy Hill, Bar Hill, Cadder, Balmuildy and Old Kilpatrick). The exact name used by the Romans for the headquarters is known thanks to the finding of a dedication slab during the excavations of Rough Castle fort in 1903 (BUCHANAN – CHRISTISON – ANDERSON 1905, 470–472), on which it is stated that the *principia* was built by the *Cohors VI Nerviorum quingenaria* (RIB 2145). Although at forts like Carriden, Inveravon, Falkirk, Westerwood, Kirkintilloch or Castlehill, proper excavations able to find the headquarters never took place, or the sites were so considerably damaged by modern development that this is no longer possible today, the situation is more complicated at Bearsden and Duntocher.

At Bearsden, certain features were identified roughly in the middle of the fort, possibly the wings of the courtyard of the headquarters, but the evidence was rather shallow and interpretations varied over time, from being seen as a camp workshop through a *praetorium* to a *principia*. If the last interpretation were to be accepted according to the excavator's suggestion, Bearsden would be rather unique among the forts on the Antonine Wall, being the only one fort on the Antonine Wall with a timber headquarters measuring some 23,5 m along the north-south axis and 19,7 m along the east-west axis (Pl. 3). The courtyard and western wall of the *basilica* were identified with certainty via postholes (BREEZE 2016, 262–264), but the building still seems to be partially incomplete in comparison to the standard headquarters and could in theory be identified as a provisional substitute of several official buildings at once. This building was not comparable with timber-built *principia* at Hesselbach (see p. 164) or Wörth forts (see p. 168–170).

Even more complex is the situation at Duntocher, where in the centre of a small fort was situated a structure resembling a barrack block, oddly with foundations typical for stone buildings. It was 19 m long and 6,7m wide and it was divided at least once laterally and several times longitudinally (Pl. 17). On the one hand, the provision of a standard headquarters at Duntocher would have been strange in the case of such a small fort. On the other hand, a surprisingly small rectangular building preceded the potential *principia*, also probably with stone walls, and therefore the spot could be perceived as a place of some importance (ROBERTSON 1957, 53–61). Both buildings at Duntocher can be regarded as minimalised versions of headquarters thanks to their superior position in the centre of the fort and, despite the fact that they do not resemble classical *principia*, they could have performed a similar role for the small detachment located in the smallest fort on the Antonine Wall. The general flaw in this interpretation is the absence of any other buildings inside the fort and the fact that it is based on negative evidence only: the building simply does not seem to be like anything known on the Antonine Wall to date and unfortunately is also not comparable with anything found in the context of the Odenwald Limes or ORL in general, where forts of similar size as Duntocher are frequently counted among fortlets (see p. 177–179, 263–264).

The remaining forts with headquarters have provided most of the information generally known about the forts on the Antonine Wall. At Mumrills the largest *principia* on the frontier was found, having proportions of some 36 m x 30,5 m, thus occupying ca 1100 m² (Pl. 7). Similarly to Castlecary (Pl. 8) and Old Kilpatrick (Pl. 9), the headquarters here had two phases of existence, of which the first was the larger. The building consisted of a courtyard with an internal colonnade, *basilica* and at least three rooms in the back, and possibly even more as the

excavator was unable to define the partition credibly. Subsequent alterations resulted in a smaller building, mostly at the expense of a courtyard, to which rooms were added at the sides and the column colonnade was then moved externally (MACDONALD – CURLE 1929, 421–431). Provision of this exceptional headquarters building together with similar lavish *praetorium* emphasized the significance of Mumrills fort in the context of the whole Antonine Wall (see p. 265, 271)

At Rough Castle, no doubt because the fort was one fifth of the size of Mumrills, a much smaller *principia* was built, encompassing just 180 m² and with a simpler plan that only contained three cells behind the small courtyard (Pl. 5). The centre, where the *aedes* was situated, hid a strongbox for the *aerarium*. On the eastern side of the paved entrance was a hole, possibly a well, into which a stone inscription (RIB 2145) was hidden prior to the definitive abandonment of the fort (BUCHANAN – CHRISTISON – ANDERSON 1905, 470–474).

At Castlecary, the headquarters was excavated only partially and therefore the total width of 26 m is known, while the other dimension can be only roughly estimated as being some 28 m, despite only 10 m of the three southernmost cells being excavated (Pl. 8). Two types of masonry were detected by the excavator, hinting that the *principia* was rebuilt at least once (HANSON – MAXWELL 1986, 138). The courtyard was paved and the rear range had only one partition despite a second being expected. At least two drains led from the rear range to the main street, but whether this was related to subsequent industrial activity cannot be determined with certainty (CHRISTISON – BUCHANAN 1903, 304–308).

An even smaller example of a headquarters was found at Croy Hill (Pl. 6), where the dimensions were 18,5 m to 20,5 m, thus encompassing not even 380 m². Despite its small size, it was provided with a courtyard and two smaller rooms on each side of the *aedes* and during its existence some minor alternations were made, which can hardly be called reconstruction (HODGSON 1995, 47). The floor of the *aedes* was reinforced by timber frames and most of the floors were probably originally flagged (MACDONALD 1937, 36–54).

Perhaps the best-known example of a headquarters from the Antonine Wall was found at Bar Hill (Pl. 1). Here excavations of *principia* took place twice during the 20th century. A relatively modest building of some 600 m² (25,5 m x 23,5 m – MACDONALD – PARK 1906, 436–437) was discovered with a courtyard backed by a cross hall and three rooms in the rear. The headquarters went through several alternations during its existence, the most significant being the transformation of the western part of the courtyard into a storehouse or granary (see p. 58–59). A cross hall or *basilica* fronted in a later stage only the two westernmost rooms of the rear

range, the third was subsequently fronted by another room, paved by large slabs. On a central courtyard was a dais in the south-western corner, from which the commander addressed soldiers during assemblies. The *aedes* in the rear was furnished with an underfloor stone-lined strongbox for the unit's treasury (KEPPIE 1986, 69–70). The single most important group of finds from the whole fort came from a stone-walled well, 1,2 m in diameter in the north-eastern part of the courtyard. Indeed, thirteen *denarii*, twelve arrowheads, one altar (RIB 2169), one building inscription (RIB 2170) and a multitude of architectural stones and smaller metal objects were all deliberately deposited into the well during the orderly evacuation of the fort by Roman soldiers (ROBERTSON 1975, 12–15).

Interesting is the example of Cadder (Pl. 2), where the *principia* was eventually turned into an industrial area (see p. 59). It was supposed to be preceded by another building of similar function, represented only by one pit, rendering this interpretation unreliable (HODGSON 1995, 48). The excavated stone headquarters encompassed 411 m² (23,5 m x 17,5 m) and consisted of a courtyard flanked on two sides by narrow rooms and a cross hall, backed by five small rooms, of which the middle one was the *aedes* (CLARKE 1933, 35–38). No well was found and the floor was flagged. Simply based on the eastern rather than northern orientation of the *principia*, it is evident that Cadder fort was in fact turned 90° right in comparison to other forts on the Antonine Wall. The main gate to the north was thus the *porta principalis dextra*.

At Balmuildy the headquarters was of almost square plan, 25 m x 26 m (650 m²), consisting of a standard *basilica* with a range of five rooms in the back and a winged courtyard (Pl. 4). The left wing of a courtyard was at a certain later stage of the fort's existence rebuilt as a storeroom with buttressed wall foundations (see p. 60). Furthermore, a small walled enclosure was added to the *basilica*, again later during the fort's existence. No well was found, while shallow traces of gravel in the outer court and masonry chippings laid in a bed of clay in the *aedes* represent the remnants of the original floor. The building had glass windows and a tiled roof, as the numerous finds of broken glass and tiles indicate (MILLER 1922, 22–26).

Old Kilpatrick's *principia* occupied some 687 m² (27,5 m x 25 m) and the excavated remains show that it consisted of a courtyard defined by timber posts on all sides and a row of five rooms in the back (Pl. 9). On the courtyard was a well and inside the middle small room (the *aedes*) a small cellar was dug for a strongbox, or the unit's treasury, the *aerarium* (MILLER 1928, 23–28). The headquarters was at least once completely rebuilt (HODGSON 1995, 48–49) and before the end of its existence, a significant part of it was converted into a warehouse (MILLER 1928, 24–25).

Apart from the sites on the Antonine Wall itself, at Bishopton a *principia* has been discovered, that was probably reconstructed or rebuilt several times, although the results of the excavations have never been published in detail (NEWALL 1957, 27).

At Cramond, only a section of insufficient proportions has been explored from the *principia* and therefore it is impossible to ascertain its overall dimensions (Pl. 10). It is however clear that there were several phases of construction and reconstruction of this building (RAE – RAE 1974, 175–178), even if these are difficult to attribute to any specific period, because the site was occupied during both the Antonine and the Severan period (HODGSON 1995, 45–46).

At Camelon was discovered at the beginning of the 20th century a *principia* of more than one 1000 m² (36,5 m x 28 m), its massive walls were buttressed on the northern side. Behind the great courtyard was a *basilica* backed by one narrow room, which could have been divided by partitions into smaller rooms, although no dividing walls were actually found (BUCHANAN 1901, 364–365, Pl. 11).

2.2.18 Forts – house of the commanding officer (praetorium)

A *praetorium* is generally perceived to have been the house where the commander of the unit stationed in the fort resided with his family. Even in northern provinces like *Britannia*, it would have strongly resembled a Mediterranean-style townhouse. At the Antonine Wall, fewer *praetoria* have been found than headquarters and they varied considerably. In general terms, a *praetorium* was defined by a peristyle courtyard with adjacent rooms. Especially in smaller forts, the *praetoria* tended to be more modest, although it seems that most of them were constructed from stone. Some complexes included a private bathhouse, larger *praetoria* were furnished with a hypocaust and plastered walls, though such examples were scarce on the Antonine Wall.

The most elaborate *praetorium* on the Antonine Wall was found at Mumrills (Pl. 7). It stood between one of the two fort granaries and the *porta principalis sinistra* and occupied more than 5 % of the whole area within the fort. Its evolved form was preceded by a timber and wattle-and-daub house of modest proportions, detectable only by a series of postholes. This building was probably destroyed by fire. The succeeding large stone-built *praetorium* had dimensions of 42 m on the east-west axis and 33 m on the north-south axis (more than 1300 m²). It consisted of a large courtyard and 15 rooms, of which at least one was furnished with a hypocaust and private bathhouse (in the south-eastern corner of the building), which was reconstructed at least three times (see p. 45–46). The second and third phases of the baths were

marked by the direct expansion of the bath-suite at the *praetorium*'s expense. This led to the abandonment of several rooms (MACDONALD – CURLE 1925, 434–449). Some rooms were paved. In the north-eastern corner was a kitchen with an open hearth and in the south-western corner were living quarters. Based on the size and the furnishing of the commander's house, it is quite reasonable to assume that the most senior commander on the Antonine Wall resided there (see p. 36–37, 265, 271).

The *praetorium* at Rough Castle was significantly smaller but still occupied around 470 m² of the fort and thus represented the largest building on the site (Pl. 5). Only three rooms around the anticipated (only confirmed via drainage gutters) courtyard were detected during the excavations and floors in certain areas have been flagged. According to the excavator, the building was reconstructed several times (BUCHANAN – CHRISTISON – ANDERSON 1905, 480–481), although it is more likely that mere minor alternations took place instead of a general reconstruction (MACIVOR – CLARE – BREEZE 1979, 282).

At Castlecary, the *praetorium* lay east of the only granary (Pl. 8), but just a fraction of its walls was documented during the excavations at the beginning of 20th century (CHRISTISON – BUCHANAN 1903, 313–317).

Cadder's *praetorium* is relatively hard to interpret despite being extensively excavated (Pl. 2). A house of some 400 m² (19 m x 21 m) was initially built of stone, but no internal partitions survived and the known internal arrangements consisted only of a central courtyard (CLARKE 1933, 44–48). Part of the hypocaust survived in the south-western corner of the building; the succeeding two timber buildings can only be interpreted as workshops (HODGSON 1995, 32–33; see also p. 59).

The commanding officer's house at Balmuildy was located between the eastern gate and one of the granaries, occupying roughly 650 m² (27 m x 24 m, Pl. 4). In plan it was a relatively standard house, with 15 rooms around a gravel central courtyard. The floor in the corridor was made of masonry chippings only. Some rooms were equipped with a hypocaust, which was abandoned and backfilled before the end of the occupation. Further evidence of building activity inside the *praetorium* during its existence consisted of the expansion of one of the southern rooms into a courtyard corridor. Among the finds were abundant sherds of window glass and coarse ware, although surprisingly little *terra sigillata* was found (MILLER 1922, 28–32).

The only other *praetorium* excavated in the study area was at Camelon (Pl. 11), where a house of some six rooms arranged around a courtyard stood between the southern gate and

one of the granaries. This building did not resemble the *praetoria* on the Antonine Wall but may have fulfilled the same function. According to the plan it was rebuilt at least once. The area encompassed by this house was some 970 m² (40,5 m x 27 m) and its floor was probably made of flagstones (BUCHANAN 1901, 363–364).

From the remaining forts the information about any *praetoria* is missing from various reasons. Forts like Carriden (Pl. 7), Inveravon, Falkirk (Pl. 12), Westerwood (Pl. 13), Auchendavy (Pl. 14), Kirkintilloch (Pl. 15), Castlehill (Pl. 16) and Bishopton were not (or could not have been) excavated sufficiently to reveal coherent plan of internal buildings.

At Croy Hill, the excavations revealed almost nothing about buildings other than the *principia*, a granary and an external bathhouse, although MacDonald has proposed that the sheer amount of stone debris in the vicinity of the fort must have come from additional stone buildings inside the fort, *praetorium* included (MACDONALD 1925, 290).

No traces of a *praetorium* have been found during several archaeological investigations at Bar Hill. The area where it was expected was instead occupied by a fort workshop (ROBERTSON 1975, 16; Pl. 1). An early antiquarian account, however, mentions the existence of hypocaust installations near the eastern gate, which was laid open in 18th century (MACDONALD – PARK – ROSS 1906, 452). It is likely that this led to its utter destruction. The shallow material evidence for the existence of a successive workshop (consisting mainly of slag and wrought iron) could then be related to a similar replacement of the *praetorium* by a workshop later in Cadder's existence (see p. 40).

In the case of Bearsden, the ambiguous evidence about the nature and purpose of the central building initially led to the belief that it was a *praetorium* (BREEZE 1984, 47) but today the interpretation inclines more to the *principia* (BREEZE 2016, 262–264). Due to the fact that the *praetentura* in this fort was occupied by barrack blocks and a granary, bathhouse covered half of the annexe and west of the potential *principia* stood yet another granary, there wasn't much of the space for commanding officers house inside the Bearsden fort at all (Pl. 3).

The same can be said about the small fort at Duntocher, where despite almost no buildings being identified there, it would still be relatively hard to fit the house of the commanding officer next to the central stone building or in fact anywhere in the interior except of the empty annexe (Pl. 17).

Old Kilpatrick probably had a *praetorium* in a standard position next to the *porta principalis dextra* (Pl. 9), but the area was so damaged by post-Roman development that

nothing specific could have been documented there during the excavations except for a higher density of cobbled stones, indicating the presence of a stone building (MILLER 1928, 22).

A potential *praetorium* was identified at Cramond west of the western *horreum* (Pl. 10). The evidence is relatively shallow, as only the north-western corner is known and the expected width of some 9 m for the building is too small to have been the commander's house, but the masonry was of superior quality in comparison to the storehouses or granaries on the site (RAE – RAE 1974, 179) and the drain leading from the interior to the larger drain accompanying the *via principalis* may indicate the existence of a hypocaust in an unexcavated part of the house.

2.2.19 Forts – the granaries (horrea)

The presence of a food supply depot, a granary, could be expected even in relatively small forts, despite usually not being built inside outposts like fortlets. Most fort granaries on the Antonine Wall were rectangular, stone-built structures near the *principia*. If not mentioned otherwise, they were constructed of stone, presumably with a tile roof. A characteristic of every *horreum* was a strong external buttress. These provided additional support for the heavy tiled roof, as granaries' walls were weakened by the series of windows and air vents and would stand on rows of pillars or stone supports, all to offer ventilation inside the building and separate the food from moisture and rodents (GENTRY 1976, 15–16).

Two large stone granaries were found at Mumrills, each occupying around 200 m² (eastern 30 m x 6,5 m and western 30 m x 7 m; Pl. 7). They were positioned as standard on each side of a *principia*, their longer walls parallel to the flanks of the headquarters. In both examples, the elevated floor was supported by three internal longitudinal dwarf walls. The entrances to both came from the northern side (*via principalis*) and in front of the western example were found remains of a loading platform (MACDONALD – CURLE 1929, 431–433).

At Rough Castle, a smaller granary was found in similar alignment as in the case of Mumrills immediately west of the *principia*, occupying only 137 m² (22 m x 6,2 m) and again with three sleeper/dwarf walls to support the original timber floor and two steps on the northern side in front of the entrance (BUCHANAN – CHRISTISON – ANDERSON 1905, 474–481). It is not certain whether there was a second granary on the eastern side of the *principia*, as the excavations taking place on the site could not locate any coherent layout or stone foundations (Pl. 5). The *praetentura* was occupied by barracks and workshops and aside from the bathhouse in the annexe, there seems to have been no other stone building inside the fort except for that already mentioned.

At Castlecary, surprisingly only one granary was found in standard alignment east of the *principia*, despite there being another building of similar function, albeit without buttresses and with an apse, partially excavated further east of the first one (CHRISTISON – BUCHANAN 1903, 303–313; Pl. 8). The entrance to the only positively identified granary in Castlecary probably (and unusually) came from the south, as the southern wall was sufficiently strong to carry a loading platform (GENTRY 1976, 68).

Only a modest granary (74 m² – 14 m x 5,3 m) was found at Croy Hill in the unusual spot of a *praetentura*, north-west of the *principia* (Pl. 6). Almost no traces of the dwarf walls were found in the interior despite the presence of external buttresses left no room for speculation about the building's purpose. The structural sequence shows that this building was preceded by a drain for a Military Way immediately to the south and that the granary was rebuilt at least once during the existence of the fort (MACDONALD 1937, 56–67).

The fort at Bar Hill yielded evidence about a rather unusual *horreum* in the context of the Antonine Wall. The granary appeared to actually be a double-granary, being exceptionally wide but divided by a partition into two unequal halves, with only the smaller part furnished with uneven dwarf walls for the floor support (Pl. 1). The rest was simply characterised by a cobbled floor and the whole structure had no support in the form of buttresses. The reason why this building is still considered a granary comes from evidence that it was initially undivided and there were probably also some dwarf walls in its complete interior before they were removed from one half during reconstruction (ROBERTSON 1975, 14–16). The surviving foundations thus represent only a reduced version of the former single, large *horreum* (covering an area of some 250 m²). The second *horreum* was later built inside the headquarters (see p. 37 and 58–59).

Soldiers occupying the Cadder fort had at their disposal two granaries, one to the north of the *principia* and one to the south of it in standard alignment (Pl. 2). These were almost the same size, roughly covering an area of 130 m². Only in the southern *horreum*, which was only slightly larger than the northern one, were found traces of sleeper wall supporting the original wooden floor (CLARKE 1933, 41–42). The entrances were no doubt provided from the *via principalis* as the area in front of the granaries was heavily cobbled in order to support the height of the loading platforms (GENTRY 1976, 63–64).

Two independent granaries were found at Balmuldy, again each on one side of the *principia* (Pl. 4). They were of similar proportions, but the western one was wider, encompassing 210 m², whereas its eastern counterpart occupied only 167m². In both cases the

floor was supported by dwarf walls in three rows and both were externally buttressed. The entrance was probably provided from the south as in the case of Castle Cary, indicated at least by the remains of the loading platform in the southern wall of the eastern granary (MILLER 1922, 26–28).

Despite its small size and strange layout, the fort at Bearsden was equipped with two granaries (Pl. 3). The smaller one (121 m²) was in a relatively standard position west of the potential *principia*, but the larger one (180 m²) was located in the *praetentura*, next to the *porta principalis sinistra*, its longer side parallel with the *via principalis*. The excavations of the northern example showed abundant evidence for tile roofing and some remains of dwarf walls supporting the floor (BREEZE 2016, 31–33, 35–36, 260–261).

Old Kilpatrick had in its interior two types of granaries: to the north of the *principia* was a standard stone-based *horreum* (200 m²) and south of the headquarters existed another granary (Pl. 9), this time made of timber and traceable archaeologically only via four rows of postholes, representing the foundations of the building walls and the additional internal support of the floor (MANNING 1975, 129). Given that the area of the stone granary was heavily disturbed by later development on the site, only limited evidence for internal dwarf walls remains (MILLER 1928, 21–22). Similar buildings were found south of the second *horreum* but these have been interpreted as stores or warehouses (see below p. 60–61).

At Camelon, only one granary is known for certain (Pl. 11). It stood to the north of the *principia* in standard alignment, occupying nearly 200 m², its original floor supported by longitudinal internal sleeper walls, while buttresses were provided in the exterior (BUCHANAN 1901, 365). Another building immediately south of the headquarters could be seen as a *horreum*, despite evidence for this attribution being rather equivocal. Dimensions of 31,1 m x 10 m rendered this rectangular building relatively wide for a granary and furthermore the provision of buttresses was attested by the excavator only in front of the eastern wall, with just one transverse sleeper in the interior. Evidence indicating the exact nature of this building is lacking, but the interpretation that it was a granary seems to be most plausible (GENTRY 1976, 66), although it could have also been a workshop or storehouse created from a former granary via reconstruction. The excavation report offers no help here (BUCHANAN 1901, 365).

Two granaries were identified in Cramond, the first immediately west of the *principia*, standing next to the structure with buttresses (Pl. 10), which was not another granary but instead a storeroom integrated into the headquarters (RAE – RAE 1974, 177). The second granary was next to the *porta principalis dextra* in the easternmost part of the fort. No traces of sleeper walls

survived in the western granary, while in the case of the eastern *horreum* some stone supports have been documented. Given that the site has only been partially excavated due to the presence of a church above much of the centre of the fort, the full dimension of the granaries remains unknown (GENTRY 1976, 76). The western *horreum* occupied at least 140 m² while the eastern granary covered at least 158 m². The evidence suggests that unlike the rest of this multi-period site, the eastern granary was used in one period only (HOLMES 2003, 148).

The forts at Carriden, Inveravon, Falkirk, Westerwood, Auchendavy, Kirkintilloch, Castlehill, Duntocher and Bishopton were not or could not have been excavated enough to find any granaries, but at least one is expected in every fort on the Antonine Wall, with the possible exception of Duntocher.

2.2.20 Forts – the bathhouses (balneae)

It is reasonable to assume that every permanent fort on the Antonine Wall was furnished with a bathhouse. It is, however, not necessarily true that in all the forts the bathhouses were operational during the entire existence of the mentioned fort, especially if the garrison there was reduced later. Also, some forts were equipped with two bathhouses, which almost certainly were not operational simultaneously, but rather in succession. There is no general rule for their position inside the fort; in fact, they were often situated outside, for example in an annexe, presumably because of the risk of fire. Bathhouses were on the Antonine Wall constructed almost entirely of stone, furnished with a hypocaust and in certain cases the latrines were either integrated into them or positioned close by (LE BOHEC 2015, 85). They were also exceptional in terms of the number of changes they underwent during their short existence, which was apparently in certain cases shorter than the existence of the forts to which they belonged.

At Carriden the bathhouse was found relatively recently in the south-western corner of the fort's annexe (BURNHAM – HUNTER – BOOTH 2007, 259). It occupied at least 170 m² and consisted of one row of rooms as well as a latrine added to the north. From easternmost entrance room, which probably served as an *apodyterium*, almost nothing has remained. Further west were located a *frigidarium*, *tepidarium* and *caldarium* (Pl. 18). The existence of a furnace east of the latrine is not certain as well as the presence of a *sudatorium* further west or a cold plunge south of the *frigidarium*. The latrine was later turned into a metal processing complex, the roofing of the bathhouse was probably finished with a combination of terracotta and stone tiles. Finds of used stones in the foundations of this bathhouse suggest that this was not the first bathhouse on the site (CHAPMAN – HUNTER – BOOTH – WILSON – WORRELL – TOMLIN 2009, 228–229).

Two bathhouses were found in Mumrills, one in the northernmost part of the *praetentura*, roughly in the middle between the *porta praetoria* and the north-eastern corner of the fort, and the second in the *praetorium* itself (Pl. 7). The first example, representing a bath sometimes referred to as “used by common soldiers”, occupied less than 130 m² and initially consisted of three rooms in a row (*apodyterium/frigidarium*, *tepidarium* and *caldarium*) and one adjacent in the south-east (*sudatorium*). At a certain point of the fort’s existence, which does not necessarily have to be related to the reconstruction works on the *principia* or the rebuilding of the *praetorium*, the first mentioned room was divided into an independent changing and cold room. Despite the *tepidarium* and *caldarium* having a pillared hypocaust throughout the existence of the bathhouse, in the second period a different type of heating was used in the *sudatorium*. This came from the channelled hypocaust, for which a different type of fuel was used compared to the remaining rooms. Despite no *praefurnium* being found, it is believed that it was located west of the *caldarium*. Latrines are only expected east of the *apodyterium* because of a channel drain leading in that direction from the *tepidarium*. The floors were paved and glass was used for the windows, as fragments have been found in the bathhouse (MACDONALD – CURLE 1929, 449–462). The second bathhouse in the *praetorium* (see p. 39) has a complicated structural history. The first phase of this building commenced before the construction of the commandant’s house in stone but stood over its timber predecessor. Initially it consisted (west to east) of a *praefurnium*, two *tepidaria*, an *apodyterium* merged with a *frigidarium* and a *sudatorium* attached to the second *tepidarium*. It occupied roughly 200 m². The transition to the second period of this bathhouse’s existence was marked by complete rebuilding. The *praefurnium* was significantly enlarged, three smaller *tepidaria* were added to two existing ones, while in the southernmost row a *frigidarium* and cold bath were added west of the *sudatorium*. To the south of all these a large *apodyterium* was built, the whole bathhouse now covering an area of 420 m². In the final, third period, only one more *sudatorium* was added to the north, further increasing the area encompassed by this building to 460 m² (Pl. 7). More significantly, the third period was marked by the complete rebuilding and remodelling of the heating system and the *praefurnium*. Extensive repairs also took place in two existing large *tepidaria*. The finally added *sudatorium* was heated by a channel hypocaust, unlike any other room in these baths but akin to the *sudatorium* in the northern baths. All the other rooms were heated via a pillar hypocaust (MACDONALD – CURLE 1929, 462–493). Whether this much larger and more elaborate bathhouse was accessible to common soldiers after the first mentioned bathhouse went out of service (MACDONALD – CURLE 1929, 462) cannot be verified by any means.

The bathhouse at Rough Castle was situated outside the fort, roughly in the middle of an annexe to the east (Pl. 5). South of the Military Way was the *apodyterium*, which apparently also served as a *frigidarium*, and further south were a *tepidarium*, a *caldarium* and a *praefurnium*. The building was L-shaped, with a *sudatorium* immediately west of the first two rooms. The bathhouse initially covered only 144 m², but it was later narrowed on the eastern side and so it covered just 115 m² despite also being slightly extended to the north (MACDONALD 1933, 244–248). The drainage from the baths flowed to the south, there was no basin or similar feature in the *frigidarium* and the most profound evidence for alterations (apart from those mentioned) consists of the replacement of the hypocaust's brick pillars by stone ones (BUCHANAN – CHRISTISON – ANDERSON 1905, 482–489).

At Castlecary any evaluation of evidence concerning the baths is hampered by the fact that the bathhouse was first excavated as early as 1769. Among other things, an altar dedicated to Fortuna was found there (RIB 2146) together with a small figure of the same goddess in a niche. The drawing and the description do not correspond entirely with the documentation from the beginning of the 20th century and no further excavations took place there. From Roy's plan it appears that the building was divided into six rooms with four apses and at least twenty-seven buttresses (ROY 1793, 161, Plate 39), but later excavations confirmed only a fraction of the buttresses and no internal division. According to Roy's sketch, the building was 30 m long and some 8 m wide, but only 4 m of the length were actually excavated because the remaining foundations were already ruined. Furthermore, to the east of the building was found a furnace, possibly part of a *praefurnium*, which was not attested by Roy (CHRISTISON – BUCHANAN 1903, 316–317; Pl. 8). A drain going from the bathhouse to the north was also located in the north-eastern corner of the fort, where a latrine was excavated. This was a relatively small rectangular building of some 17 m² with an eastern entrance and a paved floor (HANSON – MAXWELL 1986, 181–182). A channel emptied through the Antonine Wall to the accompanying northern ditch.

The bathing complex at Bar Hill was represented by a long strip building (measuring some 40 m x 5,5 m = 220 m²) between the *porta praetoria* and the north-western corner of the fort (Pl. 1). It consisted of five rooms (east to west: *praefurnium*, represented only by the oven and modest structure; two *tepidaria* divided at a certain point by a partition wall; a further room divided longitudinally into a *laconicum* and a passage hall, which were both originally part of the last room – an *apodyterium/frigidarium*, but divided from that at a certain point) and adjacent latrines. The entrance was situated in the western wall of the *apodyterium/frigidarium* (KEPPIE 1986, 62–63). The hypocaust was constructed of both bricks and stone pillars, while the rest of the building was made of local sandstone. A drain carried water from the *frigidarium*

to the latrines via a gutter between the north wall of the bathhouse and the rampart of the fort (ROBERTSON 1975, 20–22). Practically nothing has survived from the latrines. Waste water was exported outside of the fort by a drain under the rampart. Fresh water for the bathing complex came from a cistern south-east of the baths (MACDONALD – PARK 1906, 45). In *praefurnium* was, after the building was temporarily shut down as a bathhouse, build a kiln producing a distinctive type of pottery, which production was in the past described as “African style pottery” (SWAN 1999, 456–457), but this interpretation has been disproved (FULFORD 2010, 67–78, BREEZE 2016, 156–159). It appears that the bathhouse, following a break in usage, started to operate again after the kiln was no longer used (KEPPIE 1986, 73).

Cadder is one of the Antonine Wall forts where two independent *balneae* have been identified. Unfortunately, only the internal baths have been excavated, while the much larger and probably elaborate external bathhouse has merely been identified through uncovering part of the hypocaust and roughly sketching its general shape (CLARKE 1933, 94, Plate). The internal bathhouse in its evolved form covered 100 m², but its beginnings were quite humble. Initially it entailed just three rooms in a simple row, consisting of (east to west) an *apodyterium*, a *tepidarium* and a *caldarium*. No *praefurnium* was discovered but the bathhouse was heated by five furnaces in succession. At a certain point a *sudatorium* with a circular segment shape was added south of the *apodyterium* and the *tepidarium*. This went through several phases of construction and reconstruction. Eventually the wholesale reconstruction of the hypocaust took place in the hot rooms and a *frigidarium* was added north of the *apodyterium*. At the same time in the north-eastern corner of the fort, a simple latrine was built, which was fed by water coming from the drain from the above-mentioned room. Later the *caldarium* was demolished and the *tepidarium* received its own furnace, while the hypocaust was apparently reconstructed once again. Another major change took place when the newly built *sudatorium* was transformed into a *tepidarium* and east of it a new room was added, operating as a *caldarium*. This new block was equipped with yet another furnace (Pl. 2). In the last phase, the bathhouse apparently ceased to be used for bathing. The *frigidarium* was merged with the *apodyterium* and after the same reconstruction the drain collecting water from the baths was no longer used (probably together with the latrine). Nevertheless, the building was used for some time in this state, as the hearth inserted into the *apodyterium* walls indicate (CLARKE 1933, 53–60).

The third fort to have two *balneae* on the Antonine Wall was Balmuildy (Pl. 4). The internal one was situated between the north-eastern corner and the *porta principalis sinistra*. It was a long strip building with a projecting room in the south, in total covering slightly more than 100 m². The rooms were identified as (north to south) a *caldarium*, two *tepidaria* and an

apodyterium/frigidarium with an attached *sudatorium* to the western side. No *praefurnium* was found but a furnace was provided next to the northernmost room. The *sudatorium* had its own heating system. In front of the southernmost room was a paved courtyard and inside the *apodyterium/frigidarium* was a basin. The room partitions and hypocaust all show several periods of reconstruction with one major rebuilding of the whole bathhouse. Subsequently the building ceased to fulfil its primary function, the pipe drains leading from the *apodyterium/frigidarium* to the *caldarium* were sealed with clay and the *sudatorium* was levelled. The hypocaust was then filled with rubble and the building continued to be used for some time until its eventual abandonment (MILLER 1922, 41–47), just like the baths at Cadder fort. The debris from several reconstructions included numerous sherds of window glass, crushed flue tiles, stone pillars from the hypocaust, broken pottery from the Antonine period and an altar dedicated to Fortuna (RIB 2189). An external bathhouse was located just outside the south-eastern corner of the fort in the annexe (Pl. 4). The building was constructed directly above the two eastern ditches of the fort, which were refilled with clay, probably not long after being initially dug. Only a few sherds of pottery were found here, whereas in other parts of the same ditches that were not backfilled, pottery finds were abundant. Baths were thus built relatively early in the history of fort and were used for a relatively short period of time, as unlike any other bathhouse on the Antonine Wall no alterations to the original plan were made. Indeed, it appears that they were deliberately dismantled and very few finds were sealed in the rubble, carefully covered in the clay layer. The hypocaust was made of wide tiles. The building itself had thick walls and occupied some 250 m². The bathhouse consisted of two rows of rooms, the south-eastern one started with an *apodyterium/frigidarium*, enhanced further south by an apse with a basin. In the middle of the *apodyterium/frigidarium* was a small sink for a drain leading to the annexe ditch, just like the drains from the other rooms. North of the first room was a *tepidarium*, in which part of the concrete floor survived on top of the hypocaust. West of both of these rooms was a large *caldarium*, enhanced with an apse to the south and west and separated by an apse from the main room, serving as a *sudatorium*. The second *caldarium* to the north also included an apse and beyond that was a *praefurnium*. However, the *sudatorium* was heated from its own furnace to the west, which additionally heated the first *caldarium* (MILLER 1922, 47–55).

The bathhouse at Bearsden occupied roughly 220 m² and had a cross shape plan (Pl. 3). Its entrance was from the west. On the west-east axis, it consisted of an *apodyterium*, a *frigidarium*, a small and a large *tepidarium*, a *caldarium* and a *praefurnium*. North of the *frigidarium* was *laconicum* and south of it was a cold-water bath. Most of the building was

constructed from sandstone, although the *apodyterium* and the *frigidarium* were made from timber, leaving the trace of postholes only. Rooms of the central range were several times reconstructed and the smaller *tepidarium* was eventually put out of use and served only as a corridor. The *praefurnium* furnace supplied with heat only caldarium and two tepidaria, while the *laconicum* had its own furnace. Furthermore, hot rooms in a central row were built on a pillared hypocaust while the *laconicum* had a channelled version of the same. North of the *caldarium* was an unfinished room with buttressed walls on all sides except the south, which bordered the bathhouse. It was certainly demolished during the existence of the baths, as its material was used during one of the reconstructions. The roof was probably made of perishable materials like thatch or wood. A latrine was located south-east of the baths and was supplied with waste water from the *laconicum*, cold water bath and first *tepidarium* to its western channel while the eastern channel of the latrine acquired waste water via drain from the second *tepidarium* and the *caldarium*. From latrine, water was flushed to the annexe ditch, where it left rich organic sediments. Despite being built of stone, the latrine shared its eastern wall with the turf rampart of the annexe.

At Camelon the bathhouse was located next to the eastern rampart of the southern annexe, roughly in the middle of it, and occupied some 280 m² (Pl. 11). This building consisted of five rooms, of which the easternmost was the largest and served as an entrance. This room was externally buttressed and all the other rooms represented subsequent additions. The area around the entrance was flagged but at the other end there appeared to be a flued or channelled hypocaust. The building was probably partitioned somewhere around the apse, although exact evidence is missing (BUCHANAN 1901, 373–376). The area between the apse and the entrance could have been than *apodyterium/frigidarium*, with a cold water bath in the apse. Due to the presence of the flued or channelled hypocaust, the second part of the room may have been a *sudatorium*, which was usually located next to the entrance room. The remaining two large rooms were probably *tepidaria* (at least the presence of the pillared hypocaust indicates this). The smallest room to the north could only have been a *caldarium*, despite precise evidence for one in the form of a hypocaust or an external furnace being absent. Furthermore, two drains were identified during the excavations, probably leading to a ditch of an annexe, while another drain emptied from the potential central *tepidarium* in the opposite direction. Immediately north of the building was probably a stone latrine of some 16 m² (BUCHANAN 1901, 376).

The last complete bathhouse found in or in the vicinity of the Antonine Wall was excavated at Cramond (Pl. 10). The building at its greatest extent covered some 210 m² and was located about 100 m north of the fort. Three distinctive phases of development can be

identified here. In the first period, the building had a relatively simple L-shaped plan with (south to north) a *frigidarium*, two *tepidaria* and a *caldarium* in a row, while to the first room was attached an *apodyterium* in the west. Major changes were made in transition to the second phase of bathhouse, as east of the remodelled and enlarged *tepidaria* was added a new *frigidarium*, a cold water bath and a latrine. The old *apodyterium* and *frigidarium* were equipped with a modest hypocaust and served as “recreation rooms”. While initially only one furnace was attached to the building in the north, next to the *caldarium*, another was later added west of the second *tepidarium*. The third phase was marked by the addition of another furnace, this time enclosed in a room (*praefurnium*) positioned in a free space between the first *tepidarium* and the old *apodyterium*. The second furnace from the second phase also received some architectural protection, but only a timber one, while the rest of the bathhouse was entirely built from stone. The hypocaust in the hot rooms was pillared as far as the evidence can be followed; only in the former *apodyterium* and *frigidarium* were sparse channels of a channelled hypocaust detected. Drains for waste water generally led to the latrine and from this to the north-east. During the excavations, several sherds of Antonine Central Gaulish *terra sigillata* were found, so the bathhouse can be firmly dated to the Antonine period and should not be Severan (HOLMES 2003, 12–28). Another latrine existed inside the fort in its north-eastern corner. Its first phase, eventually destroyed by fire, was constructed of timber and its overall dimensions cannot be reconstructed, but it was certainly smaller than the succeeding stone one. That occupied some 72 m², its floor was made from large stone slabs and it was divided into two rooms with central drains that entered the drain alongside the *via sagularis* (RAE – RAE 1974, 187–188). Finds of *terra sigillata* inside the drain belong to both Antonine and Severan period (RAE – RAE 1974, 199, 202, 204), but the walls of the stone phase of this building overlaid part of the earlier *via sagularis*’ surface, potentially making the second latrine either late Antonine or Severan, although exact evidence is missing.

Sites like Auchendavy, Kirkintilloch, Castlehill and Bishopston were not investigated enough to provide any information about the existence of a bathing-suite. At Inveravon, the limited excavations found box flue-tiles in the vicinity of the River Avon, indicating that a bathhouse was nearby, but no exact evidence about its plan is at hand (ROBERTSON 1990, 46).

At Falkirk just one room of a possible bathhouse was excavated, on Kamper Avenue. The room was furnished with a channelled hypocaust, so it was probably a *laconicum* (KEPPIE – MURRAY 1981, 253–256). What is interesting is the fact that the bathhouse was located more than 0,6 km away from the *porta principalis dextra*, therefore it could not have been inside the annexe but instead was free-standing away from the fort like the one at Duntocher (see p. 52).

Not much of the interior of Westerwood is known, but two independent excavations have provided evidence for the existence of a bathhouse in the north-western corner of the fort (Pl. 13). Unfortunately, given that neither of these investigations were large-scale, the surviving evidence only shows the presence of thick walls and a hypocaust (MACDONALD 1933, 285–286, KEPPIE 1996, 85).

The bathhouse at Croy Hill was never properly excavated but some notes were taken during excavations in the 1920s. The building was situated just outside the fort to the north-east and is believed to have been extremely narrow, measuring some 20 m east to west but only 3,6 m north to south (Pl. 6). The *frigidarium* and the *apodyterium* were according to the excavator joined in the easternmost room of the whole complex of just three rooms. An attribution of room functions was made thanks to the discovery of drains bringing water inside the complex (to the *tepidarium* and the *caldarium*) and out (through the *caldarium*). In the middle was the *tepidarium*, with the *caldarium* to the west, curiously divided into two halves longitudinally. The source of fresh water was inside the fort itself, in its north-eastern corner, where a cistern was located (MACDONALD 1932, 257–262).

At Duntocher the fort was naturally too small to have a proper bathhouse inside the area enclosed by the fort's rampart. An annexe would have constituted an excellent place for such a building, as was the case of Rough Castle or Balmuildy, but no traces of baths were found. The old antiquarian record nonetheless mentions the discovery of ancient baths near the site of the Roman fort on Golden Hill, Duntocher (KNOX 1785, 611). Eventually the bathhouse was detected by trial trench in 1978 some 70 m northwest of the annexe, but wholesale excavations did not take place there (BROGAN – HENDERSON 1978, 26). The later work of Professor Keppie combined the antiquarian record with trial excavations in the late 1970s and, alongside the results of a geophysical survey in 2001, indicated that the small fort at Duntocher originally contained an equally small bathhouse beyond the walls of the annexe, which consisted of only three rooms in a row, no doubt a *frigidarium*, a *tepidarium* and a *caldarium* (Pl. 17). The walls of the building were buttressed on at least one side. The traces of the hypocaust were best detected in the *tepidarium* and the building occupied approximately 92 m² (KEPPIE 2004b, 197–209).

The fort at Old Kilpatrick was certainly large enough to contain its own bathhouse. During the excavations of 1923–1924 (MILLER 1928, 32) and 1931 (MACDONALD 1932, 232), no traces of a bathhouse were found in the fort or in its immediate vicinity. According to the antiquarian record, a Roman bathhouse was located south of the fort in the annexe (about which

the only thing known is that it was occupied by this bathhouse and was probably connected with a harbour – see p. 65), but it was almost completely destroyed together with the baths during the construction of the Fort–Clyde Canal (BRUCE 1893, 36). There exists a slight chance that another bathhouse was inside the fort, in the non-excavated *retentura*. The sole evidence for this consists of a latrine in the south-eastern corner of the fort, something that rarely stands alone. This rectangular building occupied roughly 72 m² (Pl. 9) and its phases of existence indicate a similarly complicated history as Old Kilpatrick’s *praetorium*: the building was at least once completely demolished and then rebuilt again, only to be finally levelled prior to the abandonment of the site (MILLER 1928, 28–32). Only initially was it used for sanitary purposes, whereas in its later phase it already stood on such higher ground, which did not allow the waste water to flush through the building as was the case before (HODGSON 1995, 49).

2.2.21 Forts – the barrack blocks (contubernia)

A major part of the interior of a Roman fort was occupied by shelters for soldiers. During the Antonine period these were still constructed mostly of timber, the only exception being the fort at Camelon, where all the major interior buildings were made of stone. On the Antonine Wall itself, barrack blocks (for one *contubernium*) were almost exclusively of timber, leaving archaeological traces of rows of postholes, which were not always correctly identified or even documented during the older excavations. In some cases, only few barrack blocks are known from certain forts despite expectations of more (how much remains a question of debate – HODGSON 1995, also see p. 261–264). The area occupied by individual barrack blocks varied in the case of the Antonine Wall considerably between 152 m² and 507 m². A certain range in the size of barracks was common in the Roman army, but on the Antonine Wall, or more precisely during the Antonine period in Britain, the sizes of living quarters of ordinary soldiers varied even more (DAVISON 1989, 90–91).

Excavators of Mumrills noted that many traces of barrack blocks remained on the site, but usually in such disrupted conditions that no coherent pattern could be determined via early 20th century archaeological methodology. The only exceptions were two barrack blocks in *retentura* just south of the eastern granary. From the eastern block survived some 37 postholes, roughly representing the shape of the former barrack block of about 34 m along the north-south axis and with a width of 7 m (the building thus occupying roughly 238 m²). Only one possible internal partition was identified there and distinctively two hearths and four pits as well. In the interior, further postholes were identified, which cannot be related to any specific partitioning. From the second barrack block, immediately to the east, only the western wall survived,

consisting of some 17 postholes in a row and a further four postholes that cannot be related to a specific architectural feature. In the interior of this barrack block, eight pits were excavated close to one another, although their purpose remains rather enigmatic and two features (the barrack block and the pits) may not have been contemporary (Pl. 7). Both buildings' walls were made from wattle and daub between timber posts and both were eventually destroyed by fire (MACDONALD – CURLE 1929, 433–434, Plate).

At Rough Castle, only two shapes in the plan can be identified as barrack blocks, although after closer examination one of them resembles a tent-like structure (MACIVOR – CLARE – BREEZE 1979, 240). The second consisted of about 25 postholes in the aligned form of a contubernial block (Pl. 5) of some 154 m² (26,52 m x 5,79 m). These barrack houses are sometimes called half-barracks thanks to their relatively small dimensions. If all the other barrack buildings in the fort were the same, three more could have been placed in the *praetentura* of this otherwise small fort (MACIVOR – CLARE – BREEZE 1979, 239–241). Not much of the internal divisions survived, but it can be deduced that the individual *contubernium* was allocated space equal to 17,9 m², while the few postholes inside the barrack blocks also suggest that a division on *papilio* and *arma* was somehow applied there (DAVISON 1989, 112–113).

From Bar Hill, three barrack blocks are known via excavations, despite the fact that the fort was expected to have originally contained as many as six of them in its interior (Pl. 1). Known examples were in *retentura*, two in the south-west and one in the south-east. Their sizes can be estimated as 364 m², 363 m² and 368 m², all being 43,5 m long and with widths varying between 9,75 m, 9,5 m and 10 m (DAVISON 1989, 738, 758, 808, 831). The postholes (50 in total) of the south-western example allow the complete reconstruction of ten contubernial blocks and centurion quarters in the west, although from the remaining two examples, only the southern walls and a few adjoining postholes (21 postholes from the north-western example and 42 from the eastern one) survived. All the barracks were evidently burned down during the abandonment of the site (ROBERTSON 1975, 16–18).

At Cadder, as many as eight potential barrack blocks were identified despite not all of them serving the same purpose or being used at the same time (Pl. 2). None were completely excavated, but the limited evidence still provides fundamental insights into the internal organisation of forts on the Antonine Wall. Two barrack blocks were positioned in the south-eastern corner of the fort, while six more were situated in *retentura* head-on to the *via decumana*. The barrack block immediately to the north-west of the *principia* was demolished

and then reconstructed twice (it occupied respectively 285 m², 152 m² and finally 206 m², if the interpretation of 49 postholes is correct) and it is certain that in the last period of its existence, it no longer served as accommodation for soldiers. Instead, it constituted a workshop, probably metallurgic, as traces of industrial activity in its immediate vicinity indicate (CLARKE 1933, 48–52). Other barrack blocks showed two periods of existence, divided by one complete reconstruction. Otherwise, they were relatively standard in size (occupying an area of between 272 m² and 340 m², with an almost uniform length of 37 m and a width varying from 7,3 m to 9,1 m – DAVISON 1989, 740, 760, 808) and construction, leaving behind ample traces of burned daub and posthole marks.

Despite eight contubernial blocks being expected at Balmuildy (four in *praetentura*, four in *retentura*), only one was thoroughly excavated and documented during the excavations in 1912–1914 (Pl. 4). This example lay in the north-western corner of the fort and five rows of as many as 86 postholes indicate two blocks of buildings separated by a narrow longitudinal passage. This internal division could have been related to the presence of a cavalry regiment in the fort (HANSON – MAXWELL 1986, 154), despite legionaries being expected here given the epigraphic evidence (see p. 28). The fifth row of postholes indicates either that one complete reconstruction of the barracks took place, which would make an unpaired row a remnant of a former structure, or it was a veranda. Overall dimensions of 39,6 m x 12,7 m of the combined barrack block gave an area of 501 m². The remaining three blocks in the *praetentura* and two in the *retentura* were of approximately similar size, varying in the occupied area between 483 m² and 580 m², all based only on the layout of the fort's streets and gutters and verified via several trial trenches. In the block immediately to the north-west of the *principia*, disturbed traces of hypocaust have been found, indicating housing for a centurion or a decurion. Two more blocks immediately south of the *principia* were of half the width of the former, thus covering an area of just 245 m² and 254 m² (DAVISON 1989, 740, 760, 808). In the context of all the barrack blocks in Balmuildy, almost no finds of roofing tiles have come to light, which strongly suggests that the roofing was provided via thatches or timber. Floors were only of beaten earth and occasional finds of burned stones indicate the presence of small hearths inside the barracks. Drainage gutters around the individual blocks were once reorganised, which could (but does not necessarily) coincide with the reconstruction of the single properly excavated barrack block (MILLER 1922, 32–40).

At Bearsden only two barrack blocks have been identified as such with confidence (Pl. 3). The true functions of the remaining buildings inside the fort itself are with the exception of the granaries only conjectural. Two known barrack blocks were exceptionally small, situated

alongside the *via principalis* in the *praetentura*. They occupied only 177 m² and 201 m² and their internal partitioning effectively proved that they were divided into just eight small rooms for the soldiers as well as a larger one for the officer (DAVISON 1989, 740, 760, 808). In front of these barrack blocks were three more buildings of similar proportions, narrower by 1 m and with traces of only sporadic or a lack of internal partitioning. Normally these would have been interpreted as storehouses, but in the case of Bearsden the question has been raised as to whether these were not the stables. Despite this theory fitting well with the space allocation inside the fort, phosphate analysis failed to confirm the presence of large mammals and therefore no direct evidence for horses has come to light (BREEZE 1984, 43–46, BREEZE 2016, 273–277). Finds from the Bearsden excavations have revealed an interesting pattern in the distribution of pottery inside the fort. Finds of *terra sigillata* were attested only in officer quarters of the barracks and the central part of the fort, while *mortaria* and other cooking pots were more evenly distributed in the interior of the fort (BREEZE 1977, 134–142).

At the westernmost fort of the Antonine Wall, Old Kilpatrick, six barrack blocks were positively attested in the *praetentura*, while four more were expected but never found in the *retentura* (Pl. 9). Three of the barracks in the western part of the fort were positioned directly on the *via principalis* on each side (those on the southern side of the *via principalis* occupied an area of approximate 450 m² each; those on the northern side 490 m² each). Four of these, further from the *principia*, faced their counterpart opposite, while the closest ones to the headquarters abutted its western neighbours. The last two contubernial blocks mentioned differed from the others in several ways. Their floors were evidently made from heavy cobblestones, while all the other barrack blocks' floors were simply made from gravel, if the evidence survived at all. Much more importantly, it seems that all the barrack blocks were initially constructed via a different method from the other barracks on the Antonine Wall. The sleeper tracks were probably dug for the individual supports of the walls (just like the walls of the barrack blocks on the Odenwald Limes, see p. 164–168, 173) and these were during the existence of the fort replaced with standard posts plus wattle and daub construction. However, this did not occur in the case of the two above-mentioned barrack blocks closest to the *principia*. Thus, after the reconstruction, one should expect the reduction of garrison. The fort was still used after the demolition of these two blocks, evidenced by a layer of burnt wood and daub. Moreover, scattered posts close to the former walls could not have been contemporary with the standing walls on the one hand and did not form any coherent building pattern on the other. The excavator stated that two methods of barrack construction represented proof of two periods of existence of a fort (MILLER 1928, 15–18), which is doubtful, because abandoning two

contubernial blocks is not evidence for a break in the occupation (HODGSON 1995, 48–49). It is certain that relatively major reconstruction took place at some point of this fort's existence and afterwards the garrison was either reduced or reorganised. A lack of evidence about the events in the *retentura* hampers any general conclusions.

As many as ten possible barrack blocks were identified at the Antonine fort at Camelon (Pl. 11). Being exclusively constructed of stone, their size varied between 410 m² and 490 m², with one exceptionally large example in the *retentura* occupying 537 m². All the other mentioned examples were situated in standard alignment in *praetentura*, although that at the rear of the fort was actually parallel with the *via principalis*. No internal partitions were found, the floors were probably mostly gravel and only in three cases does it seem that the barrack block was widened at one of its ends, indicating the presence of officer quarters (BUCHANAN 1901, 351–366).

At Bishopton (Whitemoss), at least one barrack block was identified in the *retentura*, covering roughly 364 m². It consisted of ten *contubernia*, had officer quarters in the eastern part and was built with sleeper walls instead of ordinary postholes, like the Old Kilpatrick barracks. Unfortunately, only brief points were published about this site in general, so details are missing aside from the fact that the excavator stated two subsequent destructions and reconstructions of this barrack block (NEWALL 1955, 123).

At forts like Carriden, Falkirk, Westerwood, Auchendavy, Kirkintilloch and Castlehill, no meaningful attempt was made to find the barracks. At Inveravon only disturbed traces of something (which could be described as the half-barrack block) were discovered, but the limited nature of the excavations precludes any further interpretation (DUNWELL – RALSTON 1995, 545). No finds of barrack blocks were made at Castlecary (CHRISTISON – BUCHANAN 1903, 319–320). Despite MacDonald's proposal of the presence of stone-built barracks at Croy Hill (MACDONALD 1925, 290), successive excavations have never confirmed his theory (SNEDDON – MURTAGH 2009, 15). There is also no equivocal evidence for any barrack blocks at Cramond because they were either destroyed by successive store buildings and workshops or they were located in what remain unexcavated areas (HOLMES 2003, 149–151).

2.2.22 Forts – stores (armamentaria) and workshops (fabricae)

For the purposes of this thesis, in this category of stores and workshops, all the buildings that were probably used for crafting or storing other goods than foodstuff will be discussed. In addition, such an approach naturally brings to discussion fragmentary evidence from buildings

whose exact functions cannot be deciphered. Certain storage no doubt took place in the frontal part of individual barrack blocks, as well as in the headquarters or *praetorium*, which comprised rooms for storing the commander's private possessions. Additional storage could take place in long narrow buildings, usually close to the *principia* and in front of the barrack blocks. However, these have sometimes been interpreted as stables. Other buildings, also considered as stores, had different plans. Some buildings evidently changed their purpose during their existence or after reconstruction and, despite initially being used for something else, they eventually became storerooms.

Except for the known and already discussed buildings in the interior of the Mumrills fort, two clusters of postholes in the *praetentura* were identified (Pl. 7). The southern one, consisting of at least 38 postholes and two pits with several other pits and a fireplace nearby, formed an enclosure of approximately 240 m². This was probably a timber-framed building with a narrower part aligned to the *via principalis*. Its proportions do not indicate that it was a barrack block and its foundations exclude the possibility that this was another granary. A storehouse or workshop might be the interpretation, but based on the negative evidence only, the postholes might have also been remnants of successive barrack blocks disturbed by various subsequent reconstructions (MACDONALD – CURLE 1929, 433–434). The other cluster of postholes (27 in total) and pits (at least 2) forms no coherent pattern for interpretation. Similar groupings of postholes were identified also in the annexe and it is not certain whether they should be related to early Antonine fort there or building activity in the annexe (see p. 62–63).

At Rough Castle no positive evidence came to light for the existence of any specialised storehouse or workshop (Pl. 5). A cobbled enclosure east of the fort, proposed to serve as additional storage place or similar function (MACDONALD 1933, 261, 270), was only partially excavated and bears no evidence for any architectural structure within it (see p. 63–64).

A building with an apse excavated roughly 6 m east of the granary at Castlecary resembled in terms of proportions yet another granary, but it was not supported by any buttresses and had no dwarf walls or similar internal features (CHRISTISON – BUCHANAN 1903, 313–314). Interpretation as another storage building is again dubious, but its proximity to the granary still makes it more likely than any other interpretation (Pl. 8).

Due to the superior quality and frequency of the investigations at Bar Hill fort during the 20th century, evidence for additional storage places and craft production is greater here than at other sites. As already mentioned above, the western part of the *principia* courtyard was during the late phase of this fort's existence turned into a store. Evidence points to the

construction of a simple timber-framed building with an elevated floor, therefore in a certain way resembling a granary (KEPPIE 1986, 67–75). The original granary, on the other hand, was equipped with standard dwarf walls only in one half of the building (ROBERTSON 1975, 14–16). Pottery production took place in the bathhouse during the intermediate period when it was not operational (SWAN 1999, 456–457). Nevertheless, the most suggestive evidence comes from the site of a putative earlier *praetorium* (Pl. 1), from which nothing survived except for a few remains of flues, possibly from a hypocaust. Alternatively, these could have been associated with metal processing. The successive stone building was of rectangular shape, covering a little less than 130 m². The interpretation stands solely on the finds of many pieces of wrought iron, iron nails, iron slag and glass slag together with at least several fireplaces attested via an excessive amount of ash (MACDONALD – PARK 1906, 44). When exactly the building changed its primary purpose or replaced the *praetorium* and how substantially it was transformed or rebuilt cannot be determined with current data.

Evidence from Cadder points to the fact that at its later stage the fort hosted substantial industrial activity. Already mentioned was the case of the *praetorium*, which was turned from its initial stone form into a timber house of slightly bigger proportions (see p. 40). No internal division via partitions were found, which makes any interpretation of this building rather complicated, but the presence of a partially open range in the northern part of the building, supplemented with a water tank and not entirely associated drains, points to certain industrial activity, hardly compatible with the accommodation of a commanding officer (Pl. 2). Headquarters similarly hosted some crafts (see p. 38), despite evidence of related structural alterations being absent, one must solely rely on the presence of a cistern and a large hearth or kiln in the courtyard during a later stage of this *principia*'s existence (HODGSON 1995, 32–33). The barrack block immediately to the north-west of the *principia* was during its existence also turned into a workshop that processed metal, as the traces of burned material and soot in its interior indicate (CLARKE 1933, 50). This barrack block faced in the east a series of massive pits, again suggesting industrial activity. Some of these partially obliterated postholes belonging to the preceding building at this spot were also connected with industrial activity. This rectangular building of some 220 m², from which only some postholes have survived, stood north of the northern granary and was divided by one internal partition along an east-west axis. Some of the posts of this partition, additionally serving as the roof support, were packed in clay. This indicates that the building was rebuilt at least once (the positions of the posts in the previously used holes were reinforced by clay) before being demolished prior to the boom of

industrial activity in the neighbouring former barrack block. Moreover, this building north of the northern granary exhibited evidence for metal processing (CLARKE 1933, 42–44, 89).

The left wing of a *principia* courtyard at Balmuildy was at a certain point rebuilt into a storeroom with buttressed wall foundations (MILLER 1922, 24, see also p. 38). In the westernmost part of the fort's central range, two narrow, rectangular stone buildings were identified, the closer one to the granary covering some 145 m², the farther one neighbouring the *porta principalis sinistra* occupying 114 m² (Pl. 4). One internal partition was found in the former and two in the latter. Identification of the primary function of these buildings is precarious, but the wall of the larger one was penetrated in the north by a flue, which was further traced along the eastern wall (MILLER 1922, 28). Intensive traces of burning were identified in the vicinity of the flue, indicating the existence of some form of hypocaust heating. The shape of the building, however, does not indicate any kind of luxurious living quarters and no further testimonies of a hypocaust or better living standards like window glass or *terra sigillata* were reported. Instead, sherds of coarse ware and various storage jars were found inside, which points, indirectly, to the function of a store, possibly combined with metal processing as the flue and burnt debris might indicate, akin to the evidence from the workshop at Bar Hill (see p. 58–59).

At Bearsden, the situation is complicated by general uncertainty regarding the primary function of the majority of the buildings inside the fort, excluding two barrack blocks in the *praetentura* and the bathhouse with a latrine in the annexe. Whether three narrow blocks north of the barrack blocks were stores, workshops or stables is not certain (see p. 55–56, Pl. 3). A further small building in front of the eastern barracks, occupying just 36 m², could have also been a storehouse or a small stable. Slightly less problematic seems to be the building next to the eastern gate. This rectangular structure of some 55 m² also brought no evidence about its purpose via finds (BREEZE 2016, 160, 261), but its general plan and position in the central block indicates that it could have been a workshop or a storehouse (based on parallels from other sites on the Antonine Wall like Bar Hill or Cadder), though this is still based only on the negative evidence for any other attribution (BREEZE 1984, 39–40).

Storage function at Old Kilpatrick could have had the building succeeding the latrine in the south-eastern corner. Not only could the building not have been used for sanitary purposes in its later stage (see p. 52–53), but also a large amount of glass fragments were found there in a stratified context, safely postdating the first phase of the existence of this building (MILLER 1928, 29–32, 50). The further two buildings south of the above-mentioned granary were

suggested as storehouses by the excavator. They both occupied an area of approximately 160 m² and, being of timber construction, they left the characteristic trace of postholes in a roughly rectangular plan (MILLER 1928, 22). Their interpretation as storehouses is however problematic due to the presence of an additional internal row of posts, with which both mentioned buildings dangerously resembled yet another timber granary, albeit less well preserved (see p. 44). Whether they were originally constructed to store foodstuff or other less perishable materials and products is hard to determine, but their storing function is further supported by their position in the fort. Indeed, a harbour and a jetty were expected, though never found, immediately south of the fort and therefore these buildings were situated as close to these facilities as possible.

The building south of the *principia* at Camelon has already been described as a *horreum*, despite the absence of dwarf walls and buttresses on three out of four sides, which makes this attribution less certain than in the case of the granary north of the headquarters (see p. 44). Further north of the proven granary another rectangular building was discovered, occupying a substantial area of 330 m². Its walls were recorded to be at certain areas as great as 3 m wide (BUCHANAN 1901, 365–366), which could indicate that this was granary-like structure with strengthened walls in general, not just with buttresses (Pl. 11). It could have been a massive storehouse at the same time, but the evidence is shallow, as is typical at Camelon.

At Cramond, considerable industrial and storing activity can be expected because of the fort's positioning as an excellent supply base at the mouth of the River Almond. Despite storehouses and workshops being evidenced there, dating is generally a problem as the fort was not only reoccupied during the Severan period, but some building activity took place there in a (possible) sub-Roman period as well. Some 80 m south-east of the fort an industrial complex with probable multi-period occupation and timber structures or buildings of unknown dimensions has been excavated (Pl. 10). The site was probably used for metal processing, as the roasting furnace for iron ore indicates (HOLMES 2003, 28–33). Inside the fort it seems there was the already mentioned buttressed building integrated into the *principia* (see p. 39, 44). The main reason why this is not perceived as another granary is that no traces of any floor ventilation like dwarf walls have been found in its interior. A storage room for non-perishable commodities, not endangered by moisture or rodents, therefore seems to be this building's most likely function (RAE – RAE 1974, 177). Two more buildings inside the fort bear the traces of industrial activity at Cramond (the northern one occupying an area of some 258 m², the southern one 284 m²). They were both situated in the north-eastern corner of the *praetentura* and by their general shape and dimensions resemble barrack blocks (Pl. 10). However, the regular wall partitions were missing in both of them and the southern one went through several phases of

construction and reconstruction, during which it was systematically extended westwards. Stone-lined tanks, a hearth, a kiln and several drains all indicate metal processing at these blocks, particularly of bronze, due to waste lead found inside the southern example (RAE – RAE 1974, 181–187). Dating of both blocks is unfortunately complicated, so it is uncertain whether all these activities took place in the Antonine period or if they can be related to the Severan occupation of the site (HOLMES 2003, 148–149).

2.2.23 Forts – the annexes

Annexes are generally the least explored parts of the forts on the Antonine Wall. They were fairly common features adjacent to the Roman forts but were overlooked for a long period of time when the main excavating focus was put on the forts themselves. In the case of the Antonine Wall, the annexe was usually attached to the fort in the east or west and it was defined by a ditch or ditches and sometimes also the rampart. With the exception of Camelon, the only type of stone building identified inside the annexes were bathhouses. However, not all the baths were inside the annexes and not all the annexes housed the bathhouses. Indeed, some bathhouses were clearly provided externally to the annexes. Wherever the complex excavations inside the annexe took place, they usually discovered evidence of some industrial activity, mainly metal processing. It is almost certain that a broad selection of crafts took place inside the annexes, mostly in semi-permanent structures, leaving traces of postholes. These have frequently been found inside the annexes but not relatively positioned in any pattern that would offer a plan of a particular building. Interpretations of the internal arrangement of the space inside annexes are further complicated by the excessive number of waste pits, which freely intersected all the above-mentioned structures and were quite abundant in all the annexes examined (BAILEY 1994a, 305–308).

At Carriden, despite little being known about the fort, extramural features were identified a relatively long time ago (ST. JOSEPH 1951a, 167). The annexe lay on a well-defined plateau west of the fort itself and was planned from the start of the Roman occupation of the site since it was circumvented by the same ditches as the fort itself (Pl. 18). The annexe was defended by three ditches, but no rampart was detected. The overall estimated size of the enclosure is ca 1,4 ha, which is almost the size of the fort (BAILEY 1997, 590–591). The only identified building in the interior was a bathhouse (see p. 45).

At Inveravon, large excavations never took place, but several small-scale investigations led to the conclusion that east of the smallest fort on the Antonine Wall lay an annexe of unknown proportions (BAILEY 1994a, 300). Not much is known about it except for the presence

of a timber structure of unknown dimensions but three phases of existence. It served to process metal or alternatively this took place nearby (DUNWELL – RALSTON 1995, 540, 572).

At Mumrills, a relatively well-defined annexe was found immediately west of the fort (Pl. 7). It occupied an area of 1,7 ha and was younger than the fort (STEER 1963, 89). The annexe was located on a spot where an early Antonine fort at Mumrills originally stood. This existed only briefly and not much is known about it except for the fact that it was abandoned and dismantled before the construction of the Antonine Wall. The garrison subsequently moved westwards to the position of the known fort at Mumrills and later the annexe was constructed atop the old fort (BAILEY 2010, 101–102). Forts western ditch was probably backfilled when the annexe was added (BAILEY 1994a, 303). In the interior of the annexe no bathhouse or other substantial stone buildings were found, but the limited investigation in 20th century identified as many as eight pits, at least 39 postholes, one fireplace (MACDONALD – CURLE 1929, 500–501, PLAN) and one hearth, possibly associated with blacksmithing (ROBERTSON 1942, 119–127). At least one building with a paved floor, stone foundations and wattle and daub walls was identified in the relative centre of the annexe (STEER 1963, 93). Whether these structures belonged to the early Antonine fort or the annexe cannot be determined with certainty (see p. 58).

At Falkirk, the presence of an annexe can only be postulated because little is known about both the fort and the adjacent structures (BAILEY 1995, 577–600). The theory about its presence was based only on the discovery of a hypocaust outside of the fort, which may have been a bathhouse inside this annexe (KEPPIE – MURRAY 1981, 254), alongside some traces of timber building nearby (BAILEY 2006, 79-80). No other evidence has been found and because the traces of Roman fort were actually identified at Falkirk Pleasance some 0,6 km away, the bathhouse may have actually been barely related to the annexe. If it existed, it must have been much closer to the fort, for which currently there is no evidence (see also p. 51).

Rough Castle had an annexe attached to its eastern wall (Pl. 5). It was divided from the fort by one ditch, while the second was backfilled when it was constructed (BAILEY 1994a, 303). The annexe itself was separated from the surrounding area by one ditch to the south, three ditches to the east and the Antonine Wall and one ditch to the north. Whether the annexe was built simultaneously with the fort cannot be said with certainty (BAILEY 1994a, 300–303). It occupied some 0,8 ha and was thus larger than the fort itself. From the interior is best known the bathhouse (see p. 46–47). The Military Way was detected going through the interior from the *porta principalis dextra* to the east, where it left the annexe, and possibly then through

another gate (BUCHANAN – CHRISTISON – ANDERSON 1905, 449, Fig. 4). The Military Way partially cut the enigmatic enclosure in the north-western corner of the annexe, which was cobbled (and then un-cobbled and re-cobbled again). The enclosure was divided from the rest of the annexe by a ditch and a timber-framed barricade. No structure inside was identified and the allocated space thus remains unclear. It could have served for storage but not much more than that it was burned to the ground at least twice can be told about it (BUCHANAN – CHRISTISON – ANDERSON 1905, 452–463). It was also proposed that this enigmatic feature could be the remnant of a fortlet in similar alignment to the later fort as at Duntocher, but no archaeological evidence points to this conclusion (see p. 75).

Another fort with evidence of an annexe was Castlecary. Here only very limited information was gained from the excavation report at the beginning of the 20th century (Pl. 8). Apparently the annexe was encompassed on two sides by one ditch, and from the original two ditches in the eastern part of the fort, the outer one was secondarily backfilled with the construction of the annexe, while the inner one was retained until the abandonment of the fort (BAILEY 1994a, 303). The whole annexe was further protected by a turf rampart or similar structure built on the stone bedding about 2,4 m wide (CHRISTISON – BUCHANAN 1903, 302–303). No baths or other structures were detected in the interior; in fact, aside from a few vestiges of a road system, nothing was excavated there (CHRISTISON – BUCHANAN 1903, 328).

No clear evidence of an annexe has been offered in the case of Cadder. Here the presumption was based on evidence of a never-excavated bathhouse east of the fort, which was expected to be inside this annexe. Nevertheless, no trenches or ramparts were discovered in the vicinity of the fort and all the extramural features identified comprised several rubbish pits in front of the *porta praetoria* and some ditches nearly 140 m south of the *porta principalis dextra* (CLARKE 1933, 60–61). These features together with the identified (but not documented) foundations of sleeper beams can equally be related to the vicus or the annexe.

Balmuildy's annexe was located east of the fort (Pl. 4). Despite the importance of the fort, it occupied only 0,7 ha and was enclosed by just one ditch, with no rampart detected. From its interior is known the bathhouse mentioned above (see p. 48–49), which was definitively later than the fort defences – it was standing above the backfilled ditches, fronting of the eastern wall of the fort. These ditches were secondarily backfilled by clay prior to the construction of the bathhouse, but the majority of them remained opened until the abandonment of the fort, which is why numerous pottery finds have been made even though under the bathhouse itself ceramic finds were rare (MILLER 1922, 53, *contra* BAILEY 1994a, 303). No buildings other than the

bathhouse were identified even though finds of postholes and iron nails were numerous. The only one other building (expected but not found) there was a shrine to Mars and Victory. From this just one tile, a sculptured figure of Mars and Victory forming part of an altar dedicated to the former (RIB 2190) survived. The building itself was probably constructed from timber (MILLER 1922, 55–56).

At Bearsden and Duntocher, the annexes were of a fundamentally different nature from any other instance on the Antonine Wall. Both seem to have been part of the original plan of the forts and were in fact integrated into them in a manner resembling one fort divided into unequal parts by a partition rather than an independent fort and a dependent annexe. At Bearsden, the annexe lay immediately east of the fort, divided from it by just a turf rampart, without ditches (Pl. 3). The annexe was further protected by the same rampart as the fort in the east and south, while in the east it was fronted by two ditches and in the south by only one. There seems to have been no break in the ditches between the annexe and the fort. Apart from the baths, some other buildings were identified in the centre of the annexe, but none of the detected features have offered any coherent pattern. Instead, all the traces consisted only of a few postholes and cobbled or flagged areas. The Military Way went through the annexe to the gate in the east (BREEZE 1984, 47–48, 60–61).

Duntocher annexe lay immediately west of the fort, divided from it by just a rampart (Pl. 17). No ditches were dug on the western side of the fort and those of the fortlet standing in the middle between the fort and annexe were backfilled. The annexe was separated from the outside area by three ditches in the south, like the fort, and one ditch in the west. Both the fort and the annexe were protected by the same rampart, probably mostly of turf, although clay may have been used as well (ROBERTSON 1957, 61–67). It seems that the annexe was built together with the fort and the whole section of the Antonine Wall in the area (BAILEY 1994a, 305). Almost nothing is known about the structures in the annexe interior. No traces of bathhouse were found; it is in fact known that one stood further north and west of the annexe (p. 52). Many waste pits were detected in the annexe, which were relatively rich in finds of pottery, including *terra sigillata*, used iron and demolished building material like bricks, tiles and flue tiles. No other structures were identified and the postholes formed no coherent pattern. The area immediately west of the fortlet over the backfilled ditches was heavily cobbled but again, no structure was identified there (ROBERTSON 1957, 61–67).

Old Kilpatrick fort probably had an annexe but almost nothing of it has survived. A bathhouse possibly stood inside it, south of the fort, but it was destroyed during the construction

of the Forth-Clyde Canal (see p. 52–53). No ditches or walls of the annexe were identified during the excavations on the site. Pottery stray finds show some occupation during the Roman period east of the fort, but these can hardly be connected with anything specific: they could have equally belonged to the expected vicus as well as to the extending annexe, which probably in the case of this fort included a harbour or a jetty. Only the area immediately next to the south-eastern corner of the fort showed some traces of buildings, largely consisting of brick and tile rubble. Whether these belonged to the latrine, an unexcavated external bathhouse (MILLER 1928, 32, 56), an unattested internal bathhouse or some other building in the annexe is impossible to tell (BAILEY 1994a, 311–312).

Camelon was the only fort in the vicinity of the Antonine Wall that yielded evidence of any substantial buildings in its annexe. In fact, the Antonine fort at Camelon contained two annexes, one to the south (3,2 ha) and one to the north (at least 0,9 ha). At the southern one was a completely excavated bathhouse, mentioned above (p. 50). Another stone building with a hypocaust, found immediately to the south, is usually interpreted as a *Mansio* (Pl. 11). It was built from well-made masonry, 32 m wide and of unknown length. Only one row of four rooms survived, the second southernmost with hypocaust pillars. South of the building a drain was detected, possibly connected to the hypocaust room. Inside the building and in its immediate vicinity were found numerous sherds of *terra sigillata*, *amphoras* and tiles. Traces of at least two more stone buildings were found in this annexe, but their remains were too disturbed to be documented with any precision (BUCHANAN 1901, 371–376). Later excavations revealed that other types of buildings probably dominated the annexe, usually temporary structures represented by only a few postholes. These were probably of irregular shape and housed various types of industrial activity, as traces of hearths, furnaces and rubbish pits frequently intersected their remains (MAXFIELD 1979, 28–32). Metal production and the further processing of iron and bronze were probably some of the chief activities taking place there, as the finds of several lead ingots indicate (BAILEY 1994a, 307–308).

At Cramond, the fortified annexe defended by two ditches was identified immediately north of the fort, probably encompassing the territory between the fort and the coastline (Pl. 10). The ditch goes north uninterrupted and so it is likely that the annexe was part of the original plan of the fort. The most noteworthy feature discovered there was a bathhouse, discussed above (p. 50–51). All that survived from the layout of the annexe are two ditches going roughly northwards beyond the northeast corner of the fort (HOLMES 2003, 3). Apart from the baths, the annexe again hosted some substantial industrial activity, specifically carpentry, ironworking

and leatherworking, as the finds from only a few investigations show. No structures with which to associate these finds have yet been found (COOK – LAWSON – MCLAREN 2017, 64).

At Westerwood, Croy Hill, Bar Hill, Auchendavy, Kirkintilloch and Castlehill, no traces of any annexe attached to the forts were found.

2.2.24 *Forts –civilian settlements (vici)*

Civilian settlements in the vicinity of forts on the Antonine Wall were always expected but have proved to be one of the most elusive features of this Roman frontier. Generally, *vici* were expected to accompany almost every permanent auxiliary base of the Roman Army in the Principate, but almost no traces have been found on the Antonine Wall (SOMMER 2006, 97, 116–117), unlike on the Antonine Wall, where the evidence for their existence is abundant (see p. 175–176). Some indirect evidence will be discussed below, but at present the nearest archaeologically investigated vicus was found at Inveresk (BISHOP 2004, 8–46), which is not part of this study.

At Carriden, the presence of the vicus was evidenced primarily by the find of an altar dedicated to Jupiter Optimus Maximus (RIB 3503) that specifically mentions the dedicators as inhabitants of the civilian settlement next to the fort, *vikani ... Veluniate*. The vicus probably stood between the eastern gate of the fort (the *porta principalis sinistra*) and the Roman field system in the west, in which the mentioned altar was found (RICHMOND – STEER 1957, 1–2). Nothing except for the possible street grid consisting of one crossroad (SOMMER 2006, 115–116) and one potential stake hole has been found so far (CFA 1992, 12–13).

At Mumrills nearly 150 m east of the eastern fort gate, the foundations of a house were found. Its interpretation is uncertain, but associated pits, a kiln and a hearth together with an altar (RIB 2141) may have belonged to a civilian settlement (SMITH 1939, 319–24). The problem is the location: if the excavator really dug 160 yards (146 m) east of the eastern rampart of the Antonine fort at Mumrills (SMITH 1939, 319), he was probably still inside the annexe (MACDONALD 1915, 118; MACDONALD – CURLE 1929, 500–501), whose internal ditch is 152 m away from the *porta principalis sinistra* and 140 m away from the south-western corner of the fort. Whether the vicus could have been in the annexe is discussed further (see p. 68–69). Apart from what has been mentioned already, east of the fort an enclosure was found with only a few scattered postholes, which were hardly Roman. Few finds of pottery and amphora sherds in ditches indicate the Roman origin of the structure itself, but its purpose remains enigmatic (STEER 1963, 96).

At Rough Castle, the origin of the field system and the enclosures southeast of the fort annexe were not confirmed as Roman via excavations (MATÉ 1995, 495–496). No other features indicating the presence of civilian settlement were detected in the vicinity of the fort.

Surprisingly, a lot of evidence was found for the existence of an extramural (possibly civilian) settlement next to the small fort at Croy Hill. The overall plan of the potential vicus remains conjectural, but at least several buildings stood between the southern corner of the fort, the fortlet and the Military Way. The overall plan cannot be reconstructed. Field enclosures or pasture pens were noted nearby and east of the fort (GOODBURN – HASSALL – TOMLIN 1978, 413–415), together with one kiln (HANSON 1979, 19–20).

Successive attempts to find an extramural settlement in the vicinity of Westerwood failed to find anything substantial except for the course of the Military Way and some gullies (KEPPIE 1978, 12–15; FRERE – HASSALL – TOMLIN 1987, 310; FRERE 1989, 270). Several attempts conducted via geophysics failed to find any unequivocal traces of civilian settlement east of Bar Hill (JONES 2006, 58) or anywhere in the vicinity of the fort. No positive trace of civilian settlement was found outside the gates of Bearsden except for a cobbled area and a pivot hole west of the fort (BREEZE 1984, 58). Excavations at Old Kilpatrick showed no evidence of any civilian settlement. One can only be suggested to the east of the fort, where a number of stray finds of Roman material have been claimed (MILLER 1928, 32).

The exact boundaries of the vicus east of the Cramond fort remain unknown (HOLMES 2003, 3), alongside whether within the designated area there was a civilian settlement or rather another annexe of the fort (COOK – LAWSON – MCLAREN 2017, 61–66). As mentioned above (see p. 61), some 80 m south-east of the fort, an industrial complex was excavated with buildings of unknown overall dimensions, probably used for metal processing (HOLMES 2003, 28–33). Otherwise, various sections were cut across the flagged and gravel road going south-east of the fort, the material found including fragments of Antonine and Severan pottery, leather and iron, which cannot be unequivocally attributed solely to the Roman period because the site was also used in the medieval and post-medieval period (COOK – LAWSON – MCLAREN 2017, 44, 55). Whether the finds indicate the presence of extramural civilian settlement remains unresolved.

There are several reasons why so few traces of civilian settlements outside the gates of the Roman forts on the Antonine Wall were found (in comparison for example with the Odenwald Limes – see p. 175–176). The local soil conditions could have ruined the faint and shallow traces of the houses and other timber structures. Alternatively, the traces of *vici* could

have been destroyed by ploughing or subsequent housing development. This situation is expected at Cramond (COOK – LAWSON – MCLAREN 2017, 65), but may also be true elsewhere. Nevertheless, these statements can be used whenever something expected goes unfound. A more interesting approach has been offered by Dr C. Sabastian Sommer, who regards as coincidental the absence of civilian settlements and the abundance and size of the annexes adjacent to the forts of the Antonine Wall. Civilian settlements could have been positioned in more secure areas of the defended annexes (SOMMER 2006, 118–123), possibly because the Antonine Wall was not accompanied by a *vallum* like Hadrian's Wall (BAILEY 1994a, 300). However, outside of the Antonine Wall, no civilian settlement was allowed in the annexe and as noted above, the annexe and the civilian settlement at least at Carriden and Cramond separate entities, while at Bar Hill the putative but never-found vicus was certainly not protected by any ditch or rampart like the annexes. The same can be said about the much better understood Croy Hill. What seems to be much more probable is the fact that certain parts of this frontier were so short-lived or so slightly manned that no meaningful civilian settlement evolved in the vicinity of the majority of excavated forts (e.g. Mumrills, Rough Castle, Castlecary, Westerwood, Bar Hill, Cadder, Balmuildy and Duntocher), or such settlements were represented by just a few buildings (e.g. Croy Hill). The only places where any substantial civilian settlements should have been expected are the coastal bases, where at least at two there is some evidence of *vici* (Carriden and Cramond). As regards the major sites, where a vicus should be expected but was never found, one should also consider Mumrills and Camelon, although excavations have failed to find any evidence for substantial extramural civilian settlement there.

2.2.25 Fortlets

Fortlets were small fortified enclosures attached to the Antonine Wall by their northern wall, occupying on average some 350 m². Excavated examples were protected by one or two ditches. Behind these defensive circuits stood the walls of fortlets, constructed from the same material and in the same fashion as the northern Antonine Wall, only narrower (3,4 m wide at the base on average). In the interior one would expect (though this has not always been confirmed) simple timber buildings resembling smaller versions of barrack blocks known from forts. To the north projected a gate over which a watchtower(s) or platform can be expected. A smaller gate would have been on the opposite side as well. Usually there was no gap in the Antonine Wall ditch in the north, so the existence of any causeway is questionable in general terms, but these may have been present in early phases of fortlets' existence or there was less substantial small bridge, which left practically no archaeological trace. Regardless, at least initially fortlets could have served as a controlled passage through the Antonine Wall because of the provision

of the two gates. All the excavated examples appear to have been constructed before or simultaneously with the Antonine Wall. Fortlets on the Antonine Wall were similar to the milecastles on Hadrian's Wall. Free-standing Roman fortlets were usually considerably larger than those attached to the Antonine Wall (SYMONDS 2009, 955–956). Despite expectations that there were up to 41 fortlets in roughly one Roman mile interval alongside the Antonine Wall (HANSON – MAXWELL 1986, 122), only nine have been confirmed either via prospection or excavations, while for a few more there is some indirect evidence.

The easternmost known fortlet was Kinneil (Pl. 19). It occupied 398 m² and its foundations were laid simultaneously with the Antonine Wall. The fortlet rampart was, like the Antonine Wall in this sector, constructed of clay or turf cheeks and earthen core. One ditch encompassed the site from the east, south and west, while another may have run further away (KEPPIE – WALKER 1981, 150–152). Two entrances were provided, one in the north and one in the south. The gate in the north was more substantial than the southern one, leaving a trace of two rows of five potholes on each side. Above the gateway was probably a tower, whose height can only be postulated, although a conservative value of 3 to 4 m above the ground is used in the spatial analyses (see p. 96). A cobbled road ran through the fortlet, on both sides accompanied by drains. It appears that during the first phase of the fortlet's existence, the interior was relatively densely occupied. On each side of the entrance stood simple timber buildings detected via postholes, which were probably both (despite evidence coming only from the eastern one) internally divided via partitions into four rooms. North of the buildings were less substantial lean-to structures, in which abundant traces of burning were detected. This points to cooking activity and a hearth and an oven were probably originally situated there. In the north-western corner, traces of stairs were detected, which were used to access the upper parts of the rampart and the tower above the gate. A well was located immediately to the south. A possible latrine was situated externally, to the east of the fortlet's north-eastern corner (BAILEY – CANNEL 1996, 337–340). In the second phase of its existence the whole fortlet was radically transformed. Apparently, the barracks were demolished and possibly not rebuilt again. The northern part of the fortlet was resurfaced with gravel and the gate was altered or possibly even demolished and sealed, as the box culvert ran over the original posts. It seems that originally the causeway through the ditch north of the Antonine Wall was developed, only to be removed in this later stage. The ditch was narrower directly in front of the fortlet gate than west or east of it. Whether this happened with the transition to the second phase, when the gate may have ceased operations, is uncertain. Even though the site has been extensively excavated and studied, only a few sherds of pottery have been found, mostly representing amphorae

(BAILEY – CANNEL 1996, 328). Kinneil could theoretically accommodate ca 32 men (BAILEY – CANNEL 1996, 341), but a smaller number should be considered if any commanding officer occupied a single room like in the forts barracks.

The fortlet at Watling Lodge was in general shape similar to its counterpart at Kinneil (only smaller, occupying 287 m²), except for the width of its rampart, which was almost as wide as the Antonine Wall (4,6 m). It was also built simultaneously with the Antonine Wall (HANSON – MAXWELL 1986, 93). Not much of this fortlet was excavated properly (CHRISTISON 1901, 337) and its internal arrangement remains unknown. The causeway at Watling Lodge was not removed in the north like it was at Kinneil, no doubt because Dere Street, an ancient arterial road to Scotland, ran through it (Pl. 19). The road was repaired during the existence of a fortlet at least once (BAILEY 1986, 3-4). One ditch encompassed the fortlet and was not ultimately backfilled but silted up naturally. The only known feature from the interior is a hearth in the south-western corner (BREEZE 1975, 166–173).

At Seabegs Wood, a relatively large fortlet was found, occupying 392 m², with a thick turf rampart of 2,8 m at the base (Pl. 19). It was built simultaneously with the Antonine Wall, which was aligned to it in a north-western direction before turning to the southwest after passing it. The fortlet had the standard two gates, one to the north and one to the south, and the internal road was formed by small rammed pebbles. Three posts only on the eastern side of the fortlet's northern gate were discovered, while at the southern gate only four were documented to the east. It is reasonable to assume that both gates were originally supported by five posts on each side. At a certain point the northern gate was apparently sealed by sandstone blocks. Seabegs Wood was protected in the east by two ditches, which in the south merged into one. A similar arrangement was expected, though not documented, in the west. The interior was never explored but limited prospection showed that its northern part was heavily cobbled, precisely like at Kinneil. The most important finds were several heavily corroded javelin heads and bolts, discovered above the postholes of the southern gate. These must have been deposited there during the final abandonment of the fortlet, which was definitively orderly, as the posts were removed from the postholes despite the site not being burned (KEPPIE – WALKER 1981, 143–146)

The fortlet at Croy Hill is known only via limited trial trenching (Pl. 19). It stood on a prominent plateau, 80 m southwest of the eponymous fort. Croy Hill occupied 407 m² and was protected by one ditch, which was relatively far from the rampart of the fortlet, thus creating an 8 m-wide berm. Construction of the fortlet again apparently took place together with the

Antonine Wall, but nothing of the internal arrangements have been discovered (GOODBURN – HASSALL – TOMLIN 1979, 276–8; HANSON 1977, 12–13).

Glasgow Bridge fortlet was discovered via air reconnaissance as a small ditched enclosure attached to the Antonine Wall (ST. JOSEPH 1955, 20). This was confirmed via magnetometry and resistivity in 2008, but nothing more aside from the positions of the ditches has been documented (STEPHENS 2008).

The fortlet at Wilderness Plantation was identified via aerial reconnaissance (ST. JOSEPH 1976, 12) and later extensively excavated. It occupied roughly 345 m² and was surrounded by two ditches south of the Antonine Wall (Pl. 19). Behind the 4,2 m-wide berm originally stood a turf rampart approximately 3 m wide at the base. Nothing survived from the southern gate, but the northern one was originally supported by 14 posts despite only three on each side surviving. The gate was not excavated to the northernmost edge, so it is not clear whether it was sealed in a later period or whether there was originally a causeway for it in the ditch of the Antonine Wall. From the interior little survived, with the limited evidence pointing to a similar arrangement as in the case of Kinneil: from two buildings only nine postholes survived, while to the north of them was a cooking area represented by two hearths. From these the vast majority of finds were made, mostly consisting of sherds of *mortaria* and coarse wares. No *terra sigillata* was found. No road or path was identified in the interior and the examined drain and culvert ran east to west across its potential course. At a certain point, again similarly to the other fortlets, the interior buildings were dismantled and its ruins were together with the hearths sealed under the layer of cobbles. At a later point, the site was definitively abandoned (WILKES 1974, 51–65).

Summerston fortlet was only briefly examined. It was wedged between the course of the Antonine Wall and the ditch of a temporary camp. Nothing except the outer ditch was excavated of it (MAXWELL – HANSON 1981, 87–88) and only one possible posthole in the interior was identified (GREW – HASSALL – TOMLIN 1981, 320).

The fortlet at Duntocher was certainly built before the construction of the Antonine Wall in its vicinity started (Pl. 19 and Pl. 17). In fact, it must have stood alone for some time, as it was defended by a ditch surrounding it except for to the northeast, where the main gate was located. From this nothing survived, although another gate existed in the southwest, constructed with three massive posts on each side. No causeway through the ditch was provided. The berm had a similar width as at Wilderness Plantation. The original turf rampart was 3,7 m wide, the fortlet occupied 313 m² and the interior was defined by two drainage trenches running parallel to one

another, possibly serving as drainage for the internal road or buildings. Only four postholes represented internal buildings in the first phase. The end of the first phase can be again characterised by cobbling the whole area of the fortlet including the two mentioned trenches. Only at Duntocher were definitely new buildings erected after the interior was cobbled. It seems that the buildings were again similar to those discovered at Kinneil, although the postholes survived in large numbers only in the south-west of the fortlet. In the north-western corner of the fortlet, possible turf stairs were identified. Prior to the construction of the fort, the annexe and the Antonine Wall in the area, the external ditch of the fortlet was backfilled by clay. There is no evidence of the northern gate being sealed at any point and there was never any causeway in the north or any road or path going from the northern gate across the Antonine Wall ditch (ROBERTSON 1957, 16–33).

Only trial trenching took place at Cleddans fortlet. No ditches were found, but they are expected. The fortlet itself occupied an area of some 317 m² and its rampart was 3,8 m wide on average, constructed from turf on stone bedding like the Antonine Wall. The subsequently constructed rampart did not adjoin the corners of the fortlet's northern side as it did in the case of other fortlets, but instead projected to the west some 0,45 m south of the fortlet's north-western corner. Slighter but still recordable misalignment was detected on the eastern side. Nothing from the interior or gates was examined during the excavations in 1980 (KEPPIE – WALKER 1981, 154–156).

The above-described fortlets are sometimes called mile-fortlets as it was long presumed that a certain degree of regularity was applied in the surveying of the Antonine Wall and the subsequent distribution of soldiers to the individual outposts. Up to 37 fortlets were expected to have been originally planned for the Antonine Wall by Professor Gillam (GILLAM 1975, 55). Professors Hanson and Maxwell later decided upon the figure of 41, each separated by roughly one Roman mile (HANSON – MAXWELL 1986, 122, Table 6.4). How the frontier could have been theoretically projected will be examined further in the chapter dedicated to the interpretation of spatial analyses, but it is vital to recognise here that the majority of proposed fortlets have never been found and no evidence for them ever emerged during excavations alongside the course of the Antonine Wall. This lack of success can be divided into several categories: proposed fortlets, which were never found or were at least spotted via aerial prospection; sites of proposed fortlets, which were excavated but nothing was found there; and sites of fortlets that were excavated but the documented evidence remains equivocal at best.

To the first group can be assigned putative fortlet sites at Deanfield (Bo'ness), Callendar House (Falkirk) and Allandale (Greenhill). Here no rescue or trial excavations took place in the vicinity of the Antonine Wall, which would allow traces of the fortlets to be found.

The second and largest group consists of postulated fortlet sites where over the last two centuries some excavations have taken place. Very few of these investigations can be described as systematic research, as they took place either in advance of construction, pipe trenching and so forth, or the excavator tried to verify the width of the Antonine Wall rampart, existence of a fort, fortlet, watchtower or another enigmatic feature identified either by some antiquarian or via aerial photography. Naturally, some sectors of the Antonine Wall were searched so marginally that a single mile-fortlet could have been omitted or all the traces of its original foundations may have been ploughed away. In other instances, however, an intensive search for a fortlet simply produced no evidence that the fortlet ever stood on the designated area roughly 1 Roman mile from its nearest neighbour (Fig. 5).

The point where the Antonine Wall started in the east was sought for a long time with no success. The best evidence still comes from Bridgeness, where a dedication slab commemorating the construction of a section of the Antonine Wall was discovered long ago (RIB 2139). A terminal fortlet was postulated by Professors Hanson and Maxwell roughly between Bridgeness and Grahamsdyke in Bo'ness (HANSON – MAXWELL 1986, 122). However, repeated attempts to locate it in this built-up area have failed (BAILEY – DEVEREUX 1987, 93–104; KEPPIE – BREEZE 1981, 236; DUMVILLE 1994, 293–298). The Antonine Wall may not have terminated at Bridgeness, but more logically at Carriden fort. The evidence for this proposition will be discussed further (see p. 111)

Further west, at Deanfield in Bo'ness, no fortlet was found. The mileage for this whole section of the frontier has been established from the position of the excavated fortlet at Kinneil. One Roman mile further to the west of Deanfield, at Nether Kinneil, successive but limited in scale trenching again failed to find any trace of a fortlet attached to the Antonine Wall (MACDONALD 1925, 277).

Inveravon was for some time presumed as a strategic place for the positioning of a fortlet overlooking the crossing of the River Avon. Current evidence instead points to the existence of a small fort with an annexe in the respective area where the fortlet was expected to be (FRERE – HASSALL – TOMLIN 1992, 262). No positive evidence came from a search of any kind of fortlet in the vicinity of Inveravon fort (DUNWELL – RALSTON 1995, 524).

The next fortlet was presumed to exist roughly two Roman miles further west of Kinneil at Polmont School/Polmonthill, between Grangemouth and Polmont and on a prominent position overlooking the River Avon and Inveravon fort. At this fortlet site, only very limited trenching took place in the vicinity of the Antonine Wall, which nevertheless revealed no archaeological features (ALEXANDER 1995, 13).

Near the proposed site of a fortlet at Beancross, one Roman mile further to the west, several trial trenches were cut through the Antonine Wall, revealing no evidence of any fortlet there (FRERE – HASSAL – TOMLIN 1987, 427, 429; BAILEY 1994b, 8; KEPPIE – BAILEY – DUNWELL – MCBRIEN – SPELLER 1995, 611–616).

Next in the sequence should be the site of the putative fortlet at Laurieston, which will be considered further (see p. 78). Further to the west, in Falkirk, roughly around Callendar House, no meaningful search took place.

The next stop on the Roman mileage should be sought in the vicinity of Bantaskin, still in present Falkirk. Here numerous investigations have revealed no proof of the existence of a fortlet attached to the Antonine Wall (MACDONALD 1934, 121, 123–127; KEPPIE 1976c, 62–63; MURRAY 2007, 92).

Approximately one Roman mile west of Bantaskin, nearly 8 Roman miles on the course of the Antonine Wall from Kinneil, Watling Lodge fortlet is well known (see p. 71). Approximately one Roman mile west another fortlet at Tentfield is expected. However, no such structure has been identified there despite the fact that two expansions were located in the vicinity, but not one Roman mile or its fraction from Watling Lodge (STEER 1959, 161–169, HAMILTON 1998, 38, REES 1999, 45).

At Rough Castle or in its immediate vicinity, no structure resembling a fortlet has been found. A cobbled enclosure inside the annexe (see p. 64) has been mooted as a fortlet, integrated into subsequent structures such as at Duntocher in its late phase (GILLAM 1975, 54). However, the enclosure was too wide for a fortlet of standard proportions on the Antonine Wall and there was no sign of any previous internal arrangement in its interior, as seen in the majority of excavated fortlets on the Antonine Wall. Furthermore, no trace of a separate fortlet rampart was found behind the ditches of Rough Castle's enclosure; rather, there are only traces of posts, which may have supported some form of fence. The position of this feature roughly 1,3 Roman miles from Watling Lodge also does not fit the mile-fortlet formula (GRAAFSTAL – BREEZE – JONES – SYMONDS 2015, 60).

One Roman mile further from the Rough Castle fort was an expected fortlet at Milnquarter. Here the Antonine Wall was sectioned only in a few instances and none of the section brought up any positive trace of a fortlet (KEPPIE – BREEZE 1981, 237). Expansions at Bonnyside East and West lie much closer to the presumed fort (see p. 79–80 and Table 1).

Next in the course of the Antonine Wall a fortlet was expected at Seabegs, ca. four Roman miles from Watling Lodge. It was in fact discovered roughly 3,5 Roman miles from Watling Lodge along the course of the Antonine Wall at Seabegs Wood (see p. 71). Further west another putative fortlet was expected somewhere around Allandale (Greenhill), but no investigation took place there.

On the slopes of a hill ascending between the forts at Castlecary and Westerwood, two fortlets variously called Garnhall/Netherwood/Arniebog/Hag Knowe were intensively sought. Investigations revealed the course of the Antonine Wall and adjacent ditch, an enigmatic structure at Tollpark (see p. 80), but no fortlet (GREW – HASSAL – TOMLIN 1980, 352; KEPPIE – WALKER 1985b, 8; FRERE – HASSAL – TOMLIN 1987, 310; KEPPIE – WALKER 1990, 150). Nevertheless, a watchtower was discovered at Garnhall during one of these searches (WOOLLISCROFT 2008, see also p. 23, 110, 114–115, 217, 137 and 266).

The location of the fort at Westerwood was considered as a spot for a fortlet (in accordance with the theory that some forts were secondary and these may have been preceded by fortlets), but limited excavations on the site brought up no evidence for that (MACDONALD 1933, 277–296, KEPPIE 1978, 12–17, KEPPIE 1996, 83–99).

At Easter Dullatur, roughly one Roman mile from both Westerwood in the east and Croy Hill in the west, another fortlet was expected. Almost no excavations were conducted there and the few attempts that took place were either too far away from the Antonine Wall (KEPPIE 1978, 12–17) or brought up only negative evidence about the existence of a fortlet (ENGL 2010, 118).

The next known fortlet is the one on Croy Hill (see p.71–72), lying roughly 5,8 Roman miles away from Seabegs Wood on the course of the Antonine Wall. Between Croy Hill and Bar Hill, one interval fortlet was expected at Giral Hill, but successive attempts to locate it via trenching and geophysics offered no positive evidence as to its existence (FRERE – HASSAL – TOMLIN 1989, 270; BURNHAM – KEPPIE – ESMONDE CLEARY – HASSALL – TOMLIN 1995, 335; BURNHAM – KEPPIE – ESMONDE CLEARY – HASSALL – TOMLIN 1996, 400).

At Bar Hill a fortlet was also expected, but all the available archaeological evidence points to the existence of a fort, preceded by a surveyor camp (see p. 14–16). Further west,

roughly halfway between the forts at Auchendavy and Bar Hill, another fortlet was expected at Shirva. Again, limited attempts to locate it via trenching and geophysics failed to provide any evidence about its existence (BURNHAM – KEPPIE – ESMONDE CLEARY – HASSALL – TOMLIN 1996, 400; DUNWELL – BAILEY – LESLIE – SMITH 2002, 271–273).

The fort site at Auchendavy and its surroundings were excavated in such a limited fashion that any assessment as to the existence of a fortlet either preceding or neighbouring the fort is not possible (KEPPIE – WALKER 1985a, 29–35). In the section of the Antonine Wall between the forts at Auchendavy and Kirkintilloch, one more fortlet should have been located in what is now Kirkintilloch, roughly around Hillhead. Repetitive attempts to locate it alongside the excavatable parts of the rampart failed to provide any evidence about its existence (BURNHAM – KEPPIE – ESMONDE CLEARY – HASSALL – TOMLIN 1995, 336; SPELLER K. 1995, 92; DUNWELL – BAILEY – LESLIE – SMITH 2002, 284–285; SPELLER – LESLIE 2002, 279–284).

At Kirkintilloch fort or in its vicinity another fortlet was suspected but never found (ROBERTSON 1990, 79–81). Over one Roman mile further away lay Glasgow Bridge fortlet, almost exactly seven Roman miles from Croy Hill on the course of the Antonine Wall.

One more fortlet before the fort at Cadder was further expected at Bogton. In the vicinity of the approximate location of this putative fortlet, Professor MacDonald several times surveyed the path of the Military Way (MACDONALD 1934, 155, 160), which could not have been retraced later. Only shallow traces of the Antonine Wall's rampart were documented further, with no sign of any fortlet (DUNWELL – COLES 1998, 461–479).

One possible fortlet was expected based on the one Roman mile interval between Glasgow Bridge and the known fortlet at Wilderness Plantation (each separated by roughly 2,8 Roman miles) at Cawder House, or more exactly at Cawdor Golf Course (see p. 78–79). Between Wilderness Plantation and Balmuildy one more interval fortlet was proposed at Easter Balmuildy, despite the fort and fortlet being only 1,1 Roman mile apart. No trace of any fortlet was ever evidenced there (PETERSEN 2005). To the east of the fortlet lay minor enclosures at Buchley and Wilderness West.

Less than one Roman mile to the north-west of Balmuildy is the known Summerston fortlet, separated from Wilderness Plantation by 1,9 Roman miles alongside the Antonine Wall. At Crow Hill, near Temple of Boclair, another fortlet was expected thanks to the sharp turn made by the Antonine Wall to the southwest from the top of the hill. This spot was roughly half

a Roman mile from Summerston but no trace of a fortlet was found on the summit (ROBERTSON 1990, 87).

At Manse Burn, in what is now Bearsden, the limited survey and interpretation of antiquarian records showed no positive evidence of the existence of any fortlet before the Antonine Wall reached the eponymous fort (KEPPIE 2008, 59).

Beyond the fort at Thorn Road, which is today in the town of Bearsden, successive rescue excavations revealed no archaeological features in the approximate position of a putative fortlet site around one Roman mile from the fort (RENNIE 2015, 63; MOONEY 2017, 58; ARABAOLAZA 2018, 72).

Next in the course of the Antonine Wall is the little-explored site of a fort at Castlehill, where one fortlet was also expected (HANSON – MAXWELL 1986, 122; KEPPIE 1980, 80–84). Limited geophysical investigation brought no evidence for its existence there, however (JONES – HUGGETT – LESLIE 2008, 59).

The next known fortlet is Cleddans, roughly one Roman mile from Castlehill and 4,8 Roman miles from Summerston on the course of the Antonine Wall . One Roman mile further, another fortlet has long been known at Duntocher (see p. 72–73). Two more fortlets were postulated between Duntocher and Old Kilpatrick. The first one, at Carleith, was sought at three different spots with no success (KEPPIE – WALKER 1980, 33).

The last possible fortlet was supposed to be in the vicinity of Old Kilpatrick fort, near Mount Pleasant farmstead. However, several attempts to verify the position of the Antonine Wall and its ditch revealed no evidence about the existence of any fortlet (KEPPIE – CURTIS 1987, 53; ADDYMAN 2001, 98).

In the two final cases, the evidence is ambiguous. A possible fortlet was identified at Laurieston, between the putative sites at Beancross and Callendar House. The positive evidence consists only of a drain running through the Antonine Wall and two postholes, which, thanks to their alignment could have been supports for the southern gate of the fortlet (BAILEY 2005, 70). The whole excavated area was unfortunately heavily truncated, so the interpretation could vary considerably: the evidence is all based on just two posts in the vicinity of the Antonine Wall.

At Cawder House, or more exactly at Cawdor Golf Course, in 2017 the geophysical survey discovered on the course of the Antonine Wall an anomaly attached to the south of the rampart, which could have been a fortlet or an enclosure (MALDONADO 2018, 71). The spot is

approximately in the middle between the excavated fortlet at Wilderness Plantation and the position of a putative one near Bogton. Both Laurieston and Cawder House were tested via spatial analyses in order to find out how well would they fit to the Antonine Wall frontier system (see p. 102, 104–105, 107–108, 111–113, 115–117, 119–122, 124–125, 139, 141, 143).

Two more free-standing fortlets are part of this study. Lurg Moor and Outerwards both overlook the Firth of Clyde in the west and their landscape settings are so closely connected with the frontier that they can be perceived as integral parts of the Antonine Wall frontier system. Of these, only Outerwards has been properly excavated and the results were subsequently published. This fortlet, despite being roughly rectangular in plan, was circumvented by an oval ditch and occupied 477 m². Two gates cut the 3,8 m-wide turf rampart, one in the north, the other in the south. Traces of gatehouse were documented only in the south, where it appears that the tower above the gate was supported by three pairs of massive posts only. A cobbled road ran through the interior of this fortlet, with a building on each side. Only the western building was examined in detail. This timber-framed structure clearly showed two separate phases of existence, akin to the defences and ditches. Initially it occupied roughly 46,4 m² and despite the fact that not all the internal partitions survived, the northern and more spacious room could have accommodated the officer while the rest of the building was reserved for the soldiers. It can be expected that the eastern building was of similar size, as it was at least of the same width. At the end of the first period of occupation, the whole site was burned down. After some period of disuse (the excavator suggested an interval of five to ten years), the entire interior was clayed and new buildings were erected according to a similar layout (the western one this time occupying 44,1 m²), but no internal division survived. In the subsequent western building, a hearth was found. Just from the proportions it is evident that 13 soldiers maximum could have been sheltered there (NEWALL 1976b, 117).

The never-excavated Lurg Moor fortlet was also protected by one ditch but apparently had only one gate to the south (KEPPIE 2004a, 106), even though the existence of the northern one cannot be disproved (NEWALL 1976a, 54). In the vicinity of the fortlet, sherds of Antonine pottery were found (ROBERTSON 1966, 200) and an annexe may have existed to the west and south of it (NEWALL 1959, 33).

2.2.26 Expansions and minor enclosures

Expansions were structures attached to the rear of the Antonine Wall. To date, only six are known and of these only one, Bonnyside East, has been extensively excavated (Fig. 6). It was erected on a stone base (26,8 m²), which was built later than the foundations of the Antonine

Wall. Above the stone bedding a turf superstructure was erected simultaneously with the Antonine Wall and probably extended as high as the rampart north of it (STEER 1959, 161–168). Underneath this expansion was a quarry pit, possibly used to obtain the material required to construct a road (GRAAFSTAL – BREEZE – JONES – SYMONDS 2015, 61), although other interpretations such as the positions of these were in advance demarcated via cairns are possible (POULTER 2018, 132), though improbable (see p. 15–16). A further 330 m west of Bonnyside East stood another expansion, Bonnyside West, which despite not being excavated, probably looked quite similar. All the known expansions were distributed alongside the frontier in pairs. The already mentioned examples were located west of the Rough Castle fort, two more were confirmed (though not excavated) east of the same fort at Tentfield and two more were sectioned west of the Croy Hill fortlet. The latter two were not built together with the Antonine Wall but slightly later and the western one of them was erected directly on the rock of Croy Hill without extra stone bedding (Glasgow Archaeological Society 1899, 79). Croy West and Croy East were separated from one another by about 140 m along the line of the Antonine Wall. At Tentfield the situation with expansions was further complicated by the fact that at the time of their discovery the eastern one was heavily disturbed by trees while the western one was barely discernible (STEER 1959, 169). The latter was previously reported as a watchtower base by Roy (ROY 1793, 163 and PL. XXXV). Tentfield West was separated from Tentfield East by 590 m along the Antonine Wall and 570 m as the crow flies (see Table 1).

One further expansion was presumed after the excavations at Inveravon in 1991 (DUNWELL – RALSTON 1995, 530–532). However, the excavated features do not resemble other expansions, but rather a rampart base, possibly of a fort or a fortlet at least (HANSON 1999, 47). One more feature resembling expansion was found at Tollpark near a possible watchtower at Garnhall (see p. 76). It was an earthen superstructure abutted to the southern kerb of the Antonine Wall clearly after the construction of the rampart. The remains consisted of a stone platform of 12 m length and 1,8 m width, with extensive traces of burning on top and in the immediate vicinity (KEPPIE – BREEZE 1981, 239–240). No Roman material was found during the excavations and the true purpose of this addition to the Antonine Wall remains unclear, except for the fact that it does not resemble any expansion identified so far. Whether this structure was just a support of the unstable section of the rampart or an access point to a walkway remains a matter of debate.

Expansions were usually interpreted as either observation or signalling platforms. This was further supported by the fact that the only excavated example showed traces of burning, associable with beacon stances or bonfires (MACDONALD 1934, 356–358). Unfortunately, their

true purpose remains rather enigmatic because it is relatively hard to interpret to whom, what and how exactly they could have signalled anything (see p. 123–126, 148–149, 260 and WOOLLISCROFT 1996, 169–170).

Minor enclosures at first glance seem like different types of installations from expansions, although they were attached in a similar fashion to the south of the Antonine Wall. Only three examples in the vicinity of Wilderness Plantation are known and evidence from the only excavated example, Wilderness West, points to the interpretation that the thick turf walls of the enclosure were stratigraphically younger than the rampart of the Antonine Wall (HANSON – MAXWELL 1983, 233–235). Wilderness West was encompassed by a ditch, but beyond that and the thick turf walls, the only attested structure in the interior was a pit backfilled by disturbed turves and earth (Fig. 6). Two other examples, Wilderness East and Buchley, appear not to be divided from each other or from Wilderness Plantation by any constant distance (see Table 1).

Recently it has been suggested that both the expansions and minor enclosures were roughly the same, apart from the fact that the latter were further reinforced by ditches (POULTER 2018, 127). However, the enclosure rampart, despite being slight, encompassed the structure even without seeming to have a superstructure within it (HANSON – MAXWELL 1986, 96) and natural subsoil was not disturbed during the Roman period (HANSON – MAXWELL 1983, 233), so this interpretation is dubious at best. Minor enclosures and expansions were similar to each other only in terms of size: they occupied about 30 m².

Similar scepticism should be applied to the theory about the reasons behind the positioning of the minor enclosures and expansion along the course of the Antonine Wall. Poulter's theory of long-distance alignments (see also p. 123–126, 148–149, 260) was based on the proposition that certain virtual lines connecting some sites on the Antonine Wall were intended to predetermine the position of fortlets, expansions, minor enclosures and even some forts (POULTER 2018, 113–146). The author of this thesis conducted a verification of available measurements in the LIDAR environment via ArcGIS to show that the sites were not distributed along one line exactly, but rather deviated from it sometimes considerably (see Table 3, Fig. 7). The whole logic of long-distance alignments can also be questioned with regard to why the positions of two of the minor enclosures (Buchley and Wilderness West) were supposed to be determined by the southern corner of Balmuildy fort rather than by the position of one of its gates, which were undoubtedly the first features surveyed after the *groma* in the centre of the fort was established (Hyginus, *De munitionibus Castrorum* 12). Similar is the case of possible

long-distance alignment between the Bonnyside West expansion and the possible Inveravon tower, for which no evidence exists. Here again the sites that are supposed to be aligned deviate from the line by some 20 m to 30 m (Tentfield East, Falkirk and Watling Lodge), with some, like Tentfield West or Mumrills, being far beyond any alignment (more than 100 m from their ideal positions on the alignment, see Table 3, Fig. 7). This second case hampers the logic of Rough Castle's gate being "almost" aligned with the Bonnyside West–Inveravon line by its southern gate (still deviating in reality from its supposed alignment by almost 20 m). The redefined system of alignments is offered further below (p. 123–127, 142–149).

It can thus be summarised that no prevailing distance or alignment formula stood behind the positioning of the small features mentioned along the Antonine Wall based on the currently presented evidence. The same was probably valid for the forts and fortlets, which were sometimes separated from one another by distances close to rounded Roman miles, but in other cases they were not (see Table 1). Moreover, for the regular distribution of fortlets, certain sites still need to be located and they were not. The suggested key to understanding the reasons for the positioning of the individual features of the frontier is discussed on p. 91–152.

2.2.27 The Antonine Wall – summary of the building process

The following summary of the building process is mostly based on the evidence presented above as well as the summary recently proposed by Graafstal et al. (GRAAFSTAL – BREEZE – JONES – SYMONDS 2015, 65–66). However, certain points are also taken from the work of MSc Poulter (POULTER 2018, 138) and from the traditional summary compiled by Professors Hanson and Maxwell (HANSON – MAXWELL 1986, 104–136). This summary does not reflect the present author's results, which will be added to this structure below together with results of spatial analyses (p. 142–149, 243–245). Based on the current evidence, the construction of the frontier on the Forth-Clyde isthmus ran as follows:

- 1) Rough estimation of the course of the Antonine Wall and future distribution of manpower needed to both construct and subsequently man the frontier. There are no archaeological traces of these preliminary works except for temporary structures or surveyors' camps on Bar Hill and Croy Hill.
- 2) Selection of optimal positions for permanent installations, including not only almost all of the forts (possibly excluding Croy Hill, but maybe also Westerwood) but also fortlets, expansions and minor enclosures. The Military Way has been surveyed (GRAAFSTAL – BREEZE – JONES – SYMONDS 2015, 66), but due to the absence of a stratigraphic

relationship with other parts of the frontier, it is hard to presume when exactly it was constructed.

- 3) Construction of temporary camps alongside the line of the Antonine Wall and in the vicinity of the forts (in theory partially contemporary with 2, depends on the interpretation of relations between Summerston fortlet and nearby temporary camp and between Garnhall watchtower and nearby temporary camp).
- 4) Beginning of the construction of many forts, including Mumrills, Castlecary, Balmuildy and Old Kilpatrick but possibly also Bar Hill and Auchendavy. Construction works at Cadder and Bearsden probably started as well (GRAAFSTAL – BREEZE – JONES – SYMONDS 2015, 65–66), but the evidence is equivocal in their cases. Foundations of all the excavated fortlets in the eastern and central sectors of the Antonine Wall were also laid at this stage (Kinneil, Watling Lodge, Seabegs Wood, Croy Hill and Wilderness Plantation). Duntocher started as a free-standing fortlet, so it must have preceded the erection of a rampart at its sector but that event might still postdate the construction of other fortlets (excluding Cleddans, which was also constructed before the erection of the Antonine Wall).
- 5) Work on the stone base of the Antonine Wall between individual forts possibly started together with the digging of the ditch. Subsequently, the first alterations to the original plan were made: first the fort at Mumrills was abandoned (see p. 58, 62–63) and then the course of the Wall was aligned to the new one.
- 6) Construction of turf rampart started. Before it was finished, more alterations were made – forts at Croy Hill and Westerwood were added at earliest when the ditch was already dug. Together with the rampart, at least some expansions and minor enclosures as well as some fortlets and forts were constructed (this may be stated only where the stratigraphic relationship between two monuments survived).

No more can be reconstructed based on current evidence. The clearest gaps were in the westernmost sector between Castlehill and Old Kilpatrick as we can only presume that the construction of the Antonine Wall took place there later (HANSON – MAXWELL 1986, 121–136). Any estimation of break based on troop movements was always purely conjectural (*contra* SWAN 1999, 399–480, based on general scepticism regarding any relationship between the ethnic backgrounds of the soldiers and pottery – FULFORD 2010, 67–78, BREEZE 2016, 156–159). Features not adjoining to the mural barrier at least indirectly, like the Military Way, freestanding forts or the watchtower at Garnhall, cannot be added to the sequence with confidence.

2.2.28 Antonine Wall – summary of changes and alterations during its existence

Once the construction of the turf rampart had been completed, the Antonine Wall as a frontier system still underwent several changes. A fundamental problem associated with any interpretation of these changes lies in the absence of an absolute chronology: all the events listed above and summarised below were chronologically relative to one another except for the date of the beginning of construction.

Certain forts were added to the frontier system after the construction of the turf linear barrier across the Forth-Clyde isthmus (traditionally called secondary), whereas others were constructed earlier, together with it (primary), even if in reality the difference could have been a matter of days or weeks (see p. 24–25). Currently it seems that almost all the forts on the Antonine Wall were planned to be part of the frontier from the very beginning, as even for those added later, like Cadder or Rough Castle, the Antonine Wall ditch diggers left the causeway in front of their respective northern gates. The only exceptions were Croy Hill, where the concentration of two expansions, fortlet, fort and surveyors' camp must have had certain succession, and Westerwood, for which again no causeway was left by the ditch diggers (GRAAFSTAL – BREEZE – JONES – SYMONDS 2015, 56–59, 65). The fort at Bar Hill was not attached to the Antonine Wall, so it cannot be determined whether it preceded the rampart or was constructed after it. same can be told about unexcavated Carriden.

Despite the fact that the Antonine Wall was probably built between the majority of forts at least partially simultaneously by different gangs of legionaries, it still seems that the central and eastern sectors were finished before work on the westernmost sector started (HANSON – MAXWELL 1986, 121–136). The change in labour division presented on the distance slabs clearly indicates that between Castlehill and Old Kilpatrick, the Antonine Wall and its ditch were completed at different times. That is manifested by the fact that Duntocher started as a free-standing fortlet, to which the fort and the annexe were added later. Furthermore, at Bearsden the annexe was not added subsequently as was true of the other forts (except Duntocher) but was integral to the plan from the beginning (BREEZE 1984, 61). Therefore, it may be presumed that the decision to add annexes to the frontier posts took place after the eastern and central forts and fortlets were in existence, but before the monument was complete in the west. However, there is no evidence for all the annexes being built at the same time in all the relevant forts, or that a central decision was required for any such action. Evidence tells us only that some of them were secondary features, but as in the case of the Balmuildy bathhouse points, it may not have been such a long interval between the construction of the fort and

construction of the annexe (see p. 48–49, 64). Nevertheless, what is valid for Balmuildy cannot be taken as granted for other sites. So far, the only certainty about the subsequently added annexes is that some of them housed bathhouses and in some of them industrial activity took place. This is clearly insufficient for any general assumption to be made. All the evidence about individual annexes comes from individual sites and is hardly transferable.

Various changes in the internal organisation of forts took place during the existence of the Antonine Wall frontier. Some of them, in fact the majority, can be perceived as daily routine or mundane alterations – rebuilding of bathhouses, repair of latrines, cleaning of ditches, resurfacing of roads, various repairs of buildings, possibly damaged by fire or other natural conditions – all these can be perceived as routine management in forts and are known from other frontiers of the Imperial Rome. Especially for the alterations of bathhouses there is abundant evidence that clearly indicates that bathing-suites were under constant repair and evolution. Other structural changes, however, may have been more significant.

A typical example is when a particular building was replaced by another that apparently fulfilled a different function, or the former building was demolished without being replaced despite the fort remaining occupied. The best case is the reconstruction of barrack blocks at Old Kilpatrick and the subsequent abandonment of the two closest to the central range of the fort without being replaced. This highlights the overall reduction of the garrison of the fort, which could have taken place either via the reduction of the existing unit or its replacement by a smaller unit or detachment of the unit (MILLER, S. N. 1928, 57–58, HODGSON 1995, 34–35). It must be stressed, however, that the available information remains piecemeal, as the *retentura* and *annexe* were never excavated. The possible reconstruction that took place there (or its absence) may provide an explanation for the abandonment of individual barrack blocks in the *praetentura*.

Another significant example comprises the secondary phases of fortlets. Despite cobbling potentially being interpreted as a simple concern about wet conditions and mud inside the structures (GRAAFSTAL – BREEZE – JONES – SYMONDS 2015, 61), no buildings are known from their secondary phases apart from Duntocher, which was exceptional thanks to its attachment to the fort. If no accommodation was provided for soldiers in fortlets, they still had to live and sleep somewhere, probably in forts. However, these do not manifest any enlargement except for the addition of annexes, which never yielded any evidence for contubernial blocks and therefore were not used to accommodate soldiers. The secondary phase of fortlets' existence may therefore be related with a certain reduction in the overall garrison of the

Antonine Wall. Nevertheless, this was only small, as the fortlets were obviously unable to accommodate more than 208 men in total because only ten were confirmed with certainty (see p. 69–79 and Table 4).

More significant evidence of changes during the existence of the Antonine Wall comes from Cadder. The *praetorium* was obviously turned into a workshop at a certain point of the fort's existence. Despite evidence for industrial activity at Cadder being deep in general, this fact still stands out. The question at hand is where the commanding officer resided after his apartment became a workshop? Or, more logically, where and why did he leave this fort despite his men (or at least some of them) remaining there for a considerable amount of time, during which they still performed crafts and made alterations to the fort buildings? The answer to this question is hard to find, as the evidence does not indicate how long such an arrangement lasted, but it seems that for a certain period no commanding officer's accommodation was required at Cadder. This must be the only logical explanation for its apparent absence from an otherwise densely occupied fort. Moreover, at a certain point the *principia* was turned into a workshop at Cadder.

Evidence from Bar Hill, where the only building identifiable as a commander's house was again turned into a workshop (albeit the evidence is much more equivocal here, see 41), additionally points to the increase in industrial activity at the expense of living quarters. If this information is combined with the fact that no *praetorium* was probably ever constructed at Bearsden and Duntocher, a pattern can be discerned. The size of many forts did not allow the full auxiliary unit to reside there (KEPPIE 2006, 1140). This fact was first noted a long time ago and if it is combined with faint traces of the presence of legionaries in many forts (which, however, may be also related to building activity and subsequent repairs, see p. 245–246), it is clear that various stretches of the frontier were controlled by supposed task forces, or garrisons merged from various soldiers from different units. To this pattern can be added the small structures such as fortlets, where one can also anticipate the presence of detachments from larger bases. This helps to explain the presence of dedications, altars, building inscriptions and tombstones of soldiers from different units at various sites. It makes much more sense than expectations of large-scale troop movements, which were supposed to be occurring between two periods of occupation of the Antonine Wall, for which in fact only very limited evidence exists (HODGSON 1995, 29–49).

The above-mentioned evidence also shows that this arrangement was not everywhere applied from the beginning. At least Cadder and possibly Bar Hill were forts large enough to

accommodate a full auxiliary unit and they probably initially did so, as the space behind the ramparts was allocated for the construction of a sufficient number of barrack blocks and other buildings necessary for a “standard” fort (see Table 4). The garrison of the Antonine Wall was still never planned in a clearly arranged fashion of “one fort for one unit”. Instead, it seems to have been irregular from the beginning, only to be altered later even further. This alteration may have been connected with the reduction of troops on the frontier, a fact that was noticed some time ago (KEPPIE 2006, 1135–1145).

Limited evidence thus shows two trends during the existence of the Antonine Wall: increasing industrial focus, represented by the transformation of various non-industrial buildings to industrial and storage blocks; and a slight decrease in the provision of accommodation for both soldiers and officers in the later phase. It must be stressed that these events or rather trends cannot be dated absolutely, only relatively. Indeed, the buildings and rooms within them, which were initially used for living or administrative purposes (the best examples being the Bar Hill *principia* and bathhouse, the Cadder *principia* and *praetorium*, and the Old Kilpatrick barracks and fortlets in general), later were no longer used or were transformed into storage space or workshops.

An alternative to this view has been presented by Professor L. J. F. Keppie (KEPPIE 2006, 1135–1146). In his view, the Antonine Wall forts were never fully occupied as excavations at many sites have failed to provide positive evidence for internal buildings, notably barrack blocks. Nevertheless, one should take into consideration that many of these excavations took place at the beginning of 20th century (e.g. Castlecary, Mumrills and Westerwood) and what was not detected were rows of postholes, which are sometimes hard to distinguish even with modern methods of archaeological survey. In particular, it would have been strange for Romans to build forts larger than necessary just to have empty space inside and further build annexes to these already half empty forts. Such behaviour would seem extremely irrational, especially with regard to the fact that many of the Antonine Wall forts were similar in size to continental Numeruskastellen and the Romans did not hesitate to build even smaller forts on the Scottish frontier, like Duntocher or Inveravon, which were roughly parallel to free-standing fortlets in dimensions and no doubt also in the provision of the garrisons (see p. 36, 177–179, 263–264).

The author therefore suggests that the Antonine Wall forts and fortlets were designed to accommodate the traditionally believed number of 6000 – 7000 soldiers (HANSON – MAXWELL 1986, 169, BREEZE 2008, 103, for details see also p. 260–268). Whether such figures ever served

on the frontier cannot be verified, but the fact that these sites were designed for them seems to be more plausible than that they were planned for a lower number like 4500 – 5000 soldiers (*contra* KEPPIE 2006, 1136). However, there were strong indications of a certain reduction in the size of the garrisons in some installations (most notably at Cadder and Old Kilpatrick, although the fortlets should not be omitted). This was previously related to the Mauritanian campaign of Antoninus Pius, into which the soldiers from the whole province *Britannia* were supposed to be sent in *vexillatio* (SWAN 1999, 429–435). Although this could have happened, the point of the whole argument was based on the presence of “North African-style” pottery in forts like Bearsden or Bar Hill, which was supposed to be imported and produced on the outposts of the northernmost frontier by men recruited in Northern Africa. Recent pottery studies as well as evidence from Bearsden itself contradict this theory and it seems much more realistic that the pottery was under the influence of production in present day southern France, being also imported to the Antonine Wall as part of broader military supply (FULFORD, M. 2010, 67–78, BREEZE 2016, 156–159, see also p. 48, 83).

The second trend of increased industrial activity at the forts is much harder to interpret. One of the explanations could be the absence of any meaningful *vici* in the vicinity of the majority of Roman forts: soldiers may have been pushed to produce certain supplies for themselves and repair their equipment. Several locally produced wares were attested in the context of Roman forts on the Antonine Wall (HARTLEY 1976, 81–89, BREEZE 1986, 185–189).

2.2.29 *Abandonment of the Antonine Wall*

There is no literary evidence concerning the Roman withdrawal from Scotland in 2nd century AD or the abandonment of the Antonine Wall itself. The whole province of *Britannia* was in fact mentioned in the historical records in only a few instances during 2nd century AD following the construction of the Antonine Wall. Even descriptions of the political and military situation on the frontier before the campaigns of Septimius Severus and Caracalla in Caledonia (SHA, *Historia Augusta*, Marcus 8.8, 8.22, Cassius Dio, *Roman history* 71.16) do not specify anything about the Antonine Wall or Hadrian’s Wall.

The combination of alterations and changes on the Antonine Wall during its existence was previously related to events on the continent late in the reign of Antoninus Pius and early in the reign of Marcus Aurelius. The following hypothesis was mostly based on the epigraphic evidence and its correct reading as well as putting it into a wider context of archaeological finds not only from the Antonine Wall, but the whole of northern Britain. Specifically, it was the presence of British troops at war with the *Chatti* and the putative revolt of the *Brigantians* in

what is now northern England, combined with the subsequent presence of Roman troops from Germany in northern Britain, that provided convincing evidence (SPEIDEL 1987, 233–237) for the fact that in a period of crisis the Antonine Wall was abandoned, only to be briefly reoccupied soon afterwards and then definitively abandoned at some point after 163 AD (HANSON – MAXWELL 1986, 145–151). This theory was especially appealing because it gave a certain demarcation of timescales for the events, which were above described as relative to each other. Moreover, it explained the number of alterations and possible troop movements in the forts of the Antonine Wall as well as the possible large-scale destructions at Old Kilpatrick (MILLER 1928 57–58; see p. 56–57), Balmuildy (MILLER 1922, 25; see p. 55–56) and Outerwards (NEWALL 1976b; 117, see p. 79). Thus, the events on the Antonine Wall might have been divided across the Antonine I (142 AD – 158 AD) and Antonine II (158 AD – 164 AD) periods. The whole sequence seemed to be backed by the events taking place at Hadrian’s Wall, where the epigraphy again indicates the reoccupation of the principal forts on this frontier in the sixth decade of 2nd century AD (HANSON – MAXWELL 1986, 142–143).

Scepticism of this theory was offered by Dr N. Hodgson who, after re-evaluating the evidence at hand, stressed that not every alteration at the individual forts can be regarded as an independent phase in the existence of such a fort, and that almost no site on the Antonine Wall provided any evidence for at least a temporary break in occupation (HODGSON 1995, 33–34). His further point that frontier was at certain moment reorganised rather than abandoned was already mentioned above (see p. 38, 56, 85), but Hodgson also did not present any conclusive evidence that individual changes in individual forts were interconnected with one another and that they took place at the same time. However, there seems to be no substantial break in occupation at any of the Antonine Wall forts until the Wall’s definitive abandonment.

Currently available archaeological data about this event points to the sixth decade of the 2nd century AD. No epigraphic evidence from the frontier mentions other or later emperors than Antoninus Pius. With the exception of Old Kilpatrick, no coins found in stratified contexts on the Antonine Wall were casted after the death of Antoninus Pius. Furthermore, a comparison of *terra sigillata* stamps from both the Antonine Wall and Hadrian’s Wall has shown only a 5% overlap between attested potter stamps, indicating that both walls were occupied only briefly before one was abandoned in favour of the other (HARTLEY 1972, 22–26). The value of this information further increases with the attested reconstructions of forts on Hadrian’s Wall in the sixth decade of the 2nd century AD under governor Calpurnius Agricola (in office between 162–166 AD), most notably at Chesterholm (RIB 1703), Corbridge (RIB 1149) and Ribchester (RIB

589) and with further evidence for his presence on the northern frontier (RIB 1809, RIB 1137 and RIB 1792).

Despite the date being generally acceptable, it is contradicted by some evidence. At Old Kilpatrick a coin casted between 164 AD and 169 AD was found in a stratified context (MILLER 1928, 34; ABDY 2002, 192). Finds of other post-Antonine coins in the vicinity of the Antonine Wall forts have also come from non-stratified contexts (MANN 1998, 132–133) and although they may not all have been stray finds, their value for a general dating of the Antonine Wall is significantly lower than the value of other evidence. An altar found in the vicinity of Castlecary (RIB 2148) contains a dedication that could hardly have been used before 175–190 AD (HANSON – MAXWELL 1986, 197; MANN 1963, 483–489). Certain pottery at Mumrills may have been dated to late 2nd century but it is not from the stratified levels again, just like the coin associated with them (ROBERTSON 1961, 134; HODGSON 1995, 39).

The evidence presented does not contradict the abandonment of the Antonine Wall during the sixth decade of the 2nd century AD. The retreat was obviously done in an orderly fashion and it is only logical that some sites in such circumstances were evacuated earlier and others later. The coastal bases were probably evacuated and abandoned last, as evidence suggests in the case of Old Kilpatrick. At Cramond fort was several times suggested continuous occupation between the Antonine and Severan period (RAE – RAE 1974, 174, HOLMES 2003, 150), but the site was not excavated extensively enough to offer conclusive evidence. Retaining the other principal sites on the Antonine Wall in operation for slightly longer periods also fits well with the evidence from Castlecary and Mumrills, although Hodgson's proposition about Cadder among these sites (HODGSON 1995, 39) is based on the much shallower evidence of just one coin from a non-stratified context. Whether extensive industrial activity at this fort can be related with its prolonged existence is less clear, especially if we take into consideration that such an outpost lacked accommodation for a commanding officer or an adequate headquarters. The extended existence of a certain outpost beyond the re-occupied Hadrian's Wall in southern Scotland has been proved, most notably at Newstead (RICHMOND 1952, 36–37). Furthermore, the outpost fort system was applied to the Antonine frontier in Scotland as well, where the function of the farthest one fulfilled the fort at Bertha, more than 50 km north of the Antonine Wall.

As mentioned above, the archaeological evidence for the abandonment of the Antonine Wall mostly points to the ordered and planned evacuation of individual sites. This included deliberately destroying the buildings, salvaging reusable materials, destroying or hiding non-

transportable valuables and backfilling the ditches. The rampart of the Antonine Wall itself was not levelled and the adjacent ditch was not backfilled. Similarly, it seems that the ramparts of most of the forts were not levelled, because Roy was able to trace many of them, including those lost today thanks to ploughing or other modern developments (ROY 1793, Plate XXXV).

Internal buildings were dismantled prior to burning them down. This was standard Roman military practice (HANSON 1978, 302–304), for which parallels are known from elsewhere (PITTS – ST. JOSEPH 1985, 52, 109–113) and finds of used claw tools provided further evidence for that at Bearsden (BREEZE 1979, 25). Where attested, the burnt material was usually concentrated in the interior of former buildings (MACDONALD – CURLE 1929, 439, MILLER 1928, 29), also hinting to an orderly demolition, as an uncontrolled fire across the fort would no doubt spread the ashes even further. The best evidence for the orderly abandonment of the forts on the Antonine Wall comes from the well-excavated sites at Rough Castle and Bar Hill. At both sites the secondary re-deposition of much of the valuable material into the well in the courtyard at the headquarters was evidenced. While only one inscription (RIB 2145) was found at Rough Castle (BUCHANAN – CHRISTISON – ANDERSON 1905, 470–474), deposits at Bar Hill were much richer (among other things mentioned on p. 37–38 also RIB 2169 and RIB 2170), containing various inscriptions and objects of daily use in the fort, including a sack of apparently used and burned nails (ROBERTSON 1975, 12).

Laboriously erected inscribed stones were either left *in situ* (e.g. RIB 2146, RIB 2184, RIB 2189, RIB 2190, RIB 2193) or were ritually buried under the ground, like distance slabs RIB 2197, RIB 2198 or RIB 3507 that were removed from the Antonine Wall and hidden in specially dug pits. A similar treatment was sometimes applied to altars, as the evidence from the vicinity of the Auchendavy fort indicates (RIB 2174, RIB 2175, RIB 2176, RIB 2177, RIB 2178). Sometimes the inscribed stones were simply thrust into the forts' ditches (RIB 3509). In general, no pattern or standard behaviour could be observed in the approach to the inscribed stones by the Roman army departing from the Antonine Wall. Any interpretation is further hampered by the fact that for the majority of inscribed stones now displayed in the Hunterian Museum, the notes about find spots and find context are either very sketchy or entirely absent (KEPPIE 1998, 47–48, 52, 70).

2.3 Interpretation via spatial analyses

2.3.1 *Introduction*

The core, heuristic part of this thesis deals with the spatial analyses, their application to Roman frontiers and the general implications that can be deduced from their interpretation. One of the reasons behind performing such analyses specifically on the Antonine Wall and the Odenwald Limes was to verify otherwise vague statements like the “fort was strategically positioned in the landscape”, “the site offered an excellent view to a nearby valley”, or the “fortlet was built in an excellent position in order to block south-northern communication”. Until the 1990s the verification of such statements was merely based on the “strategic view”, which some scholars simply had, alongside the detailed interpretation of topographical maps. Given that such maps were unavailable to the Roman frontier surveyors and builders, deciphering the qualities of topographical choice for individual frontier features was in their case solely based on their ability to understand the landscape and the behaviour of the people living within it. Of course, any site selection was dependent on planners’ prerequisites, such as the qualities they demanded from the spot chosen for permanent installation.

We know that defence was not a Roman priority until late antiquity. In the case of forts, we can presume that easy access to drinkable water was a priority as well as geologically stable ground for non-waterlogged foundations. Gently sloping hillsides were preferred to flat areas or hilltops. The positioning of a permanent base in the immediate vicinity of either a Roman or a pre-Roman communication nexus also seems to have been one of the logical factors, although in certain cases it is worth asking what came first, the chicken or the egg? Many other reasons may also have played a role, like proximity to a civilian/native/enemy settlement, proximity to arable ground, distance from the next nearest Roman military installation, blocking or controlling convenient communications and so forth (JOHNSON 1983, 36–38; BREEZE 1994, 47; RICHARDSON 2004, 32–33, 47–49; DOBSON 2009, 25–33).

Watchtowers were logically built in spots that would facilitate the observation of the frontier area (BAATZ 1976, 45–49). Whether the same was required of the gate and corner towers of forts and fortlets is less clear. If yes, the whole position of a permanent site would be dictated by visibility to the environs in extreme interpretation; if no, the whole structure would be a mere sentry post linked to an access point in the interior, again in extreme interpretation. It is obvious that these sometimes-contradictory requirements were balanced by a compromise.

What role the fortlets on the Antonine Wall played is enigmatic. There were important differences between the free-standing fortlets and so-called milecastles or mile-fortlets on Hadrian's Wall and Antonine Wall: the latter's were much smaller and their positions were at least in one axis dictated by the existence of a mural barrier (SYMONDS 2009, 955–956). They could have been distributed alongside the frontier with no respect to local topography, for example in a 1 or 1,1 Roman mile interval (GILLAM 1975, 51–56; HANSON – MAXWELL 1986, 121–123). They may have deviated from this formula to fit the intervisibility pattern as signal posts (WOOLLISCROFT 1996, 158–166). Moreover, they may have been located where they were thanks to the need to provide frontier crossings (BREEZE 1975, 173), or due to a desire to provide observation platform for sentries trying to prevent low-scale raiding (SYMONDS 2009, 959). Some, all or even none of these reasons might have been stressed when their locations were chosen. The evidence summarised in the previous chapter clearly points to the fact that they were permanently occupied by a garrison at least until their interior was cobbled, unlike expansions and minor enclosures, in which cases no accommodation for soldiers was identified.

Instead of interpreting the prerequisites Roman surveyors may have been seeking when positioning permanent installations on the frontier, the author of this thesis opted to interpret the sites themselves and ascertain the qualities they naturally possessed. This could have been done at the sites themselves, but apart from the fact that the author may lacked a proper “strategic view” to evaluate the qualities of the individual sites, other complications emerged. For instance, today the landscape has fundamentally different tree coverage from the past, with modern infrastructure blocking the views to many areas and general movement in the landscape is now not only directed by modern roads but is also restricted by fences and other artificial boundaries. These limitations gave the author the impetus to move to the interpretation of the frontiers via spatial analyses in artificial environment, where the model of our world, despite being imperfect and imprecise, can be altered, with the constraints removed. The first and highly necessary alteration was to remove trees from the study area, as these fundamentally block the views, potentially hampering one's whole interpretation of the frontier's visibility and accessibility. Furthermore, it seems that specifically in the context of the Antonine Wall and many of its sites, the tree coverage in antiquity was generally less than it is today, with the landscape of the Antonine Wall being significantly deforested even 300–400 years prior to its construction (RAMSAY – DICKSON 1997, 146; PEATY 1998, 211; PEATY 2001, 660–663; TIPPING – TISDALL 2005, 454–460). In addition, the Romans were known to deforest stretches of land in the frontier area where they deemed it necessary (Frontinus, *Stratagems* I.3.10). All in all,

spatial analyses in GIS offer a sophisticated and relatively cheap way to answer the questions drafted above and summarised in detail just below.

2.3.2 Spatial analyses and the Antonine Wall – questions and goals

The main goal of the analyses was to decipher the qualities of the landscape positioning of the individual features of the Antonine frontier system in Scotland. Practically, visibility and accessibility were tested. The nodal questions can be summarised as follows:

Were forts, fortlets and other small features on the Antonine Wall intervisible to each other? To what extent was intervisibility important to the planners and surveyors of the frontier? Does the distribution of sites throughout the landscape indicate that they were positioned in order to be intervisible, or was there any other spatial pattern in place, like the alignment of the sites to one or more lines? Were forts and fortlets distributed alongside the frontier according to a regular pattern?

What kind of landscape observation did the spots chosen for Roman installations offer? In which areas did they offer the best views? Were any areas out of sentries' lines of sight from permanent installations? And if yes, can we suspect that some unidentified Roman sites existed on spots with favourable views over these neglected areas?

How well positioned were the sites on the frontier in terms of accessibility? In many cases the forts and fortlets were in the immediate vicinity of a river or a stream and therefore no doubt guarded a river crossing or benefitted from proximity to river transport. But what about the others? Were they in the best spot to block the most convenient north-south communication? Or were they distributed in roughly equal intervals on the east-west axis?

The main goal can therefore be summarised as the spatial interpretation of Limes. The potential answers cannot be taken as more than suggestions or logical implications, pointing to how the frontier was surveyed or to the prerequisites for individual installations on the frontier based on their setting in the landscape. Naturally, many of the results are in accordance with general assumptions about the Antonine Wall. However, others are contradictory. There is also a certain amount of overlap between the results of this thesis and the work of other scholars, most notably Dr David J. Woolliscroft (WOOLLISCROFT 1996; WOOLLISCROFT 2001) and MSc John Poulter (POULTER 2009; POULTER 2018). Where necessary, their results and implications are therefore discussed and put into the context of the results of the presented study.

2.3.3 Spatial analyses and the Antonine Wall – methodology of viewshed analysis

The main tools used in this thesis are so-called viewshed and cost path analyses, performed using the ArcGIS 10.4 programme. Each analysis is ultimately dependent on the quality of input data. For detailed information, see Appendix 1.

Viewshed analysis is a tool used to determine mutual visibility between two cells in a raster (digital elevation model, DEM). The points mentioned below, representing either the gates or the central spots of smaller installations, are the observation locations (see Table 2). For each individual cell in the whole raster, a simple question is asked by the programme: is it visible from the exact coordinates of an observation location, or is the line of sight to it blocked by the elevation of some other cell, which is high enough to obstruct the direct line of sight in Euclidean space? The processed result of viewshed analysis is a binary raster, where a positive answer to the question of intervisibility is symbolised by a value of 1 and a negative answer by a value of 0. This tool has been used successfully in archaeology for a relatively long time (CHAPMAN 2006, 83–85; CONOLLY – LAKE 2006, 225–233; HOWARD 2007, 281–282).

Viewshed analysis was performed in DEM based on the LIDAR data (see Appendix 1) for each site separately. For all forts, the analysis was calculated from the positions of all fort gates, excluding Bishopton/White Moss, where the exact coordinates of the individual gates could not have been determined due to the absence of a comprehensive excavation report (NEWALL 1955, 123), as well as Inveravon, where the single observation point for a fort or a fortlet (FRERE – HASSALL – TOMLIN 1992, 262) or an expansion (DUNWELL – RALSTON 1995, 530–532) was used, based on the excavation report. For all other small installations (expansions, minor enclosures, watchtower) the analysis was calculated from the approximate central position of the installation. Only for fortlets from the position of the northern gate was used (see Table 2).

The search for the exact coordinates of the individual sites was usually twofold. Initially the reference from the excavation report was taken as an approximate position of the installation. The approximate area was then further searched in several versions of image analysis of LIDAR data and, if traces of ditches or ramparts were identified, the coordinates were obtained from the central point of (for example) a gate. If no physical traces could be found in the LIDAR, the excavation reports were searched for any drawings or plans, which were then imported to ArcGIS in proper scale as referenced layers. From these positions of individual features were determined (if in the plan there were any physical features additionally visible also on the LIDAR and correlation could thus be made). In cases where neither of these

methods was applicable, only the approximate positions of the sites were used as stated in the RCAHMS database, access to which was kindly provided by RCAHMS (licence number IMSL-IR-54739). All the coordinates for all the points of observation can be found in Table 2, where detailed information about the means of attaining these coordinates and their approximate accuracy are offered in a note.

The viewshed analysis was always calculated from the height of 5 m (OFFSETA) above the surface of the studied raster (if not stated otherwise), compensating for the minimum height of the installations (consisting of the approximate height of the Antonine Wall, which was more than 3 m above the ground, and adult male height, less than 2 m). It is quite likely that the positions of the observers in the towers above the gates of forts like Castlecary or Balmuildy were in fact in more elevated positions (see p. 32–34), but to keep the analysis simple, only minimalistic values were used (the general line of sight thus could have been only better than stated). If higher OFFSETA or OFFSETB were used, it was usually only on the experimental basis or in cases where it could be justified, like in the case of the watchtower at Garnhall, where a 9 m OFFSETA was applied because of an explicit statement by the excavator that this structure was a watchtower (WOOLLISCROFT 2008, 163).

In his limited study of intervisibility on the Antonine Wall, MSc Poulter used the 7,6 m high offset, which he based on the approximate minimum height of the watchtowers on the Limes in present-day Germany (POULTER 2018, 114). Nevertheless, his results in terms of the intervisibility of individual sites were almost the same as the authors. For similar analyses on Hadrian's Wall, Alberto Foglia used even more optimistic offset values (8,9 m and 11,9 m), primarily due to the assumption that the stone structures of this frontier were higher than the earthen and timber structures on the Antonine Wall (FOGLIA 2014, 40).

In order to determine the intervisibility between individual points in the analysis, the 5m OFFSETB was also applied, together with OFFSETA. Thus, the line of sight was calculated not only from an elevation of 5 m above the ground (altitude of the line of sight of the observer – signal transmitter) but also to the top of a hypothetical 5 m-tall platform (altitude of the line of sight of the observed – signal receiver), which would be seen even in spots where the base of that hypothetical platform would remain invisible through obstruction by the terrain (CONOLLY – LAKE 2006, 229–230). In other words, two platforms could have been intervisible even if the observers could not see the ground on which the other platform was standing, they could still see the top of the opposite platform.

2.3.4 Spatial analyses and the Antonine Wall – methodology of cost path analysis

Cost path analysis is a method used to calculate the optimal or semi-optimal path through the landscape in an artificial environment. The term “optimal” comprises the balanced amount of time spent travelling, the effort one has to spend climbing up various slopes and of course the distance one has to travel. Every GIS programme uses different algorithms to calculate the balance of these parameters. Therefore, with the same data set but different software, slightly different results can be gained when conducting a cost path analysis between the same sites. Nevertheless, cost path algorithms are generally designed to efficiently find the path with the minimum total cost, so the general directions of the calculated paths are usually the same regardless of the software, the results being determined by the landscape itself (BELL – LOCK 2000, 86; WHEATLEY 2002, 151–159; CHAPMAN 2006, 107–111; CONOLLY – LAKE 2006, 213–225, 234–262).

This thesis only used cost path analysis in several instances, despite the author’s initial intention for a much wider usage. The positioning of most of the sites was either self-evident from the local topography or could be deduced on the intervisibility basis, hence despite testing some sites’ positions in terms of accessibility, no meaningful results worthy of publication were made. The second major limitation of this study was the landscape change: despite the altitudes of the hills and the general look of the landscape along the course of the Antonine Wall not changing since Roman times, the low-lying areas around the Firth of Forth, the Firth of Clyde and the Kelvin Valley immediately north of the Antonine Wall were all prone to flooding and periodically becoming marshland prior to the construction of the Forth Clyde Canal in 18th century as well as various other drainage works in 19th century (TIPPING – TISDALL 2005, 446–447). It is evident that some parts of the landscape were not suitable for building a road, but it is almost impossible to determine the exact boundaries of these in respective periods as well as the positions of river crossings used in respective periods. Disappointingly, despite the results of various software varying in terms of the results of cost path analysis, they all tended to follow very low-lying paths throughout the Antonine Wall landscape, which would have been impractical not only for the Romans. All the author’s attempts to “force” the software to avoid these areas lead only to the non-realistic and indirect path courses. Furthermore, wherever the Military Way was excavated or surveyed, it followed the course of the Antonine Wall with just a few shortcuts, despite probably being built as the first feature of the frontier. The Wall itself appeared to have been planned according to the “best field of view” – going in zig-zag course from one turning point to another, only roughly respecting the landscape between individual forts and fortlets (POULTER 2009, 120) – so the course of the road in reality follows the most

convenient course only haphazardly. The only other usage of cost path analysis was thus to evaluate the accessibility of individual sites from the area beyond the frontier, north of the Antonine Wall. Here the above-mentioned limitation arose: one could not be certain of which parts of the low-lying ground in the vicinity of the numerous tributaries of the Kelvin, Clyde, Avon and Forth were solid in Roman times, and which were inaccessible. This constraint clearly manifested itself in the case study of Balmuildy and so for the majority of sites only simplistic analysis via an interpretation of the slope in the site environs was used (see p. 133–140).

2.3.5 General visibility to the landscape

A good point at which to commence the interpretation of the Antonine Wall via viewshed analysis is the most elevated site on the Antonine Wall, Bar Hill. From the position of the four fort gates, the slopes of the Campsie Fells and the Kelvin Valley were visible (Fig. 2). In the north-eastern direction the view was obstructed by the prehistoric and never properly excavated site at Castle Hill. Nevertheless, from Bar Hill a sentry at the northern gate of the fort could see the surroundings of present-day Kilsyth and theoretically as far as the village of Hight Banton, which is more than 10 km away to the north-east. To the east the line of sight from the *porta principalis dextra* was relatively restricted, but the surroundings of Giral Hill and Croy Hill were observable even though one would not have been able to see much further. The southern line of sight was good as far as contemporary Mollinsburn village, more than 8 km away from the fort. However, the sentry post on top of sealed *porta principalis sinistra* provided the best view, as one could theoretically see most of the surroundings of the central and western sections of the Antonine Wall. The position of Bar Hill offered a clear view as far as the present-day village of Torrance 15 km away or the surroundings of Lennoxton lying north-west of the fort some 9 km away. The combined line of sight of all the Bar Hill gate towers covered a respectable area of 420 km² in a 10 km perimeter. Even if the perimeter is halved, still some 59,74 km² of the landscape remains visible from the position of the fort, which is almost double the average value of the visible area from all the other installations on the Antonine Wall (see Table 5). Truly, the view from Bar Hill covered the better part of the Forth-Clyde isthmus and no other fort on the Antonine Wall had such a good line of sight to its environs.

Indeed, the other forts had an inferior line of sight in comparison to Bar Hill. The sentries from the gatehouses of Mumrills fort had a relatively limited line of sight in the western and eastern directions, seeing not much further than to the positions of the neighbouring sites and a less than 1 km perimeter around the fort (Fig. 8). Only the *porta praetoria* provided a

good line of sight to the better part of the Firth of Forth and as far as the present-day towns of Stenhousemuir and Airth Castle.

From Camelon on the other hand, the sentries had an excellent line of sight in all directions in more than a 3 km perimeter around the fort, although beyond that little more would have been seen. This may be the reason why not even 15 km² of the landscape was visible from the fort in a 5 km perimeter (Fig. 9).

From the four gates of Castlecary fort the sentries had a very limited line of sight to the east, west and south. Only to the north-east and north-west could one see beyond a 1 km perimeter (Fig. 10).

Auchendavy offered a very restricted line of sight to the south and only a limited view in the north-western direction. Not even much of the Kelvin Valley could be seen from the position of this fort and almost nothing that is already visible from Bar Hill can be seen from here (Fig. 11).

Balmuirdy had even worse results in terms of visibility to the landscape (Fig. 12). Indeed, from this fort not even a 1 km perimeter was theoretically observable. Neither Carriden nor Old Kilpatrick had any meaningful line of sight to the inland. Carriden had an excellent view over the shore between the present-day villages of Kincardine and North Queensferry and the area observable from the fort was some 35,7 km² in a 5 km perimeter (see Table 5). The edge of the line of sight from this fort ended precisely at the extremity of the line of sight from Cramond (Fig. 13, 19). From Cramond, again nothing was visible of the hinterland, but the sentries had an excellent view over the shore of the Fife Peninsula between contemporary North Queensferry and Kinghorn village (Fig. 14). As Cramond was a seaside fort, one could see from there well beyond the island of Inchkeith, all the way to the horizon, which is nearly 20 km away if one looks from the top of the *porta decumana* there.

The position of the fort at Old Kilpatrick offered a relatively good line of sight over the coastline between present-day Bishopton and Greenock. Again, almost nothing could have been seen from the fort to the north and east (Fig. 15). Furthermore, the sentries from the *porta praetoria* had no line of sight to the non-Roman coast in the west. This area was visible in some detail for soldiers on watch duty in Bishopton. This site offered a superior view of both the vicinity of Old Kilpatrick and the coastline between present-day Kilpatrick and Cadross villages, with a particularly good line of sight to the estuary of Leven (Fig. 16).

What could have been seen from Bishopton was practically the same as what the sentries could see from Lurg Moor fortlet, although the surroundings of Gare Loch and the southern shores of Rosneath Peninsula were also visible and the fortlet was much closer to this stretch of coastline than Bishopton (Fig. 17). The next documented seaside fortlet at Outerwards had a superior line of sight over the eastern part of the Cowal Peninsula, the Isle of Bute and the island of Great Cumbrae (Fig. 18). Not only is there almost no overlap between the two mentioned seaside fortlets in terms of view to the landscape and the seaside region, but if one merges the lines of sight of both sites, it is immediately apparent that an approximately 5 km wide and almost 10 km wide stretch of the Firth of Clyde between the Cowal Peninsula and the shore of the Central Lowlands was left unobserved by the Romans (Fig. 19). This apparent gap is even more interesting if one takes into account the fact that almost the whole eastern shore of the Cowal Peninsula was visible from one of the fortlets, yet the water surface of the Firth of Clyde remained invisible to both. It has been presumed for some time that one more fortlet somewhere between Lurg Moor and Outerwards would have offered the Romans much more practical knowledge about traffic and events in the Firth of Clyde (NEWALL 1963, 43, see also p. 130–133)

The area visible from the remaining forts varied considerably. In fact, four of them had a very poor line of sight, whereas two were positioned excellently in order to give their garrisons a view of events in their broader surroundings. The remaining four forts proved to operate somewhere between these two categories. The last group of forts with an “average” line of sight to the surrounding area was situated in the eastern half of the Antonine Wall. These were the forts at Falkirk, Rough Castle, Westerwood and Croy Hill. They are grouped together here because they shared another common denominator: a limited or almost lack of line of sight to the south. Falkirk (Fig. 20) and Rough Castle (Fig. 21) were in fact solely oriented to the north, or more precisely to the area of present-day Grangemouth, Falkirk suburbs and Denny village, which can all be described as the broader surroundings of Camelon fort. Westerwood (Fig. 22) and Croy Hill (Fig. 23) were located on spots from which there was a splendid view over the Campsie Fells and the Kelvin Valley. Practically nothing could be seen from either of them in the southern direction. Visibility to the broader stretches of landscape in the eastern and western directions was in both cases limited.

Of the remaining four forts, Inveravon is the easiest to interpret. The extremely inferior results of the viewshed analysis (Fig. 24) of this site can be explained by the frontier surveyors’ need to position this fort as close as possible to the crossing of the Avon. Therefore, this fort’s sentries could only see the stretch of land where Grangemouth now lies and nothing more

beyond the immediate surroundings of the fort. In fact, from the fort only 11,52 km² of land was visible in a 5 km perimeter (see Table 5)..

Cadder was in terms of the results of the viewshed analysis somewhat similar to the Croy Hill or Westerwood forts, as the sentries at the gates had a good view only to the north over “their” section of the Kelvin Valley (Fig. 25). In all other directions nothing could have been seen from the Cadder gatehouses. The viewshed for the Cadder fort was experimentally conducted with higher offsets as the site was quarried in the 20th century and the original elevation of the tower platforms was probably higher than the current elevation + 5 m of the standard OFFSETA. However, even with OFFSETA set to 10 m the results were not significantly better, so Cadder remains an inferior site in terms of visibility over the landscape.

Bearsden represented another example of a fort with marginal visibility to the surrounding area (Fig. 26). As the fort is currently situated in a heavily built up area, two terrain models and higher offsets were used for viewshed analysis, all ignoring the obstruction of modern buildings. Neither of these attempts brought any positive results in terms of general visibility, despite the fort having a limited line of sight in the eastern and western directions. The horizon for observers from the northern gate lay just 230 m north of the fort.

From Duntocher the sentries could observe a stretch of land of some 26,17 km², which may not seem that small compared to the results of the line of sight in a 5 km² perimeter around the fort (see Table 5), but the fort only had a good view to the south, whereas to the north, east and west the visibility was very limited (Fig. 27).

The remaining two forts had on contrary far better lines of sight. Kirkintilloch was exceptional, as unlike any other fort on the Antonine Wall, it had a good line of sight in all directions beyond a greater than 3,5 km perimeter, except to the east. The area observable from Kirkintilloch was some 65 km² in a 10 km perimeter and 31,98 km² in a 5 km perimeter, rendering this site a relatively good observation spot on the Antonine Wall (Fig. 28).

The second-best view to the landscape on the Antonine Wall was provided at Castlehill fort (Fig. 29). The best view from the fort was to the east and south and particularly to the areas where the Antonine Wall lay in the east. One could see from the fort as far as to the north-western end of present-day Duntocher and beyond towards the Kilpatrick Hills. Interestingly, one had a fairly good view of contemporary Bearsden in the east, except for the position of the eponymous fort. In the north-eastern direction Roman sentries could see as far as the fringes of the current-day hamlets of Mugdock and Blairskaith, nearly 7,5 km from the fort. In theory, the

course of the Antonine Wall could have been followed from Castlehill as far as to Twechar near Bar Hill (more than 30 km away from the fort).

The visibility of the broader landscape from the fortlets can generally be described as inferior in comparison to the views from the forts. Only Wilderness Plantation had a favourable position with a view over the Kelvin Valley stretching to the north-eastern outskirts of present-day Torrance village in the east and Mugdock hamlet in the north, some 8 km away (Fig. 30). Watling Lodge (Fig. 31) and Croy Hill (Fig. 32) fortlets had similar or slightly inferior views over the landscape compared to the nearby forts at Camelon and Croy Hill. Only Kinneil had significantly better viewshed results because of its view over the Firth of Forth and its strategic position over the estuary of Carron (Fig. 33). All the remaining fortlets had significantly inferior visibility to the landscape. From Seabegs Wood fortlet one could only see to the immediate perimeter around the fortlet, which can be roughly represented in a two-dimensional map as a 4,6-km wide elliptical section (Fig. 30). From Croy Hill fortlet one could observe practically the same stretch of the landscape as from Croy Hill fort (Fig. 32). The low-lying position of Glasgow Bridge fortlet gave the potential sentries in this outpost only a limited view over the broader landscape, mainly focused on the nearby section of the Kelvin Valley (Fig. 35). In a 5 km perimeter around the fortlet only an area of some 15,45 km² could have been seen from the potential observation platform on top of the northern gate. The positioning of Summerston fortlet was significantly inferior in terms of visibility and one could not see much farther than 1 km in all directions apart from to the south (Fig. 36). Both Cleddans (Fig. 37) and Duntocher (Fig. 38) fortlets had very restricted views over the broader landscape despite having a slightly better line of sight to the north than to any other directions.

Two more possible fortlets can be included in the study. If it ever existed, the fortlet at Laurieston would have had an excellent view over almost the same stretch of land as the nearby lying fort at Mumrills (Fig. 39). Cawder House's possible fortlet on the other hand had a better view over the landscape than the nearby lying fort at Cadder, having in its line of sight not only the stretch of the Kelvin Valley between present-day Bardowie and Kirkintilloch but also the broader surroundings of the fort at Cadder (Fig. 40).

From the elevated position of 9 m above the ground of Garnhall watchtower one could clearly see in the east the 1,5 km-wide stretch of landscape north of the Antonine Wall up to the Rough Castle fort 6 km away (Fig. 41). Directly to the north and east were visible the Campsie Fells to a distance of more than 5 km, while to the south and west the horizon lay roughly 1 km away from the watchtower site.

The expansions at Tentfield East (Fig. 42) and Tentfield West (Fig. 43) had practically the same line of sight as the nearby lying fort at Rough Castle, apart from the fact that the Tentfield East had a slightly better line of sight to the area just before the Firth of Forth.

From Bonnyside East (Fig. 44) and Bonnyside West (Fig. 45) the same could have been seen in the northern and southern directions as from Rough Castle. Both sites had slightly better lines of sight to the west than the mentioned fort, despite the fact that nothing substantial there could have been seen from them, such as the important valley of Bonny Water.

Croy Hill East (Fig. 46) and Croy Hill West (Fig. 47) expansions generally had inferior lines of sight in comparison to the nearby lying fort and fortlet. None of them offered views over the stretch of landscape invisible from the two mentioned sites, but they still had in their lines of sight some 40 km² in a 5 km perimeter.

Three minor enclosures in the vicinity of Wilderness Plantation had practically identical lines of sight as the mentioned fortlet (Fig. 30), apart from the fact that Wilderness East had a slightly better line of sight to the east while Buchley was slightly inferior in terms of general landscape observation (Figs. 48, 49, 50).

2.3.6 *Intervisibility between individual sites on the Antonine Wall*

In general terms, the intervisibility between individual sites on the Antonine Wall was fairly good. This can be presumed even without any sophisticated analysis, as the average distance between forts was 3,3 km and if one includes smaller sites there was some kind of installation at almost every Roman mile (if all the forts, fortlets, expansions, minor enclosures and watchtowers are considered, the average interval between them was 1,68 km). Nevertheless, a certain pattern in the intervisibility of individual sites can be found and will be discussed below once the evidence has been presented. All the below presented can be also checked in Table 5.

Of the forts north of the Antonine Wall, only that at Camelon was in visual connection with the installations alongside the mural barrier. The forts at Ardoch, Strageath and Bertha were all situated on the banks of rivers and therefore the visibility from them was rather poor. Camelon, situated 1,1 km north of the nearest installation on the Antonine Wall – the fortlet at Watling Lodge – had an excellent view over the estuary of the Carron and the suburbs of present-day Falkirk. In addition, the sentries in the towers above the fort's gates could in theory see the gates of the forts at Mumrills (5,57 km away), Falkirk (2,56 km away) and Rough Castle (2,13 km away). A rather large distance of 10,77 km away as the crow flies, from the top of the Camelon fort gates one could see the *porta decumana* of Westerwood fort and beyond that the

summit of Bar Hill, occupied by a fort 16,21 km from Camelon (Fig. 9). These distances are of course excessive for distinguishing anything without optical enhancement. Interestingly, the Croy Hill fortlet was in theory intervisible with one of the gates of the Camelon fort, but the considerable distance between them (13,72 km) renders this link rather accidental. At a much more practical distance from the Camelon fort was the fortlet at Watling Lodge, which was also directly intervisible with the fort. Three of the four expansions in the vicinity of Rough Castle (Tentfield East – 1,3 km distance to Camelon; Tentfield West – 1,59 km distance to Camelon; Bonnyside West – 2,98 km distance to Camelon). The list of sites intervisible with Camelon also included the possible fortlet at Laurieston (4,91 km distance to Camelon) and the known fortlet at Kinneil (11,36 km distance to Camelon). Some other possible fortlets in the eastern sector may have also theoretically been in the line of sight of the fort, namely Deanfield (12,73 km away), Nether Kinneil (10,45 km away), Polmont School (8,64 km away), Callendar House (4,05 km away), Falkirk Bantaskin (1,67 km away), Tentfield (1,64 km away) and Rough Castle (2,11 km away). Interesting to note is the fact that with the exception of the closest site (Watling Lodge), the line of sight from Camelon fort ended more or less at the positions of the above-mentioned intervisible sites. Especially in the cases of Mumrills, Falkirk and Rough Castle forts, it is evident that had they been moved by about 200-300 m in any direction, they would not have been intervisible with Camelon. This so-called edge connection seems to have been a repeating pattern in the intervisibility of individual sites, but only in a few cases is it as evident as in the case of Camelon and its adjacent forts (see Fig.9).

As one of the most important forts on the Antonine Wall, Mumrills was intervisible with Camelon as already mentioned, but at the edge of its direct line of sight lay Inveravon as well, 3,15 km away. Several other sites may have been intervisible with this fort at a threshold; only with the application of OFFSETB did observers seem able to see each other between the gatehouses of Mumrills and Falkirk (being 3,03 km apart). At the edge of this indirect line of sight lay also two expansions east of Rough Castle: Tentfield East (6,2 km away) and Tentfield West (6,76 km away). Kinneil (5,87 km away) was also intervisible with Mumrills only with the application of OFFSETB, while the fortlet at Watling Lodge (5,5 km away) and the possible fortlet at Laurieston (0,67 km away) were directly intervisible with the Mumrills fort (Fig. 8). Of the other possible fortlets, Polmont School (3 km away) lay directly at the edge of the line of sight from Mumrills, while the positions of Deanfield (7,31 km away), Callendar House (1,58 km away) and Falkirk Bantaskin (4,05 km away) were in the direct line of sight of the fort. Nether Kinneil (4,88 km away) and Beancross (0,47 km away) could have been intervisible with Mumrills using only with application of OFFSETB.

Castle Cary fort had a relatively low amount of intervisibility with other Roman sites. It was directly intervisible with only one other fort, Rough Castle, lying 5,48 km away from it (Fig. 10). Both nearby lying smaller installations were directly intervisible with Castle Cary, including Garnhall 1 km away and the Seabegs Wood fortlet 2,32 km away. In theory, observers from the *porta principalis dextra* could have seen the positions of the two western Rough Castle expansions (Bonny side East and Bonny side West), being respectively 5 km and 4,68 km away from the Castle Cary fort. Theoretically, an observer at the gates of the Castle Cary fort could still have seen the platform of Tentfield West, but the excessive distance of 6,19 km between them makes this link very conjectural. The position of the possible fortlet at Allandale was visible from Castle Cary at a 1,16 km distance, while several other potential fortlet sites could have been intervisible with Castle Cary, namely Rough Castle (5,59 km away), Milnquarter (3,78 km away) and Tollpark (1,35 km away).

The positioning of Bar Hill 43 m south of the Antonine Wall is the key to understanding why this fort not only had best line of sight over the landscape out of all the forts on the Antonine Wall, but why it was also intervisible with a plethora of the Wall's installations both to the east and west (Fig. 2). Statistically up to 21 other Roman military installations could have been seen from the gate towers of Bar Hill, 11 to the east and 10 to the west. Included among these was one of two putative fortlets. Thus, in theory the sentries from the Bar Hill *porta principalis dextra* could see the positions of the Rough Castle (14,03 km away), Westerwood (5,39 km away) and Croy Hill forts (2,64 km away), while from the *porta principalis sinistra* the forts at Auchendavy (3,02 km away), Kirkintilloch (5,79 km away) and Castlehill (18,43 km away) were visible. The fortlets intervisible with Bar Hill were Croy Hill (2,5 km away), Glasgow Bridge (7,53 km away), Wilderness Plantation (11,52 km away) and Summerston (13,7 km away) as well as the putative site at Cawder House (10,65 km away) and in theory also the watchtower at Garnhall (7,42 km away). Crucially, almost all the smaller features like the expansions (Croy Hill West – 1,92 km away; Croy Hill East – 2,06 km away; Bonny side West – 13,23 km away; Bonny side East – 13,56 km away; and Tentfield West – 14,74 km away) and the minor enclosures (Wilderness East 11,26 km away; Wilderness West – 11,8 km away; and Buchley – 12,05 km away) were intervisible with Bar Hill with the exception of the Tentfield East expansion. The positions of a number of possible fortlets were visible from the Bar Hill fort, namely Tollpark (7,07 km distant), Girnall Hill (1,29 km away), Shirva (1,49 km away), Hillhead (4,43 km away), Bogton (8,86 km away), Boclair (14,2 km away) and Thorn Road (17,41 km away). Several others may have been intervisible with the fort via the application of OFFSETB, such as Tentfield (14,64 km away), Rough Castle (14,15 km away),

Milnquarter (12,32 km away), Easter Balmuildy (12,44 km away) and Manse Burn (15 km away).

Auchendavy was at first glance positioned in an inferior position to be intervisible with any other Roman installation in the western direction, despite having a good view to Bar Hill in the east (the distance between the forts was 3,02 km). With the application of OFFSETB, Auchendavy was intervisible with neighbouring Kirkintilloch at the threshold (the distance between the forts being 2,62 km; Fig. 11). If Kirkintilloch were moved from its prominent position by a few tens of metres, its intervisibility would be lost. In theory, one could see in a similar way the top of the platform erected above the Summerston fortlet gate, but the distance of 10,54 km between them renders this link rather conjectural. At a much greater distance of 15,29 km lay the Castlehill fort, which could have been seen from Auchendavy, but again such a distance is excessive for any visual link between the two. The positions of several possible fortlets were visible from Auchendavy, notably Shirva 1,54 km away, Boclair 11,04 km away and Thorn Road 14,26 km away.

Balmuildy was only intervisible with the fort at Castlehill, 5,6 km away. Its positioning was extremely disadvantageous in terms of potential direct intervisibility with other Roman sites, but surprisingly two neighbouring fortlets at Summerston (0,99 km away) and Wilderness Plantation (1,68 km away) were intervisible with this fort via the application of OFFSETB. All the minor enclosures in the vicinity of Wilderness Plantation may have also been intervisible with the fort in a similar manner (Buchley – 1,15 km away; Wilderness West – 1,4 km away; Wilderness East – 1,94 km away). If they ever existed, three potential fortlets were intervisible with Balmuildy. Easter Balmuildy (0,75 km away) would have been intervisible with Balmuildy only through the application of OFFSETB, but the positions of two others to the west lay exactly at the edge of the direct line of sight from the elevated positions of the Balmuildy gates: Boclair (1,5 km away) and Manse Burn (2,08 km away, Fig. 12).

The location of the fort at Castlehill offered an excellent view over the positions of many other Roman installations alongside the Antonine Wall. To the west one could comfortably see the 1,64 km distant fortlet at Cleddans as well as the 2,88 km distant fortlet and successive fort at Duntocher. Despite intervisibility with Old Kilpatrick being blocked by the terrain, the view to the Clyde Estuary was open and the 10,6 km distant fort at Bishopston as well as the 22,94 km distant fortlet at Lurg Moor were theoretically in the line of sight, despite the sheer distance between the sites rendering such intervisibility unsuitable rather than practical (Fig. 29). Castlehill surprisingly lacked intervisibility with its nearest neighbours in the east, as neither

the positions of the fort at Bearsden nor the fortlet at Summerston could have been seen from this site. The first visible Roman site in the east was the 5,6 km distant Balmuilty. Despite there being a relatively considerable distance between these two sites, it is interesting that one could see over the terrain exactly to the position of the *porta praetoria*, whereas all the other gates remained either intervisible only with the application of OFFSETB or not at all. If the position of Balmuilty were moved by some 50 m to the south or north, its intervisibility with Castlehill would have been lost. Equally, if the fort were moved by about 100 m to the east, its intervisibility with Castlehill would have been greatly improved but the intervisibility with Wilderness Plantation and all its neighbouring minor enclosures would have been lost for Balmuilty fort. The positions of all the military installations between Balmuilty and Bar Hill were visible from Castlehill, but the distances were rather excessive: Buchley (6,77 km away), Wilderness West (7 km away), Wilderness Plantation (7,28 km away), Wilderness East (7,53 km away), the possible fortlet at Cawder House (8,07 km away), Cadder (9,1 km away), Glasgow Bridge (11,16 km away), Kirkintilloch (12,61 km away), Auchendavy (15,3 km away) and Bar Hill (18,43 km away) were all visible from Castlehill. The positions of several possible fortlets were in the line of sight of Castlehill, specifically those more distant to the fort, like Easter Balmuilty (6,4 km away), Bogton (9,84 km away), Hillhead (14,07 km away) and Shirva (16,95 km away). Much closer potential fortlets were located either at the very edges of the direct lines of sight or in areas where a platform would have been needed in order to be seen from the Castlehill fort. Specifically, these were the three possible fortlets in the vicinity of Bearsden, namely Thorn Road (1,1 km distance from Castlehill), Manse Burn (3,56 km distance from Castlehill) and Boclair (4,33 km distance from Castlehill).

The location of the above-mentioned fort at Bearsden was disadvantageous in terms of its intervisibility with any neighbouring sites (Fig. 26). No known fort or fortlet was intervisible with Bearsden: its position was simply unfavourable. However, if in theory one considers the at least 7 m high observation points at both Bearsden and Castlehill and assumes that there were no trees or other obstructions in the direct line of sight between them, the two forts would have been intervisible at a threshold. It is of course questionable whether this would have been of any practical use and whether these particular threshold values were intentional. Moving Bearsden a few hundred metres would not have substantially solved the intervisibility issue with Castlehill and virtually no change in its position would have made it intervisible with its eastern neighbours like Summerston or Balmuilty. Three potential fortlets along the course of the Antonine Wall in the vicinity of the Bearsden fort could have served as relays, specifically the possible fortlets at Thorn Road (0,94 km away), Manse Burn (1,48 km away) and Boclair

(2,29 km away). No evidence has come to light about their actual existence; on the contrary, a search for them only yielded negative results (see p. 77–78). The case of Boclair on the summit of Crow Hill is especially disappointing, as it was the only position on the course of the Antonine Wall between Summerston and Bearsden that could have hosted a fortlet intervisible with both the fort and the fortlet. A possible fortlet at an approximate position at Thorn Road, Bearsden, would have again offered a unique site intervisible with both the Bearsden and Castlehill forts, but in order to fit the intervisibility pattern, the fortlet must have stood on a more than 150 m-long stretch on the Antonine Wall. The final point that is interesting to note about the positions of the possible fortlets in the vicinity of Bearsden is that they would have all been situated at the edge of the line of sight from Castlehill. Further suggestions regarding the positioning of Bearsden are offered below (p. 124–127, 129–130, 133).

The results of the intervisibility test via viewshed analysis yielded the same results for the Duntocher fort and fortlet (Figs. 27, 38). In the west and lying at the very edge of the direct line of sight were the fortlet at Cleddans (1,32 km away) and the fort at Castlehill (2,85 km away). Despite it being impossible to see the position of Old Kilpatrick in the west from the Duntocher fort, from its annexe gate one could see the top of the possible Mount Pleasant fortlet 2,88 km away (two points would have been intervisible only with the application of OFFSETB). At a rather excessive distance of 7,71 km, one could have seen from Duntocher the fort at Bishopton.

Cadder might have been directly intervisible with the nearest possible fortlet in the east, Cawder House (1,03 km away). The position of this fortlet lay at the edge of the line of sight from the fort (Fig. 25). Similarly, Cadder could have been intervisible with the possible fortlets at Boclair (4,77 km away), Manse Burn (5,54 km away) and Thorn Road (8,02 km away), each of them lying on one of the edges of the lines of sight from Cadder's gates. At a 9,1 km distance from Cadder stood Castlehill, which was the only directly intervisible fort. In theory, one could have seen the top of the Wilderness East expansion from the *porta praetoria* at Cadder, 1,73 km away. Had the observer's position above the *porta decumana* been 7 m above the ground, the upper parts of the possible fortlet at Bogton could have been seen 0,8 km east of the fort. Only if the observation platforms at Cadder were raised up to 10 m above the current terrain would Cadder have been intervisible with Kirkintilloch (3,64 km away) and Bar Hill (9,54 km away), albeit still only with the application of OFFSETB at the standard value of 5 m.

Kirkintilloch was therefore not intervisible with its immediately neighbouring fort to the west (Cadder) under standard conditions as they were applied to the rest of the presented

analysis. Intervisibility with its eastern neighbour, the fort at Auchendavy, was possible at a threshold as only the upper parts of the 2,63 km distant fort's *porta principalis sinistra* could have been seen. From the Kirkintilloch one would have had a comfortable view of Bar Hill fort 5,79 km away and in theory to the west Castlehill fort 12,61 km away. The fortlet at Glasgow Bridge (1,66 km away) was directly intervisible with Kirkintilloch, while from the fortlet at Summerston only the very top of the platform could have theoretically been seen in excessive distance 7,78 km away from the fort. The Wilderness Plantation fortlet (5,67 km away) could have been intervisible with Kirkintilloch only with the application of OFFSETB. The positions of several possible fortlets lay on the very edge of the direct line of sight from Kirkintilloch, notably Hillhead (1,36 km away), Shirva (4,31 km away), Bogton (2,96 km away), Boclair (8,33 km away), Manse Burn (9,13 km away) and Thorn Road (11,57 km away).

The results of the viewshed analysis in terms of intervisibility with neighbouring sites were the same for the Croy Hill fort and the Croy Hill fortlet, being only 55 m apart (Figs. 22, 32). They both had an excellent view of Bar Hill and specifically its *porta principalis dextra* a 2,58 km distance from the fort. No positions of Roman military installations beyond Bar Hill were visible from Croy Hill, but the locations of both expansions (Croy Hill East – 0,56 km away from the fort; Croy Hill West – 0,68 km away from the fort) were visible from the Croy Hill fortlet. They were not visible from the fort (Figs. 22, 32). The putative site of a fortlet at Girnall Hill (1,28 km away from the Croy Hill fort) could have been seen from both of them. To the east, all the Roman military installations lay on the very edge of the line of sight from all the Croy Hill sites. Only the position of the *porta praetoria* at Westerwood (2,83 km away) was directly intervisible with the Croy Hill fort and fortlet. In contrast, the location of the putative fortlet at Tollpark was directly visible from Croy Hill at a 4,42 km distance. From the watchtower at Garnhall only the upper parts were visible (4,78 km away). The only other installations directly intervisible with Croy Hill were the fort at Rough Castle (11,4 km away) and three out of four of its neighbouring expansions (Bonny-side West – 10,6 km away; Bonny-side East – 10,93 km away; Tentfield West – 12,1 km away), all again lying on the very edge of the line of sight and in excessive distance. The only other installation intervisible with Croy Hill may have been the possible fortlet at Easter Dullatur (0,79 km away).

From the position of the Westerwood fort one had a limited view towards the Croy Hill fort (2,76 km away) and fortlet (2,9 km away) as well as to Bar Hill (5,4 km away). Especially with the Croy Hill was the connection on the edge feasibility – the fortlet stood on the very last point directly visible from the Westerwood gates – had it been moved by less than 100 m along the course of the Antonine Wall to the west, its intervisibility with Westerwood would have

been lost (Fig. 23). The position of the possible fortlet at Easter Dullatur was visible from Westerwood 2,02 km away as well as another possible fortlet at Tollpark. The Garnhall watchtower lay at the very edge of the direct line of sight from Westerwood's *porta principalis dextra* (1,91 km away), while the more distant Castlecary was unobservable from Westerwood. The only other sites intervisible with Westerwood were again Rough Castle (8,53 km away) and three out of four of its neighbouring expansions (Bonnyside West – 7,73 km away; Bonnyside East – 8,06 km away; and Tentfield West – 9,24 km away), all again lying at the very edge of the line of sight. A 10,71 km distance from Westerwood lay the fort at Camelon and these two sites were also in theory intervisible, despite the edge nature of the connection. Their excessive distance apart again made this connection unfeasible and hard to detect in practice.

The Rough Castle fort was at first glance positioned on a spot from which one had only a very limited line of sight to the east and the south-west, where most of the neighbouring Roman sites on the course of Antonine Wall lay. Only three out of four of the nearby lying expansions (Bonnyside West – 0,82 km away; Bonnyside East – 0,48 km away; and Tentfield West – 0,63 km away) were intervisible with the Rough Castle fort, while from Tentfield East (1,19 km away) one could not see Rough Castle or its environs without a more than 10 m-high platform and even then the view to the fort in general would have been blocked, apart from the annexe gate. Aside from Camelon (2,13 km away), no position of a fort or fortlet could have been seen from Rough Castle in the east (Fig. 21). In the south-western direction several sites stood at the very edge of the line of sight from Rough Castle, including the fortlet at Seabegs Wood (3,19 km away), the fort at Castlecary (5,48 km away), the watchtower at Garnhall (6,61 km away), the fort at Westerwood (8,53 km away) and the fort and fortlet at Croy Hill (11,41 km and 11,54 km away, respectively). An excessive distance of 14,04 km from the fort lay the theoretically visible summit of Bar Hill. Three sites of potential fortlets were also observable from Rough Castle: Tentfield (0,51 km away), Allandale (4,32 km away) and Tollpark (6,97 km away). In theory, some sites close to the Firth of Forth in the east, like the potential fortlets at Nether Kinneil (12,42 km away) and Deanfield (14,78 km away) together with the known fortlet at Kinneil (13,38 km away) were intervisible with Rough Castle, but the distance separating them was again excessive for any practical visual contact.

The position of the fort at Falkirk, which is today located in a similarly heavily built-up area as Bearsden, was directly intervisible with the forts at Camelon (2,56 km away), Mumrills (3,03 km away) and Inveravon (6,35 km away). At the edge of its line of sight, 2,37 km in the west lay the position of the fortlet at Watling Lodge and further in that direction, the tops of

hypothetical 5 m-tall platforms of the expansions at Tentfield East (3,06 km away) and Tentfield West (3,62 km away) could have been seen (Fig. 20). In the east, the location of the fortlet at Kinneil (9,03 km away) could theoretically have been seen. The positions of several possible fortlets could have been seen from the Falkirk fort gates, specifically Falkirk Bantaskin (0,93 km away), Callendar House (1,44 km away), Laurieston (2,35 km away), Pollmont School (6,17 km away), Nether Kinneil (8,06 km away) and Deanfield (10,45 km away).

The positioning of the fort at Inveravon directly next to the bank of the River Avon rendered this site inferior in terms of its number of visual connections with other Roman sites on the Antonine Wall. Being the easternmost known fort, it only had connections with western sites: it was directly intervisible with the forts at Mumrills (3,16 km away) and Camelon (8,8 km away), the fortlet at Watling Lodge (8,83 km away) and the Tentfield West expansion (10,09 km away – Fig. 24). The fort at Falkirk lay 6,35 km away from Inveravon and they were intervisible only at a threshold with the application of OFFSETB (the direct visual link was only between the positions of two elevated platforms). In the same manner, Inveravon was also intervisible with the Tentfield East expansion (9,52 km away) and with the possible fortlets at Falkirk Bantaskin (7,36 km away), Callendar House (4,92 km away) and Laurieston (4,01 km away). Closest to the Inveravon fort (0,26 km) was the site of a putative fortlet at Polmont School, again lying directly at the edge of the line of sight from Inveravon.

Carriden was not intervisible with any frontier installation on the Antonine Wall but in theory had in its line of sight a 0,8 km-long stretch of the Antonine Wall, at least according to the traditional interpretation that it ended in present-day Bo'ness around the findspot of Bridgeness slab (RIB 2139). If this was the case, then the fort at Carriden was intervisible at least with the possible eastern terminal fortlet somewhere at Grahamsdyke, Bo'ness (Fig. 13). However, the latter's position could not be seen from Kinneil, so more fortlets or other installations must be missing. Alternatively, the Antonine Wall could have terminated at Carriden itself (BAILEY 1987, 98–102) or in vicinity of this fort. If that were so, just one fortlet was needed to fit the intervisibility pattern, because the viewshed with applied OFFSETB of both Carriden and Kinneil terminated at present-day Kinglass Park (see Table 2, in vicinity of known construction/labour camp, see p. 14), where the fortlet (2,25 km away from Carriden and 2,65 km away from Kinneil) would have been in visual contact with both the known fort and the known fortlet (Fig. 51).

Old Kilpatrick was not intervisible with any known installation on the Antonine Wall. However, it had in its line of sight the fort at Bishopton (4,26 km away) and the fortlet at Lurg

Moor (16,48 km away). The positions of none of the possible fortlets were visible from Old Kilpatrick, but had there been no plant obstruction on the direct line between Old Kilpatrick and the locations of the possible fortlets at Mount Pleasant (0,61 km away) and Carleith (1,95 km away), these putative sites would have been intervisible with the fort from the height of a 5 m elevated platform (Fig. 15).

Bishopton was directly intervisible with the Old Kilpatrick (4,26 km away) and Castlehill (10,6 km away) forts, the Duntocher fort and fortlet (7,68 km away), the Cleddans fortlet (9 km away) and the possible fortlets at Mount Pleasant (4,95 km away) and Carleith (6,24 km away – Fig. 16). The Cramond fort had no known Roman military installation in its line of sight (Fig. 14).

Thanks to its positioning, the Kinneil fortlet was theoretically intervisible with many Roman military installations in the eastern sector of the Antonine Wall. Due to the excessive distance of those links, however, only one of them can be taken as more than coincidence: the connection with the fort at Mumrills, 5,88 km away. Sentries from this fortlet could in theory see directly to the position of the Camelon fort, even though the distance between them was 11,36 km. Furthermore, Kinneil was intervisible with Falkirk (9,03 km away), Watling Lodge (11,5 km away) and Rough Castle (13,38 km away) as well as with the positions of the putative fortlets at Beancross (5,4 km away), Laurieston (6,71 km away), Callendar House (7,62 km away) and Falkirk Bantaskin (10,01 km away). The positions of the two postulated fortlets in the proximity of the Kinneil fortlet, Nether Kinneil (1,02 km away) and Deanfield (1,45 km away) were also intervisible with this site (Fig. 33).

The fortlet at Watling Lodge had in terms of intervisibility a poor connection with the central part of the Antonine Wall. In this direction, only the positions of two expansions near Rough Castle were visible: Tentfield East (0,69 km away) and Tentfield West (1,25 km away). To the north, the position of the fort at Camelon (1,1 km away) was clearly visible and in the eastern direction as well the positions of all known Roman installations (Falkirk – 2,37 km away; Mumrills – 5,5 km away; Inveravon – 8,83 km distant; and Kinneil – 11,5 km away) plus those only postulated (the possible fortlets at Falkirk Bantaskin – 1,49 km away; Callendar House – 3,92 km away; Laurieston – 4,83 km away; Polmont School – 8,65 km away; Nether Kinneil 10,54 km away; and Deanfield 12,91 km away) were directly intervisible with Watling Lodge, despite the distances being excessive (Fig. 31).

The Seabegs Wood fortlet was intervisible only with relatively proximate Roman sites on the course of the Antonine Wall (Fig. 34). At one of the edges of the line of sight to the

south-west was Castlecary fort (2,32 km away) and a further distance in theory and with the application of OFFSETB, the upper part of a watchtower at Garnhall was visible 3,45 km away. To the north-east stood the Rough Castle fort (3,18 km away) on the last visible spot in that direction. The position of the Bonnyside West expansion 2.37 km away was visible from the Seabegs Wood fortlet and the intervisibility with Tentfield West (3,9 km away) could have also been maintained on the basis of the link between two elevated platforms. The sites of possible fortlets at Milnquarter (1,46 km away), Allandale (1,15 km away) and Tollpark (3,8 km away) were also visible from Seabegs Wood.

The fortlet at Glasgow Bridge was in theory intervisible with a plethora of known as well as possible Roman installations on the Antonine Wall (Fig. 35). It had a direct line of sight to the forts at Kirkintilloch (1,66 km away), Bar Hill (7,53 km away) and Castlehill (11,16 km away). With the application of OFFSETB the position of this fortlet was also intervisible with the Croy Hill East expansion (9.68 km away) as well as with the possible fortlet at Bogton (1,34 km away). From Glasgow Bridge the locations of the possible fortlets at Cawder House (3,15 km away), Boclair (6,84 km away), Manse Burn (7,63 km away) and Thorn Road (10,1 km away) were also visible.

The fortlet at Wilderness Plantation was intervisible with Balmuildy (1,68 km away) at a threshold: only from the top of its platform above the gate were the upper parts of the *porta praetoria* and the *porta principalis sinistra* of Balmuildy visible (Fig. 30). Otherwise, from the fortlet were visible positions of the forts at Kirkintilloch (5,67 km away), Castlehill (7,28 km away) and Bar Hill (11,52 km away) as well as all three minor enclosures in the direct vicinity (Wilderness East – 0,26 km away; Wilderness West – 0.29 km away; and Buchley 0,53 km away). A number of possible fortlets would have been intervisible with Wilderness Plantation had they existed. The list includes Easter Balmuildy (0,93 km away), Bogton (2,67 km away), Boclair (2,97 km away), Manse Burn (3,71 km away), Thorn Road (6,19 km away) and Shirva (10,03 km away).

The Summerston fortlet was intervisible only with the *porta decumana* of the Balmuildy fort (0,99 km away). Otherwise, the sentries from the top of this fortlet could theoretically see the positions of the forts at Kirkintilloch (7,78 km away), Auchendavy (10,5 km away) and Bar Hill (13,67 km away – Fig. 36). No other known Roman sites on the Antonine Wall were visible from the spot of this fortlet except for the positions of the possible fortlets at Boclair (0,59 km away), Hillhead (9,25 km away) and Shirva (12,8 km away).

From the Cleddans fortlet only the Castlehill fort (1,64 km away) and the Duntocher fort and fortlet (1,32 km away) were visible at the edges of the line of sight (Fig. 37).

The Lurg Moor seaside fortlet was in theory intervisible with a plethora of installations in the western part of the Antonine Wall. Surprisingly it was not intervisible with its nearest neighbours, the Outerwards fortlet and the Bishopton fort (Fig. 17). Had the second been moved some 150 m to the area of present-day Greenock Road, the sites would have been intervisible, although it is questionable what practical use this intervisibility over a distance of 12,43 km would have had. Lurg Moor had over an excessive distance a direct line of sight to the positions of the Old Kilpatrick (16,45 km away), Duntocher (20 km away) and Castlehill (22,94 km away) forts, the Wilderness Plantation fortlet (30,34 km away) and the Buchley (29,82 km away) and Wilderness East (30,59 km away) minor enclosures. The positions of several possible fortlets were also intervisible with Lurg Moor, namely Mount Pleasant (17,15 km away), Carleith (18,52 km away), Thorn Road (24,15 km away) and Easter Balmuildy (29,45 km away).

From an elevated position of 9 m above the ground of the Garnhall watchtower, the forts at Castlecary (1 km away), Westerwood (1,91 km away), Croy Hill (4,78 km away), Rough Castle (6,61 km away), Bar Hill (7,42 km away) and Camelon (8,8 km away) were visible (Fig. 41). The relationships with the neighbouring forts at Westerwood and Castlecary were crucial, as they are both located at the edges of the line of sight. Indeed, had Garnhall been moved by some 30 m to the east, it would have lost its intervisibility with Castlecary, yet had it been moved more than 70 m to the west, it would have no longer been visible from Westerwood. Indeed, the Garnhall watchtower was located more or less in the middle of a 100 m-long stretch of land immediately south of the Antonine Wall, which was in visual connection with both forts. The landscape determination of the position is even more evident if one takes into consideration that the centre of the Garnhall watchtower was exactly on the direct line connecting the position of the *porta decumana* of Castlecary fort and the *porta principalis dextra* of Westerwood fort (2,98 km apart, see p. 124–125). The positions of the fortlets at Seabegs Wood (3,45 km away) and Croy Hill (4,93 km away) were also intervisible with Garnhall as well as with the expansions at Bonnyside West (5,82 km away), Bonnyside East (6,14 km away) and Tentfield West (7,32 km away). The sites of possible fortlets at Tollpark (0,36 km away), Allandale (2,30 km away) and Milnquarter (4,92 km away) were also intervisible with the Garnhall watchtower.

The results of the viewshed analysis should be discussed as regards two possible fortlets where at least some evidence for their actual existence has been documented. Laurieston could have been directly intervisible with the forts at Mumrills (0,67 km away), Inveravon (4,01 km away) and Camelon (4,91 km away). With the application of OFFSETB the intervisibility could have also been maintained at a threshold with the fort at Falkirk (2,35 km away). Both Kinneil (6,72 km away) and Watling Lodge (4,83 km away) lay in the potential line of sight of Laurieston and at the very edge of it were located also the elevated positions of the expansions at Tentfield East (5,52 km away) and Tentfield West (6,08 km away – Fig. 39). Otherwise, several positions of other possible fortlets were visible from Laurieston, including Callendar House (0,91 km away), Falkirk Bantaskin (3,37 km away), Polmont School (3,82 km away), Nether Kinneil (5,73 km away) and Deanfield (8,15 km away).

The possible fortlet at Cawder House was directly intervisible with the forts at Cadder (1,03 km away), Kirkintilloch (4,74 km away), Castlehill (8,07 km away) and Bar Hill (10,65 km away). Intervisibility with the Glasgow Bridge (3,15 km away) and Wilderness Plantation fortlets (0,87 km away) and all the minor enclosures (Wilderness East – 0,61 km away; Wilderness West – 1,15 km away; and Buchley 1,40 km away) was possible only from the height of 5 m elevated platforms (Fig. 40). The positions of several other possible fortlets were visible from Cawder House, including Bogton (1,81 km away), Boclair (3,74 km away), Manse Burn (4,51 km away), Thorn Road (7 km away) and Shirva (9,17 km away).

Despite being separated from each other by only 0,57 km, the Tentfield East and Tentfield West expansions were intervisible with different sets of installations on the Antonine Wall. A potential observer at Tentfield East could have seen the positions of the Camelon (1,3 km away), Falkirk (3,06 km away), Mumrills (6,2 km away) and Inveravon (9,52 km away) forts but would have had no line of sight to the Rough Castle fort (Fig. 42). The positions of Watling Lodge (0,69 km away) and Kinneil (12,19 km away) were also visible from Tentfield East as well as from the top of the platform at Tentfield West. This expansion was intervisible with the same installations as Tentfield East, i.e. Camelon (1,6 km away), Falkirk (3,63 km away), Mumrills (6,76 km away), Inveravon (10,09 km away), Watling Lodge (1,25 km away) and Kinneil (12,75 km away) as well as Rough Castle (0,63 km away), Seabegs Wood (3,9 km away), Castlecary (6,19 km away), Garnhall (7,32 km away), Westerwood (9,24 km away), Croy Hill (12,25 km away) and Bar Hill (14,75 km away). Tentfield West was not intervisible with the Croy Hill fort, only with the eponymous fortlet (Fig. 43). From both of these expansions were visible the positions of the possible fortlets at Tentfield (0,17 km from Tentfield West and 0,73 km from Tentfield East), Falkirk Bantaskin (2,72 km from Tentfield

West and 2,17 km from Tentfield East), Polmont School (9,9 km from Tentfield West and 9,34 km from Tentfield East), Nether Kinneil (11,79 km from Tentfield West and 11,23 km from Tentfield East) and Deanfield (14,15 km from Tentfield West and 13,6 km from Tentfield East), but from Tentfield East the position of Laurieston (5,52 km away) was also visible, while from Tentfield West the possible fortlets at Callendar House (5,17 km away), Allandale (5,04 km away) and Tollpark (7,67 km away) were visible.

The second group of expansions west of the Rough Castle fort consisted of Bonnyside East and Bonnyside West. They were both intervisible with Castlecary (5 km from Bonnyside East and 4,68 km from Bonnyside West), Bar Hill (13,56 km from Bonnyside East and 13,24 km from Bonnyside West), Rough Castle (0,48 km from Bonnyside East and 0,82 km from Bonnyside West), Westerwood (8,06 km from Bonnyside East and 7,73 km from Bonnyside West), Garnhall (6,14 km from Bonnyside East and 5,82 km from Bonnyside West), the Croy Hill fortlet (11,07 km from Bonnyside East and 10,7 km from Bonnyside West) as well as each other (0,34 km apart). Furthermore, Bonnyside West was intervisible with Camelon (2,98 km away) and Seabegs Wood (2,37 km away), while from Bonnyside East one could see the top of the *porta principalis dextra* of the Croy Hill fort (10,94 km away). With applied OFFSETB they were also both intervisible with the possible fortlets of Allandale (3,85 km from Bonnyside East and 3,52 km from Bonnyside West) and Tollpark (6,5 km from Bonnyside East and 6,17 km from Bonnyside West).

In terms of amount of intervisibility with other Roman frontier installations alongside the Antonine Wall, one of the worst results have expansions west of the Croy Hill fortlet. Neither was intervisible with any other fort than Bar Hill, being 2,06 km from Croy Hill East and 1,92 km from Croy Hill West (Fig. 47). The only other feature with which these two installations could have been intervisible was the Croy Hill fortlet, being 0,47 km from Croy Hill East and 0,59 km from Croy Hill West. In theory, the Glasgow Bridge fortlet was also intervisible at a 5 m elevated platform height with Croy Hill East, which was 9,68 km away (Fig. 46). Both expansions were also intervisible with the area where the Giral Hill fortlet was expected (being separated from it by a distance of 0,64 km from Croy Hill West and 0,77 km from Croy Hill East).

Despite not being separated from each other by any large distance, two of the three minor enclosures only had a limited amount of intervisibility with the other Roman military installations on the Antonine Wall (Figs. 48, 49, 50). Wilderness East was intervisible with the forts at Balmuilty (1,94 km away), Kirkintilloch (5,35 km away), Castlehill (7,53 km away)

and Bar Hill (11,26 km away) as well as with the fortlet at Wilderness Plantation (0,26 km away) and the minor enclosures at Wilderness West (0,55 km away) and Buchley (0,79 km away). The positions of the possible fortlets at Easter Balmuildy (1,19 km away), Cawder House (0,61 km away), Bogton (2,41 km away), Shirva (9,78 km away), Boclair (3,21 km away), Manse Burn (3,96 km away) and Thorn Road (6,44 km away) were also visible from this location. Buchley and Wilderness West were both intervisible only with the forts at Balmuildy (1,15 km from Buchley and 1,39 km from Wilderness West), Castlehill (6,77 km from Buchley and 7 km from Wilderness West) and Bar Hill (12,05 km from Buchley and 11,8 km from Wilderness West), the fortlet at Wilderness Plantation (0,53 km from Buchley and 0,29 km from Wilderness West) and each other (0,25 km apart). In theory, the positions of the possible fortlets at Easter Balmuildy (0,39 km from Buchley and 0,64 km from Wilderness West), Cawder House (1,4 km from Buchley and 1,15 km from Wilderness West), Boclair (2,48 km from Buchley and 2,69 km from Wilderness West), Manse Burn (3,2 km from Buchley and 3,43 km from Wilderness West) and Thorn Road (5,68 km from Buchley and 5,9 km from Wilderness West) were also visible from both of them.

2.3.7 Conclusion I.

When the lines of sight of individual sites on the Antonine Wall are combined, it is immediately apparent that Roman army had an excellent visual control over the Forth-Clyde isthmus (Fig. 52). The locations were with few exceptions chosen in order to provide a good view over the frontier area. Especially the results of the viewshed analysis facilitate a better understanding of the frontier area – best line of sight was in most of the cases to the north and that was probably the zone of interaction. Combining the visibility of multiple sites, the course of the Antonine Wall was also under surveillance. The course of the Military Way running immediately behind the Antonine Wall must have also been in the line of sight, but further south not much could have been seen, especially from the easternmost installations, where the line of sight rarely stretched more than 1 km to the south despite the fact that from the same sites one could see 6 km (ca 4 Roman miles) or more to the north (see Fig. 52).

In the central section of the Antonine Wall, the line of sight was naturally determined by the Campsie Fells, hence the distances between the forts and fortlets and the respective edges of their lines of sight were around 5.5 km (3,72 Roman miles). Each individual site had in the line of sight of its section of the valley a certain amount of overlap, but no areas could be described as blank or omitted. In the southern direction, the situation was again worse. The Croy Hill fort, fortlet and adjacent expansions had no line of sight to the area of present-day

Croy and Boardloch Wood and no other Roman site on the Antonine Wall could observe what was going on there. Despite the installations between Bar Hill and Cadder had better lines of sight to the south, it is still obvious that the major concern was the view to the north. The general distance between a site in the central sector of the Antonine Wall and its northern limit of line of sight was around 4,5 km (3 Roman miles). In the west, these figures were lower because of the Kilpatrick Hills. Potential Roman observers from the Castlehill fort could only see as far as to the area of Windyhill Golf Course, some 1,5 km distance to the north. Nevertheless, even in the west the combined line of sight of all known installations covered a 3 km-wide stretch of the landscape between the Antonine Wall and the observer's horizon from individual sites. As described above, the combined line of sight of seaside forts (Carriden and Cramond) in the east covered the Firth of Forth almost without overlap. More tangled was the situation in the west, where at least one fortlet somewhere between Lurg Moor and Outerwards was missing in order to observe the Firth of Clyde and the Cowal Peninsula (see p. 130–133, Fig. 19).

The amount of intervisibility between individual sites on the Antonine Wall was at first glance overwhelming. Statistically, from an average fort on the Antonine Wall one would have seen 7,6 other Roman sites either on the Antonine Wall or in its immediate vicinity (this statistic comprises also the forts at Camelon and Bishopton). The fortlets were in terms of number of connections worse, corresponding with their less favourable landscape settings. From an average fortlet on the Antonine Wall only 7,25 other Roman sites would have been visible. The same statistics can be offered in the case of expansions and minor enclosures, although as regards the former, the value of 8,7 connections with other Roman sites per installation was heavily influenced by the superior Tentfield West with its attested 18 visual links to sites in the eastern and central sections of the Antonine Wall (see Table 5). Similarly, in terms of minor enclosures the average value of 8,3 connections per installation was boosted by the superior position of Wilderness East and the fact that half of the intervisibility links of the minor enclosures could actually be described as intervisibility between one another across very short distances (see Table 1).

Since to the above-mentioned statistics counts both intervisibility links between neighbouring sites and those 10 km apart and more, a certain amount of rationalisation is needed in order to interpret the data correctly. One way to approach this is to check whether neighbouring sites were intervisible, as this represents the shortest intervisibility possible, which is handy either for a frontier surveying or any signal communication where no optical enhancements are available. Starting from the east, a problem immediately emerges with Carriden, which was not intervisible with anything. In fact, uncertainty about the precise

position of the end of the Antonine Wall in the east hampers any interpretation of this frontier section before Inveravon, as the fortlet at Kinneil was intervisible only with relatively distant sites, at 5,88 km Mumrills representing the closest (see Table 5).

The Inveravon fort was comfortably intervisible with its nearest neighbour at Mumrills over a distance of 3,15 km. Mumrills was intervisible with both the immediately east-lying possible fortlet at Laurieston (0,67 km away) and the more distant fort at Falkirk, 3,03 km away. Falkirk to the west was intervisible with both Watling Lodge 2,37 km away and the more northerly Camelon (2,56 km away). Camelon was also intervisible with nearby Watling Lodge (1,1 km away). The intervisibility chain can be further followed via the connection of Watling Lodge to the expansion at Tentfield East (0,69 km away), being intervisible with the Tentfield West expansion (0,57 km away), which had in its direct line of sight Rough Castle (0,63 km away). Alternatively, a more direct communication link can be followed, as the above-mentioned Camelon was directly intervisible with Rough Castle at a distance of 2,13 km.

Regardless, Rough Castle was intervisible with both of its western expansions (Bonny-side West – 0,82 km away; and Bonny-side East – 0,48 km away) and the Seabegs Wood fortlet at a distance of 3,18 km. This fortlet was also intervisible with Bonny-side East and Bonny-side West, being 2,37 km away from the latter. The intervisibility chain can be followed with ease to the fort at Castlecary, 2,32 km from Seabegs Wood. This fort was not intervisible with neighbouring Westerwood despite the distance between them being just 2,91 km. Fortunately, a watchtower at Garnhall (1 km from Castlecary and 1,91 km from Westerwood) was positioned on the only spot on the ascent to the Westerwood fort, from which both these sites were visible. Westerwood was intervisible with both the Croy Hill fort and fortlet over a distance of 2,76 km and 2,9 km, respectively. From the Croy Hill fort one could not see the positions of either of the nearby lying expansions, only the site of the fortlet 55 m away. From here both Croy Hill East and Croy Hill West could be seen 0,47 km and 0,59 km away, respectively (Croy Hill East was separated from Croy Hill West by 0,14 km). One would have also had a direct line of sight from Croy Hill fortlet to Bar Hill over a 2,5 km distance, which was additionally visible from the Croy Hill fort over a 2,58 km distance. Croy Hill West was separated from Bar Hill by 1,92 km.

With its superior positioning, Bar Hill was comfortably intervisible with Auchendavy over a distance of 3,02 km. Despite the link between Auchendavy and Kirkintilloch being much tighter, the position of one could have been seen from the other across a 2,63 km distance. Despite Kirkintilloch being intervisible with Glasgow Bridge over 1,66 km, the position of

Cadder (3,6 km away) could not have been seen from it or from Glasgow Bridge (Glasgow Bridge to Cadder being 2,02 km). As an excellent relay for signal communication with Balmuilty fort could serve the Cawder House possible fortlet (3,15 km from Glasgow Bridge and 1,03 km from Cadder), attested so far only via geophysics.

As mentioned above, Cadder could have been directly intervisible with Kirkintilloch if the observation platform stood 10 m or more above the current surface (see p. 108). Despite this height being double the OFFSETA used in the rest of the study, it is not as excessive as it seems at first glance. Indeed, the area of the fort was quarried during 20th century and so the original terrain may have been several metres higher. Moreover, building a 5-6 m-tall tower over the *porta praetoria* was certainly possible there (CLARKE 1933, 18). However, if this was not the case and the anomaly detected at Cawder House was not an archaeological feature (MALDONADO 2018, 71), there was no link between Cadder and the other installations on the Antonine Wall. Alternatively, the closest intervisibility link was between Wilderness East and Cadder over a distance of 5,35 km, or between Wilderness Plantation and Cadder over a distance of 5,6 km, were one to ignore Cawder House but still believe that the top of the Cadder gate towers was more than 8 m above the current ground level.

Wilderness Plantation was intervisible with all the minor enclosures, which were further intervisible with each other, being separated from one another from east to west by 0,26 km, 0,29 km and 0,25 km. They were all intervisible with the Balmuilty fort (separated from Buchley by 1,15 km, from Wilderness West by 1,4 km, from Wilderness Plantation by 1,68 km and from Wilderness East by 1,94 km). Apart from the sites mentioned just above, the only other Roman installation intervisible with Balmuilty was the fortlet at Summerston, 1 km to the north-west as crow flies. Summerston had no line of sight to any known Roman military installation alongside the Antonine Wall to the west. Balmuilty was intervisible with Castlehill (5,6 km away). This intervisibility link overlaps Bearsden, which in theory may have been integrated into the intervisibility system via just one relay at Crow Hill, where Boclair fortlet was expected but never found. From this spot the fortlet at Summerston was visible 0,59 km to the east, while to the south-west the position of Bearsden was visible 2,29 km away. Between Bearsden and Castlehill (2,04 km apart) there was no intervisibility, not even between 5 m elevated platforms above the gates, but had the platforms been 2 m higher, the sites would have been intervisible. Alternatively, one would have to rely on another fortlet as a relay, positioned on Thorn Road, roughly 1 km north-west of the Bearsden fort and at least 0,8 km south-east of Castlehill.

Castlehill was intervisible with the fortlet at Cleddans 1,64 km away, which was again in the line of sight of both the Duntocher fort and fortlet (1,32 km away). The western end of the Antonine Wall was not particularly enigmatic as the eastern terminus, since the fort at Old Kilpatrick was practically located on the bank of the Clyde estuary and was still attached to the Antonine Wall, unlike Carriden. Thanks to its low-lying position, however, the Old Kilpatrick fort was not intervisible with Duntocher. At least one relay was needed, which would have a line of sight to both the Duntocher and Old Kilpatrick forts. The only such spot on the line of the Antonine Wall was located at the approximate position of the possible fortlet at Mount Pleasant, where a stretch of 125 m of the course of the Antonine Wall could be seen from both forts, or more precisely, where there could have been built a platform elevated 5 m above the ground, which would have then been intervisible with Old Kilpatrick and Duntocher (Fig. 54).

The visual connections sketched above can therefore be summarised as three possible scenarios of lateral intervisibility chains on the Antonine Wall: optimistic, pessimistic and realistic.

- 1) The optimistic scenario takes into consideration all the known sites, including expansions and minor enclosures, the possible fortlets at Laurieston, Cawder House and Giral Hill as well as the intervisibility between Cadder and Bearsden plus their respective neighbours as described above. The overall number of links in discussion is therefore thirty-four and the overall length of lines of sight is 49,49 km, rendering the average distance between two intervisible sites 1,46 km. In this scenario, the longest link between two sites appears to be the connection between Kirkintilloch and Cadder, which was 3,6 km (see Fig. 55).
- 2) The pessimistic scenario is much more conservative and does not include minor enclosures and expansions within the intervisibility system as they were redundant for the mutual intervisibility of major sites and their true purpose remains enigmatic. No possible fortlets are included and no higher elevation of observing or observed positions is taken into consideration, with the exception of Garnhall, where the existence of a watchtower was already proven via excavation (WOOLLISCROFT 2008, 174–175). In this scenario (see Fig. 56), the overall length of the lines of sight is 49,75 km, the forts at Bearsden and Cadder are simply overlapped and visual links often go straighter than the Antonine Wall. Only twenty links between sites are retained and for that reason the average distance between intervisible sites is 2,49 km, with the greatest inter-site distance being between Kirkintilloch and Wilderness Plantation and coincidentally also between Balmuildy and Castlehill (in both cases 5,6 km as the crow flies).

- 3) The realistic scenario is the author's preference (Fig. 57). It takes into consideration the possible fortlets where at least some evidence for their existence has been found (i.e. at Laurieston and Cawder House) but ignores those where no evidence has been found (i.e. Boclair). Cadder and Bearsden are also included because links between Cadder and Kirkintilloch and between Bearsden and Castlehill were technically achievable. Expansions and minor enclosures are again ignored due to the reasons already mentioned in the pessimistic scenario. Twenty-three links are therefore present in the realistic scenario and the average distance between intervisible sites is 2,15 km. The longest direct link between two sites remains the connection between Balmuildy and Castlehill (5,6 km).

The first conclusion is therefore that the utmost precondition for the existence of any visual signalling on the Antonine Wall was met. In all of the scenarios the sites were intervisible enough to relay messages to each other laterally and the distances were not excessive for the transmission of simple messages like "Alarm!" via beacons or torches (WOOLLISCROFT 2001, 35). As a weak spots of proposed system can be perceived both ends of the linear barrier, where evidence about posts fitting to the pattern are missing. However, it would be wrong to think that at least some fortlets were not present between Old Kilpatrick and Duntocher and between Carriden and Kinneil/Inveravon, at least from the logical point of view of displaying such a piece of art as the Bridgeness slab (RIB 2139) somewhere without the regular presence of soldiers.

In contrast, the presence of more fortlets at terminal parts of the Antonine Wall should be expected because beyond these sections, intervisibility was maintained across the whole length of the frontier, frequently with some effort. This effort can be best understood in the case of so-called edge connections: situations where one site was at the very edge of the line of sight of another. Up to 146 connections were documented in the presented study between thirty-nine studied sites (seaside forts and fortlets not included – see Table 5). Of these, at least forty-four can be described as edge connections in meaningful distances (generally below 5 km distance), or almost exactly one third of the total number. As summarised above, frequently these edge connections were between neighbouring sites, so in other words a hypothetical fortlet was located on the last visible spot from a hypothetical fort. This arrangement is best decipherable in cases where a site was positioned on the only spot on the Antonine Wall from which it was visible from both its western and eastern neighbours. This pattern was most obvious at sites where the overlap of areas visible from their neighbours only left a narrow stretch of land where the mutually intervisible sites could have been placed. Excellent examples have been described

above, like Garnhall (Fig. 58) or Balmuildy (Fig. 59), but the same can be said about Rough Castle (Fig. 60), Westerwood (Fig. 61) or Bar Hill, just to mention the most prominent instances that have their direct neighbours to the east and west at the very edge of their lines of sight. The same can be said about Camelon and its relationship with the entire eastern sector of the Antonine Wall: not much more could have been seen from this fort except for the positions of the forts and fortlets on the Antonine Wall.

It is therefore tempting to propose that the positions of some sites were dictated by the above-mentioned intervisibility pattern. However, this pattern may have also been connected with the surveying of the frontier, which was done predominantly via optical tools such as *groma*. Intervisibility was crucial for the laying out of the positions of the forts and all other features of the frontier, including the mural barrier itself. The amount of mutual intervisibility could therefore be put in coincidence with another pattern that has yet to be discussed in detail: long-distance alignments.

2.3.8 Long-distance alignments

While studying the intervisibility pattern of the individual sites on the Antonine Wall, the author came to a similar conclusion as MSc John Poulter: that some sites were located on the direct line connecting two neighbouring sites of the first one along the course of the Antonine Wall (POULTER 2018, 115). In his study about surveying the Antonine Wall, Poulter initially adjudged that no long-distance alignment was applied at the Antonine Wall, unlike at Hadrian's Wall or the Stanegate (POULTER 2009, 22–31, 76–86, 112–114). Later he admitted that certain long-distance alignment was applied in order to maintain a two-level signalling system operating over a long distance, transferring calls like “alarm” or “serious alarm” (POULTER 2018, 124–134). The long-distance alignments discovered by Poulter (see p. 148–149, 260 and Fig.7) are however only a fraction of the true situation. Below a more complete picture is offered, which also includes the sites that did not fit Poulter's long-distance alignments.

The positions of some fortlets as well as the watchtower at Garnhall and several expansions were on the lines connecting for example the *porta principalis dextra* of one fort with the *porta decumana* of another. This pattern is repeated so frequently that it cannot have been absolutely coincidental, even though in certain cases the alignments may have been so because the Antonine Wall was a linear barrier. Interesting patterns can be followed, as the mutually non-intervisible sites fitted to certain long-distance alignments with a precision of metres, most notably in the terminal parts of the frontier in the vicinity of Old Kilpatrick and Carriden. A plethora of mutually intervisible forts had their gates aligned according to the direct

line connecting the gates of other (and sometimes distant) forts. Thirty-one alignments were identified by the author, varying in length between 5,5 km and 26,76 km. The average alignment was 11,15 km.

The easiest alignments to interpret were those between mutually intervisible sites, like between Camelon and Croy Hill (position of Westerwood *porta praetoria* was located on the line connecting Camelon *porta principalis dextra* with Croy Hill fortlet northern gate – Fig. 65), Camelon and Westerwood (Seabegs Wood – Fig. 66) and Camelon and Garnhall (Castlecary – Fig. 67). Similarly, there was alignment between the Bar Hill fort and the Wilderness Plantation fortlet (positions of gates of Auchendavy and Kirkintilloch were defined by the line connecting mentioned fort gate with a fortlet – Fig. 77), between the Bar Hill and Kirkintilloch forts (Auchendavy – Fig. 68), between the Bar Hill and Rough Castle forts (Westerwood and Castlecary Figs. 65, 67), between the Bar Hill and Westerwood forts (Croy Hill fort – Fig. 69) and between the Mumrills fort and the Watling Lodge fortlet (Laurieston and Falkirk – Fig. 70) (for details, see Table 6). Achieving these alignments was relatively easy for surveyors, as they could simply choose a spot on the line surveyed with *groma* or even simpler tools at the requested distance as long as the weather was good for intervisibility.

The task was more complex in cases of alignments between mutually non-intervisible sites where only the aligned was visible from both ends of the alignment. Examples include the alignments between Bar Hill and Castlecary (Garnhall watchtower and Westerwood's *porta principalis dextra* stood on the line connecting the rear gates of Bar Hill and Castlecary forts – Fig. 71), between Bar Hill and Balmuildy (Auchendavy and Kirkintilloch – Fig. 63, 68), between Balmuildy and Cadder (Buchley, Wilderness Plantation and Wilderness East – Fig. 72), between Falkirk and Bonnyside West (Watling Lodge, Tentfield East, Rough Castle and Bonnyside East – Fig. 73), between Castlecary and Westerwood (Garnhall – Fig. 71), between Auchendavy and Wilderness Plantation (Kirkintilloch – Fig. 63), between Cadder and Duntocher (Castlehill – Fig. 74), between Cadder and Auchendavy (Kirkintilloch – Fig. 63) and between Kinneil and Bonnyside West (Rough Castle – Fig. 73). These alignments, if not coincidental, could have been achieved only by choosing a spot for one of the terminal sites from the position of the aligned.

Nevertheless, most curious were the alignments between otherwise non-intervisible sites, where not even the aligned had any line of sight to both ends. These were initially viewed by the author as accidental, but they were so numerous that such interpretation seems improbable. One of the Mumrills gates stood on a line connecting the Carriden and Westerwood

forts' gates, while the other gate was directly on another line connecting the Carriden fort and the Garnhall tower (Fig. 75). It should be noted that none of the long-distance alignments went through the early Antonine fort at Mumrills in places where the gates might be expected, even though the author searched for them. It seems clear that the younger Mumrills fort was aligned between the positions of other Roman military installations, while its earlier counterpart had no spatial relationship to them. The Kinneil fortlet was on the line connecting the Carriden fort and the Seabegs Wood fortlet, while on the same line there was also one of the gates of the Falkirk fort (Fig. 70). Another gate of the Falkirk fort was on a direct line connecting the gates of Mumrills and Rough Castle forts, which were again mutually non-intervisible (Fig. 70). The most complex alignments were found in the westernmost sector, where any direct intervisibility between sites was not achievable. All three gates of the Bearsden fort were on the lines connecting the various gates of Balmuildy with Duntocher and Old Kilpatrick (Fig. 62). These alignments are particularly curious especially since they remind the alignments used on the Odenwald Limes, despite there they were always present between intervisible sites (see p. 218–222). On one of the lines between the Balmuildy and Old Kilpatrick fort gates lay the fortlet at Duntocher (Fig. 76). The Castlehill *porta praetoria* was located exactly on the line connecting the Old Kilpatrick *porta praetoria* with Wilderness East (Fig. 74). Through the position of the supposed but not attested *porta decumana* of the Duntocher fort was a line connecting the gates of Old Kilpatrick and Bearsden (Fig. 76). If a line were drawn between Bearsden's eastern gate and Cadder's western gate, the position of the possible fortlet at Cawder House would be exactly on it (Fig. 78).

These alignments, if not coincidental, must have been extremely laborious for the surveyors to design without the advanced use of two-dimensional topographical maps in combination with the extensive usage of trigonometric functions (both were unavailable to the Romans, according to the author's knowledge). Just for the alignment of Duntocher and Bearsden between the Old Kilpatrick and Balmuildy gates, observation spots for surveyors must have been on a small hill west of Balmuildy (Wester Balmuildy farm), Carscadden Wood (near the Castlehill fort), Golden Hill (north of the Duntocher fort) and on the hill east of Carleith Primary School (see Fig. 62). Each was intervisible only with its direct neighbour, so achieving a direct line was not an easy task. In other cases, some curious distance formula was observable, such as in the case of alignment between the Bar Hill *porta decumana* and the Balmuildy *porta praetoria*, on which lay the Kirkintilloch *porta praetoria* 4 Roman miles as the crow flies from the former and 5 Roman miles from the latter (Fig. 63). A similar distance constant may have been applied in the case of other alignments, but it was not the general pattern for all of them.

If one accepts the fact that the majority of the above-mentioned alignments (see Table 6) were intentional, new light may be shed on the way the frontier was surveyed. First of all, if the alignments were intentional, they (or at least some of them) were unrelated to the two-level signalling system proposed by Poulter (POULTER 2018, 124–134), as some were located between non-intervisible sites and therefore had nothing to do with two-level visual signalling system. It is, however, complicated to understand the need to align the positions of some sites to the lines connecting the others. What practical advantage does this offer the builders in comparison to positioning the forts and fortlets on the basis of a distance formula alongside the frontier (Table 1), intervisibility (Table 5) or on a favourable position in terms of local topography (see p. 133–148 and Table 4)?

The first step to the interpretation is finding a definition of aligning and aligned. The initial positions determining the locations of the others seemed to predominantly be the forts at Carriden, Camelon, Castlecary, Bar Hill, Balmuildy and Old Kilpatrick. These can all be described as topographically determined, as Carriden and Old Kilpatrick were located where they were because of their access to the estuaries of the Forth and the Clyde, whereas Camelon, Castlecary and Balmuildy were positioned on river/stream crossings (Carron, Red Burn and Kelvin respectively) and Bar Hill on the highest point and best observation spot on the Antonine Wall. The positions of all the other sites were based either on aligning with at least one directly or on aligning with one of the forts already aligned to the above-mentioned five (see Table 6). One exception to this rule is Inveravon, which is not included in this study as the positions of its gates cannot even be conjectured. It seems that direct lines from the Castlecary and Rough Castle forts going through the Mumrills and Falkirk forts may have defined the whereabouts of the Inveravon fort in theory, but the size of the fort based on the distances between the fort gates defined by these alignments would have been at least 0,3 ha, for which there is currently no archaeological evidence (Fig. 64). As some of these alignments are only conjectural, there is no point in proceeding with alignment theory in the case of the Inveravon fort without more detailed archaeological evidence from the site.

Furthermore, the fortlets at Summerston and Cleddans do not fit to any detectable alignment as well as both the Croy Hill and Tentfield West expansions. Special was the case of Glasgow Bridge fortlet, which was located 2,07 km east of the centre of the Cadder fort, lying on the line projecting from fort's *porta decumana* through *porta praetoria* to the east (Fig. 79). This type of alignment is unique on the Antonine Wall but has several parallels on the Odenwald Limes (see p. 133–148).

2.3.9 *Conclusion II.*

The evidence presented above can thus be summarised as follows. The sites on the Antonine Wall were intervisible enough to facilitate a lateral signal system with ease. The soldiers in the forts and fortlets on the Antonine Wall had a good line of sight to the vicinity of their permanent installations, most notably to the north, whereas areas immediately south of the frontier were apparently ignored. Whether the positions of the individual features on the frontier were dictated by alignment to the lines connecting several major installations is difficult to interpret. It seems more likely that the lines of sight to the neighbouring forts and fortlets were of greater importance, as the case study of intervisibility showed in the case of Garnhall, which is both aligned and intervisible at a threshold with its neighbouring sites. A similar case is Camelon, to which several sites were aligned and existed on the edge of its line of sight.

The position of Bearsden remains problematic. It is possible that more fortlets were present in its vicinity, potentially serving as relays just as the Wilderness Plantation served for Balmuildy. However, given that none have yet been found, the only verifiable explanations for the fort's position are either topographical or fitting to the alignment. Therefore, the implication of the intermediate results is the urge to proceed with a more complex topographical study of the position of Bearsden in terms of its accessibility via cost path analysis. Such analysis in combination with viewshed is below also presented in order to verify a theory whether there was any further fortlet between Lurg Moor and Outerwards sites, which would have the line of sight to the unobserved areas from these fortlets.

2.3.10 *Cost path analysis – the goals*

The sites studied via cost path analysis were the Bearsden fort and possible fortlet between Lurg Moor and the Outerwards fortlets. As regards the former, the key question was as follows: Was the fort located in a position through which some potentially arterial or vital paths led? This may provide another explanation for its positioning, because the interpretation via viewshed analysis or affiliation to long-distance alignment brought only inconclusive evidence.

The following is therefore yet another attempt to transform above-mentioned vague statements such as the “fort was strategically positioned in the landscape” or the “fortlet was built in an excellent position in order to block south-northern communication” into something that can be verified, here via spatial analyses. This attempt is based on using the terrain model as an environment for a complex simulation of accessibility on the frontier. The question at hand is whether the fort at Bearsden did not stand on the exact point through which natural

paths in the landscape traversed. In this specific case, it is most convenient to expect communication from the north to the south. As a destination, the city centre of present-day Glasgow was selected as a natural crossroad, as while moving south one has to cross the Clyde river, an action that historically took place somewhere in the area of contemporary Glasgow.

As a starting point, twenty-two different Iron Age settlements in the area of present-day western Stirling council area were defined (see Table 7). These sites were chosen with regard to their spatial distribution rather than to their exact affiliation to the specific period of the Iron Age, sometimes termed the Roman Iron Age, taking place essentially between 1st and 4th century AD. Majority of these sites were never excavated and may have also constituted Bronze Age settlements and early medieval sites. Nevertheless, their spatial distribution was favourable for this study, as the selected sites were extensively dispersed across the present-day western Stirling council area, rendering the analysis more rigorous. Focal mobility network analysis (DÉDERIX 2016, 555–565) was calculated in order to ascertain local corridors for movement throughout the landscape; these were identical with the resulting courses of the cost path analysis performed in this thesis. Therefore, even if not all of the sites were occupied during the existence of the Antonine Wall, the corridors for movement were already present in the landscape for everybody living there at the time and dictated the most convenient roads, especially in terms of moving south. In most of these corridors there is now a modern road or at least a tourist path and they frequently follow local streams. Given that both analyses yielded the same results, below only the results of the cost path analysis are presented. If one were to remove some of the sites from the analysis, the overall two directions of the most convenient paths in the vicinity of the Antonine Wall would not change, especially owing to the number of overlaps of individual paths from different sites. This is the main reason why the spatial distribution of the sites was more important than exact dating: if at least some people lived in the area, they eventually moved through similar corridors as their predecessors and successors.

The second case study sought to determine the location of the possible unknown fortlet between Lurg Moor and Outerwards. The perceived key precondition for this site was a good view over the Firth of Clyde, as both of the other seaside fortlets were evidently positioned in order to observe this estuary. Despite never being fully uncovered, it is certain that Lurg Moor and Outerwards were connected via a Roman road, traces of it being positively identified in the vicinity of Outerwards (NEWALL 1976, 111–112). During his own search for the fortlet, Frank Newall identified the course of this potential road on several occasions, but unfortunately without publishing an extensive report and without presenting any material evidence, hence the traces he documented could have equally been early medieval or even later. He also proposed

several sites as possible fortlets, but his investigations again brought very limited precise evidence supporting or contradicting his proposals (NEWALL 1963, 43–44; NEWALL 1964, 45; NEWALL 1970, 12–13, 43; NEWALL 1984, 32; NEWALL 1988, 24–25).

The study presented here is therefore based on the presumption that between two known fortlets, a road must have existed. The third fortlet can be expected somewhere roughly in the middle of these, in a location with a good line of sight to the otherwise invisible area of the Firth of Clyde. The other precondition for its location is accessibility, so despite the sites positioned immediately near the banks or on the seaside usually possess the best views of the coastline, more elevated positions were ultimately preferred in order to connect the outpost via a meaningful convenient road. Such was the nature of the locations of the remaining two fortlets. An ideal spot would be one with a good line of sight and located near the course of a convenient path connecting Lurg Moor with Outerwards. However, a compromise dictated by the landscape should be expected.

2.3.11 *Cost path analysis – the results*

From the majority of the Iron Age settlements included in the study (see Table 7) travels the most convenient path to the south throughout present-day Stirling, Denny and Kilsyth to the area of the Camelon fort. If this course became blocked and the south-western direction was restricted, one would have naturally tried to bypass the Campsie Fells (Fig. 80). The cost path analysis shows that the convenient track went along the banks of Endrick Water and Auchentroig Burn roughly to the modern-day Killearn village, where natural corridors from the majority of the sites met and the most convenient path went further in a south-eastern direction between Blane Water and the course of the current A 81 through Strathblane up to present-day Lennoxton, where it met with the most convenient path from Toddholes to the south, which crossed through Campsie Glen. Beyond Lennoxton, the course of the path entered the line of sight of the sites on the Antonine Wall (see Fig. 81), under which it remained until reaching the barrier itself. In the relatively flat Kelvin Valley, the course of the calculated path is highly unreliable, as elevation differences in the model were minimal. The most convenient way out of the valley unsurprisingly followed the Kelvin River in the immediate vicinity of the Balmuildy fort. If this position became blocked, the second option seemed to be in the vicinity of Cadder and the third in the vicinity of Kirkintilloch, corresponding with the supposition that the locations of the Roman forts on the Antonine Wall were excellent blockers of north-south communication. However, the case of Cadder in particular should be taken with restraint as the area of the fort and its immediate vicinity changed drastically during the construction of the

immediately neighbouring Forth-Clyde Canal and thanks sand quarrying in 20th century (see p. 101, 120). Passing by the Balmuildy fort, the most convenient path followed the Kelvin until reaching Dawsholm Park in present-day Glasgow, from which it followed the most direct line towards the city centre.

For a certain number of the westernmost sites (bold in Table 7), the path to the south proceeded differently. Principally, on the way south alongside Loch Lomond, it avoided the Valley of Strathblane between the Kilpatrick Hills and the Campsie Fells and instead followed much higher ground. This alternative path followed the northern bank of Endrick Water, passed through Stockie Muir and eventually crossed this stream near Dalnair Farm, from which it led almost straight south, following the current A 809 (Fig. 80). When passing by Carbeth Hill, it left the course of the modern road and followed the straighter line of nearby Allander Water still directly to the south, through present-day Milngavie. Then the course of the path duplicated the West Highland Way railway and crossed the Antonine Wall approximately 250 m from the *porta principalis dextra* of the Bearsden fort. From Bearsden the hypothetical path turned to the south-west, following Carscaden Burn for a while and then went almost straight to the River Clyde, whose northern bank it followed until both courses of the cost path unite at the confluence of the Kelvin and the Clyde.

In the second case study, concerned with the position of possible third seaside fortlet, the cost path analysis was used as a second step because it was first necessary to ascertain between which sites it should be calculated. The Military Way on the Antonine Wall in all excavated examples either copied the course of the turf rampart or followed a slightly straighter line behind it whenever the rampart course became too sinuous (POULTER 2009, 117–121). Beyond the Antonine Wall, the amount of evidence for Roman roads is even scarcer than in the case of the Military Way. In the east, the course of Dere Street is known or suspected to move north-westward from Inveresk to Cramond, before probably bypassing Carriden via Watling Lodge to Camelon (MARGARY 1973, 466–469). In the west it is more or less accepted that the road led from Bishopton to Lurg Moor and then possibly to Outerwards, but the final destination is rather conjectural (NEWALL 1976, 111–112).

To discover the possible third seaside fortlet between Lurg Moor and Outerwards, the viewshed analysis was used in combination with cost path. The prerequisites of the possible fortlet's location were:

- 1) Line of sight to areas beyond the frontier (specifically on the shore of the Cowal Peninsula and the section of the Firth of Clyde between the Cowal Peninsula and Inverclyde) otherwise invisible from the remaining two fortlets.
- 2) Proximity to the ideal path and attested road between the Lurg Moor and Outerwards fortlets.
- 3) Line of sight to the course of the ideal path/attested road between the Lurg Moor and Outerwards fortlets.

The first step was to calculate the viewsheds from six equally spaced positions in the non-visible stretch of the Firth of Clyde from the Lurg Moor and Outerwards fortlet (see Fig. 82 and Table 8, where they are stated as AUX 1-6). The resulting lines of sight frequently overlapped each other, thereby highlighting the positions from which more than two of the initial observation points were visible. From several of the positions with the highest numbers of overlaps, viewsheds were then calculated in order to measure how strong the positions were with regard to the a) and c) prerequisites, while the distances were also measured from each site to the most convenient path and roads documented by Frank Newall (NEWALL 1963, 43–44, NEWALL 1970, 12–13, 43), being prerequisites for b) (see Table 8 and Fig. 53).

The results brought inconclusive evidence. For instance, the best views of the Cowal Peninsula and the Firth of Clyde were held by a cluster of spots above present-day Gourrock (Burneven Hill, Earn Hill, Echoing Rocks and North Knowe), which were nevertheless inaccessible both from the known fortlets and from any potential course of the Roman road between Lurg Moor and Outerwards (see Table 8). The only spot that had at least some line of sight to the Firth of Clyde as well as a degree of visibility to the course of the cost path results and to the attested remains of some possibly Roman roads in the vicinity of present-day Loch Thom was Laverockhouse Hill (Fig. 83). This hill has never been archaeologically investigated but was through the discussed analysis found to offer the best position for an observation platform with at least some proximity to the remains of the Roman road and the projected cost path in this area.

On nearby hilltop, Hillside Hill, a fortlet was suggested by Newall (NEWALL 1963, 43). However, this site showed no signs of Roman origin, despite a human-made structure having been built there. Furthermore, this position, similarly to the nearby East Hill, had no line of

sight to Lurg Moor or Outerwards, just like Laverockhouse Hill. More importantly, it had no view of the Firth of Clyde, this being blocked by Laverockhouse Hill (Figs. 53, 84). If there ever was a third fortlet between Lurg Moor and Outerwards, the author speculates that it was at Laverockhouse Hill because it represents a compromise between accessibility and visibility to the broader landscape.

The main reasons why the existence of a third fortlet should be taken seriously are demonstrated by the results of the cost path analysis. The resulting path almost exactly follows the road as it was identified by F. Newall in 1970 (NEWALL 1970, 12–13, 43). If this road was indeed Roman, the utmost precondition for its builders was to connect Lurg Moor with Outerwards by the most convenient and direct path. If nothing else, the results of the cost path analysis provide some additional ground to identify this road as Roman, as it perfectly connected two Roman sites that were not reoccupied in later periods. Any other possible Roman road, as surveyed by F. Newall as early as 1963 (NEWALL 1963, 43–44), would represent an illogical detour without the existence of a fortlet west of the present-day, artificial Loch Thom (Fig. 53, 85).

According to Newall, this road ascended Hillside Hill from the north-east, only to be lost south of East Hill. Whether the road led there because of the sentry post on Hillside Hill, Laverockhouse Hill or somewhere else is impossible to decipher, but the statistics in Table 8 show that from Hillside Hill one enjoyed a superior line of sight to the course of both stretches of possible Roman road and the area of contemporary Lake Thom, while from Laverockhouse Hill a much better view over the Firth of Clyde was provided, although only a fraction of both the road and the broader inland landscape would have been visible.

2.3.12 Cost path analysis – conclusions and implications

Based on the results of the viewshed analysis of Lurg Moor and Outerwards, which both offered a superior line of sight over the Firth of Clyde and only limited visibility inland, the author's preference for the location of the third fortlet is Laverockhouse Hill. Unlike any other site it satisfies the two most important demands for such an outpost: visibility to the Firth of Clyde and proximity to both courses of the suspected Roman road and the course of the cost path, representing the most convenient track connecting Lurg Moor and Outerwards. Only further excavations or at least brief investigations will enable additional conclusions. From the results of the above-mentioned analyses, it appears that both courses of the Roman road proposed by F. Newall could have existed simultaneously, one road connecting two attested fortlets and a second following a much longer and more demanding way along a ridge to another outpost.

This study has also shown the limitations of using cost path analysis, which will be further discussed below. The most important point is that the road documented by Newall in 1963 does not overlap in half of its course with the most convenient road to Laverockhouse/Hillside Hill from Lurg Moor. It is thus important to understand that the builders did not merely try to connect two points in the landscape. Instead, other qualities were expected from the road, like visibility to the broader landscape, which is excellent from the ridge but inferior from the course of the cost path.

The courses of the paths from the first case study (various native sites – centre of present-day Glasgow) represented suggestions rather than reconstructions of actual tracks in antiquity. The initial problem is that they cannot be verified by any archaeological means, as no road system is known from Scotland prior to the Middle Ages except for the Roman one. Reconstructed were just paths. Second, the cost path was calculated according to the model of the contemporary landscape, from which certain features were deleted and gaps were filled via interpolation, which may not necessarily represent the original landscape (see also Appendix I). For example, the path from Todholes initially passed along the shore of the Carron Valley Reservoir, which is a modern construction and it would be highly speculative to reconstruct how the valley looked before its construction. An even greater influence was provided by the construction of Loch Thom in Inverclyde in the second case study, which according to all the simulations lay on the course of the most convenient path between two known seaside fortlets. This study is thus more a summary of natural corridors and how the locations of the Roman sites fitted to them.

It appears that various forts in the western and central parts of the Antonine Wall were positioned in the immediate vicinity of these natural north-southern communication lines and became thus “crossroads” when the Military Way was constructed from east to west or vice versa. As the Antonine Wall had no *vallum* and it is still questionable whether it was ever planned there (BAILEY 1994, 300), the blocking function of forts like Balmuildy, Bearsden and possibly also Cadder and Kirkintilloch seems to have been crucial for control of the landscape. However, by no means can this be described as a general precondition for the positioning of the Roman forts on this frontier: indeed, on first glance the positioning of Bar Hill, Castlehill or Duntocher differed fundamentally as suggested above (see p. 117–123).

2.3.13 *Interpretation of the Antonine Wall sites via slope analysis – the goals*

Given that the viewshed and cost path analyses as well as the existence of long-distance alignments were unable to explain the positioning of all the forts and fortlets on the Antonine

Wall, another method was applied – the slope analysis. Indeed, interpreting the terrain slope in both the immediate vicinity and at a slightly farther distance can help to compare the local topography of individual sites. Primarily this method can be used to show from which direction the sites were best accessible, if they were naturally protected by terrain, if they were on the summit of a hill (or just a gentle hillock) or just under it and so forth. For the purposes of this analysis, the terrain model was transformed into a slope raster, where elevation played a role only as an indicator of ascent or descent, while the measured value was steepness or gentleness of the slope in degrees. The surroundings of each site were examined in a 0,3 km, 1 km and 1,5 km radius and a further two profiles were offered, one on the course of the Antonine Wall in the vicinity of the installation (not on a direct line from east to west but alongside the zig-zag course of the turf barrier) and one usually traversing from the north to the south, representing the natural access route to the site from the frontier area north of the Antonine Wall defined above. The results include modern features like roads and canals, so only general trends rather than micro-topography can be highlighted. The results are described below and summarised in Table 4.

2.3.14 Interpretation of the Antonine Wall sites via slope analysis – the results

The position of Carriden was defined by a coastline ridge immediately north of the fort. A little further to the west lay another separating feature, Carriden Glen, with an annexe between it and the fort. Otherwise, the site was accessible from both the south and the east, lying on the edge of an almost flat plateau, gently descending from the south-west to the Firth of Forth in the north-east (Fig. 86).

The position of the fort at Camelon was defined from the north and the east by a sharp step, with the fort itself standing on a slight but sharply defined plateau. The best access to it was from the south, where the site itself is today disturbed by modern development. The fort was in a broader context positioned in a relatively flat area, gently ascending towards it from the northern, western and southern sides (Fig. 87).

The position of the Mumrills fort was on a narrow plateau, defined by the ascent from the Valley of Carron in the north and Westquarter Glen to the south of the fort. Further south, the elevation constantly raised and any view in that direction was thus blocked (Fig. 88). To the east of the fort were located Westquarter Burn and Polmont Burn in relatively sharp depressions and therefore the site was best accessible from the west, where a fortlet at Lauriston lay. Access from the north would have been hindered by the need to ascend to the above-mentioned plateau some 28 m above the Valley of Carron.

The Castlecary fort was situated just under a rising hill to the west, the landscape descended towards the fort from the north and ascended again south of it. Accessibility to the site was thus good from all directions, because the plateau on which lay Westerwood and Croy Hill directed all the traffic and communication from the north through Castlecary, which is well documented by the existence of the modern M 80 motorway passing by the fort site (Fig. 89).

Bar Hill was located on the hilltop of the most prominent hill along the course of the Antonine Wall, which was accessible with some effort from all sides, although the easiest ascent offered the south-west (Fig. 90).

The Auchendavy fort was in general terms on the edge of a gentle plateau over the inner part of the Kelvin Valley, accessible equally well from the south, west and east in a generally flat area and only slightly ascending in the east towards Bar Hill (Fig. 91).

The Balmuildy fort was located on the northern edge of a small plateau overlooking the River Kelvin. The terrain generally descended towards the fort from the east and south, with the fort best accessible from the area of the above-mentioned river (Fig. 92).

The position of Old Kilpatrick was defined by its proximity to the Firth of Clyde. The site was located at the end of the sloping of the Kilpatrick Hills towards the estuary of the Clyde and was not standing on any substantial bank or plateau. Instead, it was easily accessible from both the north-west and the south-east alongside the northern bank of the Clyde (Fig. 93).

The position of the Inveravon fort was conveniently accessible from the north, because it was situated in the gap in the escarpment on which the Mumrills fort or the Kinneil fortlet lay. Therefore, the landscape ascended to a higher elevation not even 0,3 km east or west of the fort site, which was otherwise located on the right bank of the Avon, possibly guarding an ancient crossing of the river (ROBERTSON 1974, 97–101, Fig. 94).

The location of the Falkirk is hard to evaluate because the fort was located in what is now a heavily built up area. Originally it stood near the crossing of West Burn. The landscape was generally ascending towards the fort from the estuary of the Carron. There were no significant landscape obstacles in either the western or eastern directions along the course of the Antonine Wall that cannot be attributed to modern development. The landscape generally tended to ascend towards the fort from the north and proceeded to ascend far south of it until present-day Glen Village (Fig. 95).

Immediately west of Rough Castle runs the Rowan Tree Burn, effectively creating a step depression west of the fort. Otherwise the fort stood in the middle of a gentle ascent from

Bonny Water to the south. On the course of the Antonine Wall the fort was located in relatively flat area between two smaller hillocks blocking a direct view over the landscape. One was located between Tentfield East and Tentfield West, with the second just between Rowan Tree Burn and the location of Bonnyside East (Fig. 96).

The Westerwood fort was located in a relatively easily accessible spot in the vicinity of present-day Cumbernauld Airport. To the west the landscape generally descended and then again ascended towards Croy Hill. To the east the course of the Antonine Wall followed an uneven descent towards the Castlecary fort. On the north-south axis the fort was roughly in the middle of a gentle ascent of the southern bank of the Kelvin Valley further south towards Mainhead Plantation (Fig. 97).

The position of the Croy Hill fortlet was clearly defined by the ridge on which it stood, overlooking modern-day Kilsyth. The site was practically inaccessible from the north-west and the south-east, just like the Croy Hill fort and nearby lying expansions (Fig. 98).

Kirkintilloch fort was located on a slight plateau, appearing most prominent when approached from the north but better accessible from the west and south as in the east the terrain descends towards the banks of Lugle Water. The site is hard to interpret in detail because it is today located in a heavily built-up area. In general terms the landscape to the west tends to be flat while east of the fort it ascends towards contemporary Broomhill and Kirkintilloch (Fig. 99).

The Antonine Wall generally gently descended towards the Cadder fort from the east, only to sharply ascend west of it, akin to the case of Castlecary. The site was fairly accessible from the north, the Kelvin Valley, thanks to its low elevation. The area north of the fort was flat water meadow of the Kelvin River, while behind the fort to the south the terrain slowly raised. It is still questionable how the terrain profile would have appeared before the construction of the Forth-Clyde Canal and the quarrying of the fort. These two events created from the fort's position a gate to the area of present-day Bishopbriggs despite the terrain possibly looked less favourable to traffic when it was shaped solely by Bishopbriggs Burn, a tributary of the Kelvin, running some 0,35 km west of the fort. Despite the general trend of the terrain could explain the positioning of the fort as an excellent blocker of north-southern communication, in terms of micro-topography the model is heavily dependent on the human-made changes of the landscape during the modern era and therefore should be interpreted with caution (Fig. 100).

The Bearsden fort was divided from the area immediately to the north by Manse Burn. Further north the terrain very gently descended towards it while south of it the descent progressed in several steps more steeply. On the west-east axis the site was located on low ground neighbouring another depression in the east, through which the course of the above-mentioned cost path went. Further west the terrain raised relatively sharply towards the position of the putative fortlet at Manse Burn (Fig. 101).

The Castlehill fort was located just south-east of the summit of a prominent hill. It was fairly accessible from the east but in the west, south and north the slopes were steeper. Two glens further west hindered access from the Cleddans fortlet direction, while the terrain gently descended towards the fort from the north, only to start rising at the foot of Castle Hill, on which the fort was seated (Fig. 102).

The Duntocher fort was also located on a prominent hill, towards which the Antonine Wall ascended from both the east and the west. Access from the west was further hindered by Duntocher Burn and Duntocher controlled its strong topographic location on the Antonine Wall on the east-west axis. The terrain gently descended towards the fort from the north-east, only to start rising at the foot of the Golden Hill, on which the fort was seated (Fig. 103).

The Kinneil fortlet was standing on the escarpment going down towards the broader Valley of Avon. To the east the landscape was relatively flat, disturbed only by Gill and Dean Burns. West of the fortlet the elevation raised towards a gentle hill blocking the view to the Inveravon fort (Fig. 104).

The broader surroundings of the Watling Lodge fortlet were heavily influenced by the construction of the Union Canal and the Falkirk Wheel, so it is hard to evaluate the ancient topography there. In the northward direction the landscape generally descended towards the Camelon fort. On the east-west course of the Antonine Wall, the terrain generally ascended towards the fortlet from the east until reaching its prominent position, from which it proceeded further west while descending only slightly, soon to start ascending again towards the Tentfield expansions (Fig. 87).

The Seabegs Wood fortlet stood on the escarpment of a small hillock, accessible easily from all directions except for the north. Immediately north of the fortlet lies the contemporary Forth-Clyde Canal, so any interpretation of the original local micro-topography is impossible. The fortlet was probably located on a slightly prominent position in the south-west to north-eastern direction along the Antonine Wall, as the profile shows (Fig. 105).

The Garnhall watchtower was standing immediately south of the Antonine Wall. To the west of it ran the rampart on a relatively uniform surface towards Westerwood, while to the east the Antonine Wall descended towards Castlecary. However, Garnhall was on the prominent position, especially on the north-south axis, as the terrain gently ascended towards the site, which would in fact have stood on a low ridge, while south of the watchtower the landscape descended again initially slightly and then more sharply to Castle Glen (Fig. 89).

The Croy Hill fortlet stood on roughly the same topographical location as Croy Hill fort (Fig 98). The Glasgow Bridge fortlet was accessible from all directions in terms of local topography, being located on the almost flat plateau. Less than 0,3 km north, the terrain descended towards the Kelvin River. To the west of it, the landscape ascended after crossing the present-day Forth-Clyde Canal towards the hill blocking the view to Cadder, while to the east the Antonine Wall ran relatively flat profile until reaching current-day Kirkintilloch, to which it descended (Fig. 106).

The Wilderness Plantation fortlet stood on a hill blocking the view between Balmuildy and Cadder, which had generally steeper slopes towards the Kelvin River than to the south or to the locations of the above-mentioned forts. This fortlet was not located on the summit and it was easily accessible on the course of the Antonine Wall. In contrast, it would have been more challenging to reach it from the south or the north (Fig. 107).

The positioning of the Summerston fortlet on the Antonine Wall was surprisingly inferior both in terms of visibility from the spot and intervisibility with its neighbouring sites. It was located between two hillocks, Summerston Cottage and Crow Hill. Therefore, in theory it was more easily accessible from both the north and from the south. On the north-south axis it was located still on a slightly elevated position, overlooking a section of the course of Allander Water, one of the tributaries of the nearby Kelvin. A possible explanation for this odd positioning on the course of the Antonine Wall was the Roman attempt to build a sentry post blocking a convenient local path for those reaching the area of the Antonine Wall by following one of the local streams. This approach is especially interesting if one notes the fact that the frontier builders overlooked the possibility of moving this fortlet to the more convenient position of Crow Hill some 0,6 km to the west, from where they would have had in their line of sight the whole course of Allander Water descending towards Kelvin better view in all other directions (Fig. 36, 108).

The Cleddans fortlet was located on a summit of a very gentle hillock roughly located in a central part of the course of the Antonine Wall between the Castlehill and Duntocher forts.

From Castlehill the Antonine Wall descended towards Peel Glen, then ascended Hutcheson Hill, only to descend once more to Cleddans Burn, from which the terrain again rose towards the Cleddans fortlet. From the fortlet site the terrain alongside the course of the Antonine Wall descended again until reaching present-day Duntocher, where it started to rise again until reaching the fort. On the north-south axis the Cleddans fortlet faced a terrain depression immediately to the north, beyond which stood a hillock that is only slightly more elevated than the position of the fortlet today. From there the terrain systematically raised towards the Kilpatrick Hills (Fig. 109).

The Duntocher fortlet resided on the same terrain profile as the successive fort (Fig. 103). The Laurieston fortlet stood in what is now a built-up area, so the original microtopography is difficult to decipher. The respective stretch of the course of the Antonine Wall between the Mumrills and Falkirk forts is today disturbed by a railway and road corridors. Otherwise, the terrain seems to gently descend from the Falkirk fort to the Mumrills fort and the location of the fortlet bears no prominence on this axis. On the north-south axis the terrain gently ascends towards the fortlet, but the summit of this ascent lies roughly 0,2 km south of the fortlet, so again this site was not located on top of a convenient ridge, but under it (Fig. 88).

The Cawder House fortlet was located on the escarpment of the hill on which Wilderness Plantation stood. From the position of this possible fortlet the course of the Antonine Wall descended towards the position of the Cadder fort, so it was located on the edge of major descent. On a similar edge lay this site on the north-south axis: from its position south to the Kelvin River the terrain descended sharply, while behind the fortlet to the south, the slope was gentler towards Bishopbriggs Burn (Fig. 100).

Both Tentfield East and the Tentfield West expansion stood on slightly rising ground from the valley of the River Carron, being roughly in the middle of the ascent to the south. On the course of the Antonine Wall stands a hillock between them, which does not block their mutual intervisibility, but rather the line of sight from Tentfield East to the Rough Castle fort (Figs. 42, 96). Beyond Rough Castle, on the descending course of the Antonine Wall towards Seabegs Wood, two more expansions were located at Bonnyside East and Bonnyside West. Before their positions from the direction of the Rough Castle fort, the Antonine Wall steeply descended, almost rendering them non-intervisible with the fort. After passing them, the landscape alongside the course of the rampart steadily descended towards the Seabegs Wood fortlet. On the north-south axis they were both located on very gentle terrain, ascending from Bonny Water towards Drum Wood in the south-east. The upcast mound or berm was relatively

substantial in front of both of them (see p. 17), but the results of the viewshed analysis do not indicate that this would have hindered the view to the landscape (see Fig. 86). The third pair of expansions was located in practically the same position as the Croy Hill fortlet and fort. Both were on the edge of substantial crags overlooking present-day Kilsyth. Croy Hill East was located on the edge of the descent towards the location of the possible fortlet at Girnall Hill, while the position of Croy Hill West was already 18 m below it in terms of relative elevation above sea level (see Table 2). Therefore, these expansions were almost inaccessible from the north, barely from the south and with more effort from the west than from the east (Fig. 98).

All three minor enclosures occupied the same elevated position as the nearby Wilderness Plantation fortlet. The easternmost, Wilderness East, was in a slightly more favourable position in terms of its view over the landscape, being not only on a more elevated site but practically on the summit of the hill in terms of the east-west axis (Fig. 48). On the north-south axis, all the minor enclosures were still under the ridge, which ran roughly 150 m south of their positions (Fig. 107).

In terms of landscape positioning, the Cramond fort was practically identical to the Carriden fort. To the north of it was coastline and to the east it was divided from the broader stretch of landscape by the estuary of the Almond River. The landscape steadily ascends from the position of the fort to the south-west (Fig. 110).

The Bishopton fort was almost 1,5 km from the present-day estuary of the River Clyde on a slightly prominent position north-east of Castlehill Plantation. The landscape from the estuary steadily ascended towards the supposed position of the fort, while further south it started to descend slowly towards Dargavel Burn. West of it the landscape steadily ascended towards hills dividing the fort from the Lurg Moor fortlet (Fig. 111).

The Lurg Moor fortlet was located on the hillside of Maukinhill Moor, with easiest access no doubt provided from the position of the Bishopton fort in the east (Fig. 112). Outerwards fortlet was located on the edge of a small plateau south-west of Knockencorsan. It was most conveniently accessible from the north. To the west of the fortlet is Martin Glen, while to the south there is now an artificial reservoir (Fig. 113).

2.3.15 *Conclusion III.*

Through interpreting the slope analysis, the sites on the Antonine Wall can be sorted into two groups: those on accessible ground and those in locations that were either inaccessible or accessible with some effort. The former includes the terminal forts (Carriden, Cramond, Old

Kilpatrick) as well as those situated close to rivers and streams (Camelon, Inveravon, Castlecary and Balmuildy). Cadder should belong to this group as well, as its positioning seemed to be similar to Castlecary or Inveravon, but the landscape change that took place there renders this conclusion less unequivocal than for the others.

Somewhere between these two groups are sites – especially in the easternmost sector of the Antonine Wall – that were characterised by limited accessibility from/to the north by the presence of an escarpment of varying steepness, but that were not positioned on the superior position of a ridge over the Firth of Forth and the valleys of the Avon and the Carron. These comprise the Mumrills, Falkirk and Rough Castle forts as well as the fortlets at Kinneil, Watling Lodge, Seabegs Wood and Laurieston. The expansions in the vicinity of Rough Castle can be considered within this group as well.

In theory, this group could also include all the installations on Croy Hill, these being inaccessible from both the north and the south and there being barely any more prominent topographical feature in their vicinity than the one they were occupying. Other representatives of the second group are relatively easy to interpret: Bar Hill was undoubtedly located on a prominent spot, while slightly inferior but still commanding were the positions of the forts at Castlehill and Duntocher and to a lesser extent the convenient position of the fortlet at Cleddans. Theoretically one could also consider the position of the Wilderness Plantation fortlet, but it was actually the Wilderness East expansion that stood on superior ground. It is evident from a topographical perspective that such superiority was sacrificed for a better line of sight to Balmuildy. Effective positions were also held by the possible fortlet at Cawder House and to an extent also the Garnhall watchtower, even if the intentionality of its location is unclear.

The remaining sites can be roughly interpreted as those located in topographically marginal locations. In some cases, their positioning had already been determined, such as Bearsden, which occupied the position proximate to the convenient path across the Antonine Wall (see p. 129–133), or Wilderness Plantation, which was located in a place with a good view over Balmuildy and the Roman military sites east of it (see p. 120). More or less the same explanation can be offered for the positioning of the Summerston fortlet, although nearby Crow Hill was able to host a fortlet (Boclair) with a better view of the landscape as well as of Balmuildy. Given that no fortlet has been found there but instead one was found at Summerston, the preference here must have been based on a factor other than visibility. The position between two small hillocks represents the most convenient path towards Balmuildy from the area of

Allander Water and therefore it seems that this location was chosen to control or block this course or path.

Several other sites can be described as “interval forts” that did not occupy any prominent location and lay on the alignments connecting neighbouring sites, for instance Auchendavy and Kirkintilloch and possibly also Westerwood.

As regards topographically marginal sites, where the author was unable to decipher why they were located where they were, one can consider the minor enclosures of Wilderness West and Buchley. Despite the latter being located on one of the alignments, this could have equally been coincidental. Furthermore, the above-mentioned “interval forts”, which were also located on these alignments, were no doubt able to accommodate substantial garrisons, practically securing “their” sections of the frontier. The functions of the minor enclosures remain unclear and their topographical locations offer no clues for any interpretation of their purposes. The final representative of this group is the fortlet at Glasgow Bridge, which can be described as an interval fortlet roughly in the middle between the Cadder and Kirkintilloch forts but aligned with Cadder gates (and having no formidable view over the landscape and controlling no prominent position).

Yet to be mentioned are the three sites along the Firth of Clyde. They all occupied prominent positions with good views over this body of water and, because they did not adjoin any linear barrier, their cases are slightly distinctive. Any interpretation of the topographical strength or weakness of their positions is largely irrelevant, especially in the cases of the fortlets, which clearly served as observation platforms above the Firth of Clyde and could not via their garrison direct or control the movement of more than individuals.

2.3.16 Spatial analyses and the Antonine Wall – summary, final thoughts

Many of the conclusions presented above need not be repeated unabridged. Intervisibility among the individual sites on the Antonine Wall was secured by the careful positioning of individual frontier features to such an extent that a lateral signalling system could have been employed there. In most of the cases, the neighbouring sites were intervisible and so several forms of intervisibility chains could have existed (see p. 121–123, 259–267). The fact that intervisibility was of some importance to the frontier builders and surveyors is highlighted by the existence of sites intervisible with their neighbours at a threshold: if they would have been moved, their intervisibility with their neighbours on either side would have been lost. Excellent

examples of this phenomenon were the Rough Castle fort, the Wilderness Plantation fortlet and the Garnhall watchtower, although more such cases can be seen in Table 5.

The intervisibility pattern was previously studied by Dr D. J. Woolliscroft (WOOLLISCROFT 1996, 172–177) and MSc J. Poulter (POULTER 2018, 116). Poulter's approach to studying intervisibility via digitalised Ordnance Survey (OS) 1:50,000 map in Fugawi software yielded similar data as the authors, despite his use of higher OFFSETA and no OFFSETB. This may explain why in his study, minor enclosures were intervisible with a plethora of installations, despite the fact that in the author's results (Table 5), the results generally seem to be inferior. Nevertheless, there is no archaeological evidence for any substantial constructions in minor enclosures interior (see p. 79–82) and therefore Poulter's results can be considered as exaggerated. In other instances, Poulter as well as Woolliscroft offered erroneous results, like intervisibility between Duntocher and Old Kilpatrick, which was unachievable even from taller platforms than used in their studies, as Fig. 27 clearly shows. In several other cases, Poulter presented sites as intervisible even where this was impossible; in most cases this can be attributed to the imprecision of his terrain data, which were in detailed topography inferior to the LIDAR used by the author of this thesis. In other cases, Poulter proposed two sites intervisible over a long distance (mainly Castlehill and several sites in the eastern part of the Antonine Wall), despite the fact that they could have been intervisible only in the environment of Fugawi software, not in reality, because this programme does not take into account the curvature of the earth. Despite having almost no influence on the intervisibility test results in terms of kilometre distances between the observer and the observed, over tens of kilometres the lines of sight are altered if one works in three-dimensional space with digitalised two-dimensional maps. Indeed, if the line of sight is calculated from Poulter's elevation of 7,8 m over a 30 km distance, the target's hidden height is 31,49 m, which can effectively produce non-realistic intervisibility results if the earth's curvature and refraction corrections are not used, as common in ArcGIS and similar programs.

Historically, as one of the prerequisites for the positioning of individual sites on the frontier was a certain distance formula, either directly between individual sites or along the course of the Antonine Wall (GILLAM 1975, 55). In Table 6 dedicated to summarising the long-distance alignments on this frontier, several sites appear to be almost exactly 2 Roman miles from each other (in five cases) or double that value (in three cases). Were the values with thirds and other fractions included, even more cases would be found, but it nevertheless cannot be described as a prevailing pattern. Many more fortlets were expected at a certain point on the Antonine Wall (HANSON – MAXWELL 1986, 122), yet very few have been found and new ones

like Laurieston or Cawder House do not fit to any general distance formula, as many of the of the long-acknowledged ones, too. Only in vicinity of the Bearsden fort were possibly missing one or two fortlets to complete (or rather make sturdier) the potential signal chain on the Antonine Wall (see p. 107–108).

Given that the forts fit well with the fortlets and other installations on the Antonine Wall to the intervisibility pattern, one should not expect that there were any “primary” and “secondary” installations on the frontier, as already noted by others (GRAAFSTAL – BREEZE – JONES – SYMONDS 2015, 59). Indeed, some sites might have been slightly later in construction, like Westerwood, but all of the installations with the possible exceptions of the Croy Hill and Duntocher forts were primary in intent. Again, no prevailing distance formula can be found between the forts or between the forts and the other installations. They were equally or regularly distributed in the landscape, but not at any constant distance or a repeating fraction of it (see Table 1).

One of the achievements of this regularity of distribution was the comfortable visual control of the landscape from Roman sites on the Antonine Wall. Above all, it should be stressed that the area of interest was directly north of the Antonine Wall. The lines of sight from multiple sites overlapped in the Valley of Kelvin, the Valley of Carron, around the Avon River, in the foothills of the Campsie Fells and in the Kilpatrick Hills. Potential Roman patrols in these areas were constantly in visual contact with their bases. Any intruders entering the vicinity of the Antonine Wall up to a distance of some 4–6 km north of the rampart could have been spotted by several sentries from several sites if the weather allowed it. All those who entered the area north of the Antonine Wall could see the structure from a distance, together with the string of forts and fortlets best represented by sentry posts above gatehouses. Thus, concerning the already mentioned lateral signalling system on the Antonine Wall, another system may have operated thanks to the positioning of the individual sites: if an alarm via simple beacons was announced in one place, not only the sentries in neighbouring and maybe even distant sites would have seen it. Visibility over a broad landscape from a number of sites meant that these places were visible from multiple positions in the valleys of mentioned rivers and from the foothills of the Campsie Fells and in the Kilpatrick Hills. Any patrols in the 4–6 km perimeter north of the Antonine Wall could in theory see that alarm was raised in their home bases. It is not entirely conjectural to imagine that this could have been the predefined signal for all the patrols to immediately return to their parent sites. Such a system would undoubtedly have been a welcome addition to acoustic alarms, which may not have been able to operate over greater distances and might not have been heard at some deaf spots inside the respective valleys. The

author cannot present any evidence that the above-mentioned signalling systems existed on the Antonine Wall, but this study has clearly indicated that the fundamental preconditions for their existence were met on this frontier.

The above-mentioned evidence (summarized in the Table 4) indicates that not only lateral signalling could have taken the place at the Antonine Wall. Smaller forts and fortlets as well as expansions and minor enclosures usually had in the line of sight at least one of the major forts, which position was determined by the landscape and its garrison probably consisted of complete auxiliary unit or equal number of soldiers. The possibility of existence of direct signalling on the Antonine Wall, based on the hierarchical relationship between individual sites is further discussed on p. 259–267.

Visibility to areas beyond direct Roman control was not only good inland. The forts and fortlets in the estuaries of the Forth and the Clyde had with one gap an excellent line of sight to the respective Firths of Forth and Clyde. The apparent existence of a gap between Lurg Moor and Outerwards gave the author impetus to search for one more fortlet to fill it. The proposed site at Laverockhouse Hill was located in the vicinity of a spot where (inconclusive) evidence for such a site has already been noted (NEWALL 1963, 43). Despite the author's results being described as equivocal because they were not verified via excavations, the fact that the cost path analysis largely copied the whereabouts of some of the excavated traces of a possible Roman road some fifty years ago indicates that spatial analyses can help reconstruct the Roman frontiers. If the Laverockhouse Hill fortlet were to be confirmed in future, the pattern of coastal observation will become clear in the case of the western environs of the Antonine Wall. If on the other hand either no traces of fortlet are found or it is eventually verified that on Hillside Hill stood a fortlet as F. Newall proposed, then another pattern could be confirmed. Specifically, that this spot, despite not having in its line of sight the Cowal Peninsula and the Firth of Clyde, enjoyed excellent visual control over the course of the Roman road connecting the already known fortlets. Either of these results can therefore hint at vital information to help answer the question asked at the beginning of this chapter: What were the prerequisites for the positioning of Roman sites in the frontier area?

In the case of the Antonine Wall sites, these prerequisites have been examined, too. The results fit well to the theory that no single precondition for the positioning of different types of installations can be found, just like there was obviously no grand strategy behind the erections of physical frontiers in the Roman Empire (WHITTAKER 2004, 28–50, *contra* LUTTWAK 2016, 67–125 see also p. 270–272). Several nodal forts were built on the relatively easily accessible

river crossings (Inveravon, Castlecary, Cadder, Balmuildy). These can be perceived as the blockers of free movement in the landscape, as they were located on the spots through which the most convenient paths across the course of the Antonine Wall would traverse. Other installations occupied topographical strong points that had good visibility over the landscape and were in fact more easily defensible than the former, even where this was not intentional. Such sites include Bar Hill, Croy Hill, Castlehill and Duntocher. Some installations were clearly positioned in order to fit to the intervisibility pattern: their locations offered no advantages in terms of access or defence, but were on the only spots from which one could see other installations in the east and the west along the course of the Antonine Wall. One excellent example is Rough Castle, but the same is true of Garnhall and Wilderness Plantation. It is also possible that the positions of many of the sites were in terms of visibility and intervisibility chosen with respect to the location of Camelon. The long-distance alignments strongly point in that direction and there is no reason to doubt that the position of a fort was predefined by the existence of its Flavian predecessor, which was not connected with the Antonine Wall but rather with crossing the Carron River. Thus, Camelon can be regarded as the fort whose position was chosen first and all the other sites were chosen with respect to it, either via intervisibility or alignments.

The existence of alignments can provide an explanation for the positioning of several other forts and fortlets on the Antonine Wall as well as for the locations of minor features like some expansions or minor enclosures. Several forts between the nodal ones were located on the alignments and the author would like to propose a theory that when the positions of the nodal sites were selected, the locations of other forts were chosen with respect to the alignments between them, simply in order to accommodate the garrison on the course of the linear barrier evenly and survey the course of the frontier without further delays. What other advantage did the mutual aligning of several sites to each other offer is another question: a clear answer might be that from a tactical, defensive or practical perspective, it offered none. Largely based on the absence of any other good evidence, it is the author's belief that this was instead related to the initial surveying phase of the frontier. In the easternmost sector of the Antonine Wall, the sites somehow aligned to Carriden, Camelon and possibly Inveravon, always being located on the ascent from the Carron Valley and estuary. On the ridge to the south were excellent positions for surveyors to stake out their positions with respect to Carriden, Camelon and possibly Inveravon, plus sites on the horizon in the west, most notably Bar Hill and Westerwood. All these sites were, as noted above, chosen thanks either to their topographical superiority or their general accessibility. The above-mentioned surveying method would have allowed the

surveyors to set the forts' and fortlets' locations without regard to the future zig-zag course of the Antonine Wall, which could have later been far more easily surveyed between them instead of surveying the mural barrier along with the forts and fortlets. By aligning these sites together, the surveyors would have been able to better calculate the overall distance eventually passed by the Antonine Wall from one site to another. Even if they knew from the outset that the course of the barrier would be sinuous rather than straight, between three or more points on one line it is easier to estimate the whole length of the mural barrier via Pythagorean theorem or similar method. This may be the key to understanding the alignment of the sites to one another. Thanks to this, the anticipated task of constructing the frontier could have been distributed among individual gangs of legionaries building the frontier relatively quickly, as the workforce did not need to wait for surveyors to demarcate the whole frontier in detail by manually measuring it from east to west. Aligning the majority of the sites in the eastern and central sectors could have been achieved simply using knowledge of the positions of Bar Hill, Croy Hill, Camelon and Carriden. At the first two of these sites, early surveyors' camps are known (see p. 15–16), while the position of Camelon was predefined by its Flavian predecessor and the crossing of the Carron. The early construction of Carriden should also be expected because a coastal site must have been nodal for supplies.

More complicated must have been the situation in the westernmost sector. Interestingly, this part of the Antonine Wall was completed later and in theory it may have been related to the surveying as well. Given that the sites were not intervisible there, the alignment of Duntocher and Bearsden between Balmuildy and Old Kilpatrick may have taken some time. The surveyors' work there included travelling over several hills not in order to keep the line of the Antonine Wall straight, but to keep the two forts in a straight line. Only after establishing the positions of the fortlet and the fort (from positions mentioned on p. 125–126) would they have been able to start calculating the course of the Antonine Wall between the permanent posts chosen. Evidently, even for the positioning of the Castlehill fort, the alignment was used, as it lay on a direct line connecting Old Kilpatrick and Wilderness East.

The fact that the sites were aligned to one another does not necessarily mean that the locations of the forts and the fortlets were chosen haphazardly in the landscape. Given that they were not separated from each other by any distance formula, it is evident that the spots were chosen on one line also with regard to the landscape (as seen in the east, where several aligned sites overlook the escarpment over the Carron Valley, despite not necessarily being on its edge), visibility to neighbouring sites (as in the case of Kirkintilloch, which was located on one of the few spots at least theoretical line of sight to Cadder fort but still positions of its gates are aligned

to the gates of Bar Hill, Balmuildy, Cadder and Auchendavy) or strategic position blocking convenient paths in the landscape (as it was for example at Bearsden, which gates were aligned between Balmuildy and Old Kilpatrick and still it was in vicinity of convenient path from the north to the south).

The positioning of the smallest features of this frontier – expansions and minor enclosures – has also been studied in this thesis. No particular single reason for their positioning on the frontier has been discovered, in accordance with how there was not just one tactical prerequisite for the positioning of the forts and fortlets. Tentfield West was intervisible with seventeen other Roman military installations on the course of the Antonine Wall and with Camelon north of it, being second in terms of number of connections only to the Bar Hill fort. Nearby lying Tentfield East was not significantly inferior in its line of sight to the landscape, but the nodal positions of the frontier were not visible from this site (see Table 5 and Figs. 42 and 43). Both of these expansions could have served as observation platforms, just like the Croy Hill East and Croy Hill West expansions. Furthermore, they all could have been integrated into the lateral or even direct signalling system on the Antonine Wall, which alternatively could have operated without them. Croy Hill East and Croy Hill West were intervisible with only a few nearby sites on the Antonine Wall and it is questionable what they would have signalled to whom, especially given that the Bar Hill and Croy Hill forts and fortlets were already intervisible. From Bonnyside East and Bonnyside West one could hardly see any other Roman military installation or stretch of landscape that was not already visible from Rough Castle.

Even less can be said about the minor enclosures and their positioning in terms of the results of the spatial analyses: only Wilderness East was located in a good position to observe some significant stretches of the Antonine Wall or area beyond the frontier line. The other two installations were inferior in terms of positioning on the Antonine Wall, accessibility and visibility. Therefore, Poulter's theory of a two-level signalling system on the Antonine Wall should not be dismissed altogether, as it continues to provide the best explanation for the existence of the expansions and the minor enclosures at hand. Despite his calculations of the alignments not being entirely accurate (see Fig. 7 and Table 3), nor were the Roman surveying methods. Another problem that remains is the fact that long-distance alignments were also present between non-intervisible sites and this cannot be explained by any visual signalling system.

The author of this thesis therefore proposes another theory: that the long-distance alignments were made at the beginning of the construction of the frontier and that the decision

to add expansions and minor enclosures occurred later than the construction of the forts, although earlier than the erection of the barrier. The whole two-level signalling system thus represented a mean of utilising the alignments after they had fulfilled their primary purpose: helping to survey the frontier via the equal distribution of the posts on several lines. Poulter's conclusion that the entire system never properly operated or only in a few instances (POULTER 2018, 134–135) further supports the suspicion that it was only added later as a possible innovation, which proved to be nothing but a cul-de-sac, probably also because of excessive distances between signalling platforms (expansions and minor enclosures) and various forts and fortlets. Instead of this complicated system much more viable alternative is offered below (see p. 259–267). The alignments of individual sites between already chosen spots for permanent military installations naturally assured that the overall course of the linear barrier was relatively straight, not deviating from the general east-western direction if the positions of nodal sites did not required that (like it was for example in the cases of Balmuilty, see Figs. 3, 250).

2.4 Appendix I. – technical specification of models used for spatial analyses on the Antonine Wall

All the presented analyses were performed in an artificial environment in ArcGIS 10.1–4. Whenever the Antonine Wall is mentioned in this thesis (distances alongside it etc), the exact course of it is taken from RCAHMS archaeological map of the Antonine Wall (RCAHMS 2008, JONES 2011, 146–162). The terrain model used for the viewshed analysis of the Antonine Wall (not the seaside forts and fortlets, therefore excluding Cramond, Bishopton, Lurg Moor and Outwards) was LIDAR for Scotland Phase I – DTM, provided by the Scottish Government and Joint Nature Conservation Committee (JNCC). The data are free to download under the licence at Scottish Remote Sensing Portal (<https://remotesensingdata.gov.scot/>).

This airborne LiDAR was collected between March 2011 and May 2012 for certain areas of Scotland that are threatened by flooding, as the available models were unable to correctly calculate the hydrology of the landscape. Blom company (today Blom International Operations, <https://blominternationaloperations.com/>) was commissioned for data collection and final processing. The density of the points collected was a minimum of 1 point/sqm and approximately 2 points/sqm on average between the collection areas. A raw laser airborne scanning data set (LAS) together with processed digital terrain (DTM) and digital surface models (DSM) at 1m resolution (ESRI Grid and ASCII format) were delivered by July 2012 to the contract owner and on 2017 they were made accessible to academic staff as well as to the general public.

The general licence for usage can be found here:

<http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

The metadata published by the Scottish Remote Sensing Portal (SRSP) can be accessed here:

<https://www.spatialdata.gov.scot/geonetwork/srv/api/records/40017f89-2857-49cb-a913-e0784f250769/formatters/xml>

The above-mentioned LIDAR data set was also used for the creation of the slope raster utilised for the accessibility study of all the sites excluding Cramond, Bishopton, Lurg Moor and Outerwards. The slope was performed in the default setting in ArcGIS 10.4 (<https://desktop.arcgis.com/en/arcmap/10.4/tools/spatial-analyst-toolbox/slope.htm>).

Given that LIDAR was never undertaken for the entirety of Scotland, a terrain model created from different data had to be used in this thesis for the areas that were not surveyed by

airborne laser scanning. These data were based on OS Terrain 50 Contours – 10 m contours (Version: 07/2014 – supplied under the licence of Ordnance Survey – Great Britain’s national mapping agency) and OS Terrain 50 Contours – Spot heights (Version: 07/2014 – supplied under the licence of Ordnance Survey – Great Britain's national mapping agency).

From these data a triangulated irregular network (TIN) was calculated in ArcGIS 10.4 in default settings, with applied constrained Delaunay triangulation instead of Delaunay triangulation in order to better capture the known breaklines in the vicinity of rivers and mountain ridges (<https://pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/create-tin.htm>). This model was then transformed into a standard digital elevation model (DEM) by the TIN To Raster tool via NATURAL_NEIGHBORS method, with an individual cell size of 5 m in otherwise default settings (<https://pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/tin-to-raster.htm>). In this model, the viewshed analysis was calculated for Cramond, Bishopton, Lurg Moor and Outerwards.

From the same OS Terrain data, another model was calculated the cost path analysis. Initially a terrain model was created via Topo To Raster interpolation (<https://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/topo-to-raster.htm>), which was more hydrologically correct than the above-mentioned TIN conversion, because it cleared sinks and was therefore superior for the reconstruction of movement through the landscape (CHAPMAN 2006, 50, 72–73). The above-mentioned raster was calculated in default settings, except for enforcing the output cell size at a value of 5 m, enforcing the margin in cells to a value of 0 (distance in cells to interpolate beyond the specified output extent and boundary), roughness penalty 0 (the integrated squared second derivative as a measure of roughness) and tolerance 1 at a value of 5 (tolerance 1 reflects the accuracy and the density of the elevation points in relation to surface drainage). From the resulting model, the slope was calculated in the same way as above, which then served for the creation of Path Distance (<https://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/path-distance.htm>) and Path Distance Backlink (<https://desktop.arcgis.com/en/arcmap/10.4/tools/spatial-analyst-toolbox/path-distance-back-link.htm>) rasters. Both of these models, which serve as the basis for cost path analysis, were calculated in default settings with one exception: for both the accumulative cost resistance rate at a value 0,001 was used. This value is an artificial rate used to multiply the accumulative cost in order to determine the resistance adjustment. It simulates the increase in effort required to overcome costs as the accumulative cost increases (it is used to model the fatigue of a traveller). The growing accumulative cost to reach a cell is multiplied by the resistance rate and added to the cost to move into the subsequent cell. The greater the

resistance rate, the more additional cost is added to reach the next cell, which is compounded for each subsequent movement. Given that the resistance rate is similar to a compound rate and that in general accumulative cost values are very large, small resistance rates are suggested, such as 0,02, 0,005 or even smaller, depending on the accumulative cost values (<https://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/how-the-source-characteristics-affect-cost-distance-analysis.htm>). From the resulting two rasters, the cost path analysis was calculated between Lurg Moor, Outerwards and all the locations of the possible fortlets in the study dedicated to finding the third seaside fortlet between the Lurg Moor and Outerwards fortlets. The exact same approach was also used to determine the course of the possible paths connecting the centre of present-day Glasgow with the Iron Age settlements in the area of contemporary Stirling Council, but the accumulative cost resistance rate was in respective cases set to 0, as the distances between connected features were already excessive and any artificial accumulative cost resistance rate produced illogical results.

3. The Odenwald Limes

3.1 History of research

The Odenwald Limes left far less substantial remains in the landscape than the Antonine Wall. Being located in a sparsely populated region in antiquity, as well as in the Middle Ages, it is not surprising that its remains didn't start to attract scholars before the humanism period of the 16th century. For a longer period of time the main focus of interest was the collection, interpretation and publication of stone inscriptions, which as Roman heritage were occasionally also found on the Odenwald Limes. Peter Apian (APIAN 1534) and Simon Studion were among the first scholars connected with the collection and publication of the inscribed stones from Odenwald Limes, and they collected many of the inscriptions from the southern area of the Odenwald Limes, which became the fundament basis of a later collection of *Römisches Lapidarium* in Stuttgart. Simon Studion was also responsible for reporting on the excavations of the Roman military bathhouse in vicinity of the Odenwald Limes in Breuberg in 1550 (SCHALLMAYER 2010, 11).

The political and social turmoil of the Thirty Years' War effectively stopped antiquarian research into the Roman past in most German kingdoms and duchies until the Prussian Academy of Sciences started to actively encourage research into this topic around the middle of the 18th century. The first organised excavations in the vicinity of the Odenwald Limes took place in that period and inscribed stones were collected from many sites, including sites of forts at Würzberg and Hesselbach (SCHALLMAYER 2010, 12). The best representative of the renewed interest in the Roman past was Count Franz I of Erbach–Erbach, who initiated the tree clearance on watchtower sites on the northern Odenwald Limes and personally oversaw several archaeological investigations of forts at Eulbach and Würzberg (HERRMANN 1989, 2–6). The Count's interest in the Roman past was mixed with the romantic spirit of the late 18th and early 19th century, which manifested itself in the creation of Eulbacher Park, where various inscribed stones were used as romantic decorations in gardens, and an obelisk was built from stone material found in Würzberg fort (HERRMANN 2002, 20–22). The Count and his advisors and collaborators (Christian Kehrer, Johann Friedrich Knapp) also published at least some reports about their investigations and finds (KNAPP 1813), so their approach was already on the brink of being a scientific investigation of the frontier. Johann Friedrich Knapp was also the first one who compiled a topographical map of the region including the remains of the Limes (KNAPP 1854, Taf. I–II).

It was in the second half of the 19th century when antiquarian research definitively yielded to archaeology in its early years. The first such attempt on the studied section of the Odenwald Limes was the activity of Altertumsverein zu Buchen, the Antiquity Association of the town of Buchen, which excavated the bathhouse in vicinity of a fort at Schlossau in 1863 (SCHEUERBRANDT 2009, 10–12). In the late 1880s the individual positions of features on the Odenwald Limes in Hessen were extensively surveyed by Historischen Vereins für das Grossherzogtum Hessen. Apart from the limited excavation and observation reports, the main asset of these reports was the publication more advanced map comprehensively charting the locations of individual features of the Limes in the landscape, made by Friedrich Kofler (KOFLER 1894, 1), who later took charge of the excavation of several forts on the Odenwald Limes on behalf of the Reichs Limeskommission (RLK). In 1884 Professor Wilhelm Conrady and Ernst Wagner excavated Wp 10/37 and found statues of Mars, Salus, Victoria and one consecrated stone (CIL XIII 6509) in vicinity of the watchtower site (SCHEUERBRANDT 2009, 13–14).

RLK was founded by Theodor Mommsen in 1892 in order to bring a uniform and standardised methodology to the then haphazard individual surveys and excavations of the Roman frontier in Germany. The Odenwald Limes was classified as part of the tenth section (Strecke 10) of the Upper Germanic-Rhaetian Limes (ORL), together with the frontier at the River Neckar. The semi-military organisation of RLK ensured that several “officers” were charged with a mission to document the individual sections of the former Roman frontier. The commissioners Wilhelm Conrady in Bavaria, Eduard Anthes, Friedrich Kofler and Wilhelm Soldan in Hessen and Karl Schumacher in Baden-Württemberg were responsible for partial excavations of all the forts, and for frontier surveying and detailed mapping. The evidence they collected was eventually compiled into two comprehensive, and in many ways two still useful reports, one concerning the excavated forts and fortlets (ANTHES – KOFLER – FABRICIUS – SCHUMACHER – JACOBS 1903), and the other dealing with course of the palisade and Military Way as well as smaller features such as watchtowers (FABRICIUS 1935).

After the second world war the archaeological approach to the Odenwald Limes was again more regionalised. Thanks to its positioning on the trijunction of modern Hessen, Baden-Württemberg and Bavaria, responsibility for both the protection and study of the Limes reside in the local state offices for monument protection (BLfD, LfDH, LAD), and to the more specialised institutions such as RGK or regional museums (e.g. Saalburg Museum). The problem with this new approach was that the Odenwald Limes was peripheral to the interests

of most of the institutions. As it was located in inaccessible terrain and was not endangered by modern development, the upper Odenwald Limes saw little activity until late 1960s.

The reorientation of focus from the comprehensive work of centralised institutions to more localised research enabled several capable archaeologists to perform the complex excavations via modern methodology, which built the foundations of knowledge about the Odenwald Limes. The first was Professor Dietwulf Baatz, who ran extensive excavations at the Hesselbach fort between 1964 and 1966 (BAATZ 1973). Smaller excavations of individual watchtower sites took place in the 1970s and 1980s, notably of Wp 10/25 (WAGNER 1994, 115–161) and Wp 10/33 (BEHRENDTS 1983, 309–311), while research continued on the unique shrine–tower at Wp 10/37 (BAATZ 1973, 135–143, OLDENSTEIN 1980, 779–791). Unfortunately, the major excavations started to take place in the now more densely inhabited and therefore developing areas, usually prior to construction activity, as in the cases of Bad Wimpfen, Kochendorf and Neckarburken (SCHALLMAYER 2010, 17–18), while the state protected area of Geo-Naturpark Bergstrasse-Odenwald saw little archaeological activity at that time. In 1984, however, the Odenwald Limes was for the first time since the publication of RLK comprehensively summarised by another important figure in Limes research, Professor Egon Schallmayer (SCHALLMAYER 1984).

At the beginning of the 21st century, the Odenwald section of the so-called Strecke 10 came into the spotlight again with the excavations of *vicus* at the Schlossau fort, conducted by Dr Britta Rabold (RABOLD 2003, 103–107; RABOLD 2004, 148–153; RABOLD 2005, 125–129; RABOLD 2006, 134–138; RABOLD 2007, 105–112; RABOLD 2009, 130–134; RABOLD 2010a, 130–132; RABOLD 2010b, 144–149). There was also further research via non-destructive methods in the 21st century on the Upper Odenwald, notably the investigations of Wp 10/5, Wp 10/6, Wp 10/7 (SCHALLMAYER 2007b, 88–92) and Wp 10/16 (SCHALLMAYER 2009, 103–108), using geophysical methods and laser-scanning prospection, which revealed many of the surviving frontier features in the landscape (SCHALLMAYER 2008, 81–85). The Odenwald Limes was promoted to a World Heritage Site in 2005 as a part of the ORL (KLEE 2009, 9) and at the same time a new system of information panels was installed at 30 of the principal sites on this section of the Limes (GÖLDNER – WENZEL 2008, 190–194).

3.2 The frontier

3.2.1 *Historical background*

The exact date that construction began at the Odenwald Limes can only be estimated. No historical source specifically mentions the construction of this frontier or the reasons that pushed the Romans to do so. Furthermore, the only extensively excavated fort on the whole section of the studied sector of the Limes, Hesselbach, yielded no specific evidence about the date of its construction in the form of inscription or military diplomas.

The background to the construction of the ORL in general, of which the Odenwald Limes was just a small part, were the events of the late 1st century AD on the northern frontier of the Roman Empire. The Roman army was present in the area nearly 100 years before the Limes was built. The modus operandi of Roman military control of the later ORL began to be reorganised in the reign of Domitian after the first war with Chatti (83 AD – 84 AD) and the amount of change grew further after the failure of Lucius Antonius Saturninus' revolt in 89 AD against (BREEZE 2011, 167). Evidently certain elements of the Taunus Limes were built during the late reign of this Emperor (SCHALLMAYER 2007a, 50), although according to a recent re-evaluation of comprehensive evidence from a plethora of forts on the ORL, the main bulk of the first phase of the Limes seems to have been eventually built during the early reign of Emperor Trajan (KORTÜM 1998, 57). The province of *Germania Superior* was established around 85 AD (SCHALLMAYER 2007a, 49–52), which together with the victory over Chatti allowed the Emperor Domitian to adopt the title “*Germanicus*”, which was celebrated on temporary coins (e.g. RIC 127, RIC 183, RIC II 180 or RIC II 223).

After the death of the Emperor Domitian (96 AD) and the brief rule of Emperor Nerva (96 AD – 98 AD), the main enemy of Rome under the rule of Trajan (98 AD – 117 AD) was the Dacian kingdom, against which the Romans waged two successive wars (101 AD – 102 AD, 105 AD – 106 AD). These conflicts consumed a substantial part of the Rome's military might, which effectively led to the establishment of frontier systems in the areas where the Empire was no longer expanding. These were mainly in both *Germania Inferior* and *Germania Superior*, but the same trend can be seen in the erection of frontier-like sets of installations in *Britannia*, *Raetia* and *Noricum* (BREEZE 2011, 58–59). Although the foundations of the newly emerging Limes Romanus had been laid during the reign of the Flavian emperors, later Roman historians connected it specifically with the Emperor Trajan (Ammianus Marcellinus, *The Roman History* 17. 1. 11).

The limited evidence from the Odenwald Limes suggests that this section of the frontier was even later, and its construction can probably be dated to the late reign of Emperor Trajan, ca. 110 AD – 115 AD. This dating is largely based on a reinterpretation of evidence from Hesselbach fort (KORTÜM 1998, 34, SCHALLMAYER 2010, 35; SCHALLMAYER 2012, 101–102), which will be discussed below (see p. 167–168). In summary, the Odenwald Limes was probably the last linear feature added to the constituted ORL. The current evidence clearly indicates that no substantial Roman forces operated on a regular basis in the area of Odenwald Limes before the creation of a frontier there, which makes this section of ORL relatively unique.

3.2.2 Construction of the Odenwald Limes

The studied section of frontier between the forts at Wörth and Schlossau was covered by deciduous forest prior to construction of the frontier (HAVERSATH 1984, 22), so it is reasonable to assume that the initial phase of surveying, planning and subsequent building of a frontier through the Odenwald mountain range consisted primarily of massive deforestation in some pre-defined corridor. Again, no archaeological evidence has survived from this phase. Surveying is discussed further below, including the width of the corridor and reasons that the known course of the frontier was chosen instead of any possible alternative (see p. 200, 231–2, 253).

There are no known temporary or marching camps on the studied section of the Odenwald Limes. It is quite probable that at least some existed in the vicinity of certain forts, but no search for them was ever made and aerial reconnaissance, so far the best tool for identification of such structures, cannot be used in the context of Geo-Naturpark Bergstrasse-Odenwald because of the extensive forestation in the area at present. No trace of any temporary enclosure resembling temporary or labour camp was identified by the author when studying the image analysis results from the LIDAR data. No distance slabs similar to those on the Antonine Wall (see p. 16–17) were found in vicinity of the frontier line.

The first phase of the Odenwald Limes consisted of a string of earthen and timber forts, fortlets and watchtowers in the forest-cleared corridor (Fig. 114). The exact reasons for the positioning of the individual forts is discussed below (see p. 231–237 and Table 10), but it can at least be stated that small timber forts and fortlets were separated from each other by 4,1 km as the crow flies, on average (see Table 9). The forts in question were Seckmauern, Lützelbach, Hainhaus, Eulbach, Würzberg, Hesselbach and Schlossau. They are sometimes called the Numerikastellen or Numeruskastellen and their respective plans and layout are described further below (see p. 162–176). They each occupied an area of ca. 0,6 ha, which made them

outposts rather than standard forts, since the space within their walls was enough to accommodate just a small number of soldiers (REUTER 1999, 385–389, 397). The first forts on the Odenwald Limes had earthen and timber ramparts and their internal buildings were all principally timber framed. Since Hesselbach was the only fort to be extensively excavated and documented via modern archaeological methods, its structural phases and their dating are usually applied to all the other forts on the Odenwald Limes (BAATZ 1973, 37). Relatively credible analogies to the phases of development at Hesselbach were found at the forts at Würzburg and Wörth (BAATZ 1973, 115–119; LÜDEMANN 2008, 70–71).

Three fortlets are known from the studied section of the Odenwald Limes, Windlücke, Zwing and Seitzenbuche, and it appears that they may all have been part of the original layout of the frontier, just like the known seven forts (see p. 258). These fortlets were free standing structures, just like the forts, and they were approximately the same size as the fortlets on the Antonine Wall. Individual examples are discussed below (see p. 176–179). Whether they were initially of earth and timber construction like the forts is not certain, since no modern extensive excavations ever took place on any of the three mentioned sites and no discoveries supporting that view were made during the excavations of the Robern (FABRICIUS 1935, 101, Taf. 12–13; KORTÜM 1998, 34; SCHALLMAYER 2010, 125–127) and Trienz fortlets (FABRICIUS 1935, 103, Taf. 13; SCHALLMAYER 2007a, 49–54; SCHALLMAYER 2010, 129), located immediately south of the studied section of the Odenwald Limes. In case of last mentioned fortlets, used in this thesis only for comparison with Windlücke, Zwing and Seitzenbuche, the execution of excavated defences resembled the last phase of Hesselbach forts wall (see p. 177–179).

Watchtower sites were located between forts and fortlets. The first timber watchtowers were erected at the beginning of the first phase of the Odenwald Limes. Watchtowers were of relatively standard design, discussed in detail below (see p. 193–195) and in the individual excavated examples (see p. 179–193). They were constructed of timber and stone, enclosed by a single ring drainage ditch, and since no tiles have yet been found on the timber watchtower sites, their roofs were probably made of some perishable materials (SCHALLMAYER 2010, 40–41). The majority were not excavated, and only documented thanks to the surviving ring ditches and accumulations of building rubble in the middle. Some were initially protected by a simple fence (FABRICIUS 1935, 42–44, Taf. 3; SCHALLMAYER 2007b, 90; SCHALLMAYER, E. 2009, 107), although this was not attested in the vicinity of all the excavated examples.

Probably the most important component of the frontier were the roads connecting the individual sites. In general, two roads are usually expected on the ORL, the

Limesweg/Begleitweg and Grenzstrasse (FABRICIUS 1935, 31–32; SCHALLMAYER 2010, 39–40). The exact course of the roads, and their surveying, is discussed below (see p. 229–233, 236–237), but the Limesweg/Begleitweg at least, from corroborative reasons called in this thesis the Military Way, was supposed to be part of the construction of the first phase of the frontier. It connected individual watchtower sites and passed by the forts and fortlets and was sometimes accompanied by a drainage ditch of approximately 1,5 m wide on each side (WAGNER 1994, 140–142, Abb. 21). Apart of that, it was similar to the Military Way on the Antonine Wall in the width (5,2 m in average), and was made of larger stones at the base and smaller ones, or a layer of gravel, in the uppermost layer (FABRICIUS 1935, 96–99, Taf. 10, 12).

The soldiers who built the forts, fortlets, watchtowers and the Military Way during the late reign of Emperor Trajan left no inscriptions commemorating their endeavours, but it is certain that they belonged to the two legions stationed in *Germania Superior* province during the respective period – Twenty-Second from modern Mainz (*Moguntiacum*) and Eighth from modern Strasbourg (*Argentoratum*). The main evidence for this are the bricks and tiles of the Twenty-Second Legion found at Hainhaus (SCHALLMAYER 2012, 108) and Schlossau (RABOLD 2004, 152) forts, and use of the same material made by the Eighth Legion, found at Wp 10/37 (FABRICIUS 1935, 82, Taf. 11; OLDENSTEIN 1980, 679, 683). All the attested material belonged solely to the early period of the Odenwald Limes, and none of the bricks or tiles can be dated to post-Hadrianic horizons. Material that can be related to the Twenty-Second Legion is predominant in the studied sector – the building material of both legions can only be found in the vicinity of Schlossau, and only the building material of the Eighth Legion is so far attested south of that fort (BECKER 2012, 26). It therefore appears that the Twenty-Second Legion was responsible for the construction of the studied sector between Wörth and Schlossau.

Soldiers of the Eighth and Twenty-Second Legions also left amount of inscriptions on the Odenwald Limes, but it is unlikely that they formed the garrison of this frontier in the first or any other phase of its existence – the vast majority of the inscribed material mentioning the soldiers from these units is personal in nature and can be related to individual officers rather than the presence of the unit (e.g. CIL XIII 6504, CIL XIII 6508, CIL XIII 6509, CIL XIII 6516, AE 2008 963–966). The actual garrison at the Odenwald Limes in the first phase of its existence is uncertain, but all the indications points to the presence of several numeri units, which are attested via inscribed material in later periods in several forts of the Odenwald (CIL XIII 6502, CIL XIII 6511, CIL XIII 6514) and Vorderer Limes (CIL XIII 6599). These units were under the command of centurions from both legions present in *Germania Superior*. It seems that again the northern part of Odenwald Limes between Wörth and Schlossau was supplied by officers

from the Twenty-Second Legion, at least as far as the limited epigraphical evidence suggests (CIL XIII 6502, CIL XIII 6504, CIL XIII 6606). The section of the frontier south of the Schlossau fort fell under the Eighth Legion not only during the construction but also when the distribution of officers took place (BECKER 2012, 27–28).

The most significant change, which took place during the second phase of construction of the Odenwald Limes, was the addition of a palisade east of the course of the Military Way. This modification is traditionally connected with Emperor Hadrian, who gave the order to create physical boundaries on the borders of the Roman Empire (SHA, *Historia Augusta*, Hadrian 12.6). Although specific evidence from the Odenwald Limes is lacking, the dendrochronological dating of the palisade remains of the fort at Marköbel on Wetterau Limes indicates that the timber used for the construction of the barrier was cut down around 120 AD, which neatly fits the date based on historical sources (SCHALLMAYER 2003, 12–21). The palisade itself was built of trunks of rough-hewn oak trees sunken into an approximately 0,5 m wide, funnel-shaped ditch with the bottom filled with smaller stones (FABRICIUS 1935, 44–45, 58–62, Taf. 3–4, 6–7). There was apparently no ditch in front of it.

After some time, several timber watchtowers were succeeded by other watchtowers of the same type. This pattern cannot be described as general, since only two watchtowers are known from a plethora of sites, one timber and one stone. It may be that the secondary timber watchtowers were built some period of time after the first ones, but before the general shift to stone watchtowers. Dating evidence is lacking and it is probable that individual watchtowers were replaced on the individual watchtower sites according to the local conditions. The replacement of old by new simply took place when first ones were unrepairable or burned down (SCHALLMAYER 2010, 40–41). Any general statement about the succession of timber watchtowers is further complicated by the case of Wp 10/25, where apparently two timber watchtowers stood in succession on the very same spot, although there was no indication for that during the initial prospection (WAGNER 1994, 135–138). It is possible that this was also the case on many unexcavated sites, and therefore we should speak about two watchtowers in succession on only a minority of watchtower sites. This problem cannot be resolved without further excavations, since non-destructive surveys are unable to distinguish two watchtowers standing in succession on top each of each other.

The first major modification of forts took place during the reign of Emperor Hadrian, documented so far only at Würzburg and Hesselbach, where the wooden-and-earthen fortifications were replaced by a wall made of local sandstone (BAATZ 1973, 15–19, 115–119).

The fort at Wörth was also constructed in this way (LÜDEMANN 2008, 70–71), and replaced the one at Seckmauern (SCHALLMAYER 2012, 111–112). Seckmauern was apparently never rebuilt in stone, and the south Gaulish Sigillata was totally absent in Wörth as a dating material, which further suggests that this fort was founded slightly later than Hesselbach or Würzburg (LÜDEMANN 2008, 82–85), where such pottery was found, at least in limited amounts (BAATZ 1973, 85–96, 119). The interior of Hesselbach fort was rebuilt in approximately the same manner and using the same technique as its initial construction, and although there is no specific date (not only for reconstruction of Hesselbach but also all the other forts on the studied section of the Odenwald Limes), these events probably also took place during the reign of Emperor Hadrian (117 AD – 138 AD), as did the addition of the palisade and construction of the majority of the secondary timber watchtowers (BAATZ 1973, 67, SCHALLMAYER 2010, 106).

The third construction phase of the Odenwald Limes was also the final one. The timber watchtowers were demolished and replaced with stone-built successors. The existing stone walls of the forts were completely rebuilt and some limited repairs were made in the Hesselbach interior (BAATZ 1973 19–27, 62–63).

Unlike those made of timber, stone watchtowers had no ditch, and they replaced their predecessors on practically all the watchtower sites in the study sector. At least one of the stone watchtowers, at Wp 10/37, had a tiled roof (BAATZ 1973, 138–142, OLDENSTEIN 1980, 782, 788), but this was built after the abandonment of the Limes and will be discussed in detail below (see p. 192). It is apparent that different gangs of builders were responsible for the construction of the stone watchtowers again north of the Schlossau fort and south of it – as for the construction of the first phase of the Odenwald Limes. This time the difference was a slight variation in size of the stone watchtowers north and south of the fort at Schlossau (BECKER 2012, 24–25). The units responsible for reconstruction of the frontier features this time were not legions, but numeri, and in the studied sector this was specifically *Numerus Brittonum Triputiensium*, attested via CIL XIII 6511 (Wp 10/35), CIL XIII 6514 (Wp 10/33), CIL XIII 6517 (Wp 10/22) and CIL XIII 6518 (Wp 10/19). These inscriptions date this event, together with other inscribed material from Odenwald Limes (CSIR-D-02-13, 00242, CSIR-D-02-13, 00243), firmly to the year 145 AD, even though some of the stone watchtowers were finished in the following year (SCHEUERBRANDT 2012, 33–35). Whether the reconstruction of the forts took place in this specific year cannot be certain, since no direct stratigraphic relationship was ever found between the defences and internal buildings, but it is generally accepted that these alternations took place during the reign of Emperor Antoninus Pius (BAATZ 1973, 28, 66–67, SCHALLMAYER 2010, 106).

3.2.3 Forts – Hesselbach

Due the limited amount of evidence and varying quality of the excavation reports from the studied section of the Odenwald Limes, the linear barrier in the form of a palisade, the Military Way and the general construction and maintenance of the frontier won't be discussed in separate sub-chapters, as it was for the Antonine Wall, where the evidence was much more abundant. Instead the individual forts will be briefly discussed after a description of the only completely excavated fort, at Hesselbach. The limited evidence at hand from all other forts on the studied sector of the frontier suggests that the structural history and overall successive plans of the forts on the Odenwald Limes were all almost identical to those at Hesselbach (BAATZ 1973, 75).

The fort at Hesselbach was first excavated in 1895, but the RLK investigation focused only on the third phase of defences. The *via praetoria*, *via principalis* and *via sagularis* were also documented, together with the positions of gates (FABRICIUS 1935, 62–63). The investigations led by Professor Diewulf Baatz between 1966 and 1968 focused on the complete excavation of the fort, occupying 0,59 ha (BAATZ 1973).

Although there was approximately fifty years between the construction of the fort and its abandonment, the defences were rebuilt twice after their initial construction. The original defensive wall was more than 6 m wide and was made of soil fronted by a timber palisade. This construction was further reinforced by wooden posts, which probably allowed the existence of a walkway on top of the wall. Since the first defences were almost totally destroyed during the construction of second and third defences, the height of the rampart can be only estimated to ca. 2 m or more. In front of the palisade was a berm ca. 1,8 m wide, and further beyond was a single ditch (*fossa punica*), ca. 4 m wide and ca. 1,8 m deep, with a steeper slope on the exterior. Lumps of charcoal were found in the foundations of the oldest defences, which could indicate that the site was burned prior to the construction of the first phase of the fort, possibly during the deforestation of the Limes corridor (see p. 253). The fort initially had only three gates, *porta praetoria*, *porta principalis sinistra* and *porta principalis dextra*. The gates were flanked by simple timber gate towers, each of which was supported by six posts. No evidence was ever found for the existence of corner towers in the early, or any other, phase of the defences (BAATZ 1973, 13–15).

The second rampart was made of a combination of drystone masonry, timber and soil, with stone rubble. The gates, ditch and berm remained unaltered, but the former earthen rampart was demolished, and a new wall was built instead, made of rough sandstone blocks on each side. The overall width of the fort wall now varied between 5 m – 6,9 m and the space between

the two stone facings was filled with soil, interspersed with timber logs. There was probably a walkway on top again, but the kind of parapet provided cannot be determined, nor the overall height of this wall. Steps were provided at the rear for access to the walkway (BAATZ 1973, 15–19).

The third and last defences were those documented by RLK in the 19th century. The upper parts of the previous wall were demolished, and the rest of the structure was integrated as the core of the new stone wall, made of roughly hewn local sandstone blocks connected with mortar. This masonry was again provided on both extremities of the wall body and the middle was filled with earthen rubble and the remains of the former walls. When the new defences were built, they were simply placed in front of the older fortification, thus reducing the width of the berm. At the foot, the wall was up to 8,2 m wide (Pl. 20). Although much of the evidence didn't survive, it is almost certain that the exterior walls of the fort were plastered. The parapet was certainly this time made of stone and its broken sections were found as rubble inside the ditch of the fort. The berm was reduced to a width of 0,6 m – 0,8 m and the ditch was re-dug. This time a classical v-shaped ditch (*fossa fastigata*) was provided, as the former ditch was waterlogged for a certain amount of time before the construction of a new one, which was wider (up to 6 m) and shallower (only 1,5 m deep) than its predecessor (BAATZ 1973, 19–21).

The gates were completely reconstructed in the last phase. A small entrance (1,25 m wide) was added at the rear of the fort, which cannot be described as a standard *porta decumana*, but some communication at least could pass through it. Interestingly, no causeway was provided in the rear over the ditch, but a wooden drainage gutter ran on one of the sides of this entrance. Three new massive gatehouses were built of similar plan, but not the same dimensions. Still only a single entrance through each gate was provided, always flanked on both sides by one gate tower, which was entered from the rear via doors at the ground level. The gates were built after the walls of the fort were finished. The towers walls were 0,6 m – 0,75 m wide. The roofs of both the first and second gate towers were not made of tiles, since broken material of this type was not found in their vicinity (BAATZ 1973, 21–27).

It is reasonable to assume that the Hesselbach excavations between 1966 and 1968 found almost all the buildings that originally stood in the fort's interior. The internal roads consisted only of a gravel, which in certain areas reached up to 0,35 m in thickness, in several successively laid layers (BAATZ 1973, 42). Some of the roads were furnished with drainage gutters, running in the middle of the road (BAATZ 1973, 53–54). The roads projected beyond

the gates, but their further direction is known only in general terms – instead of running straight, they turned after some meters towards the palisade (KOFLEK 1896c, Taf. 1, Fig. 1–2).

At the centre of the fort stood a building that can be identified as the *principia*. The first phase of its existence is relatively hard to interpret because of later disturbances, but it appears to have been a rectangular timber building, occupying ca. 200 m². The whole structure was of timber construction, with substantial posts in the corners of individual rooms, connected via sleeper walls. At the northeast end of the building was a vestibule supported by a row of four massive posts on each side of the *via principalis*, by which the *principia* hallway roofed the middle of the fort. This vestibule itself served as an entrance to the small courtyard, with two side porticos. From there it was possible to enter the rear area of the building, consisting of the *basilica* and three separate rooms further to the southwest, the middle of which was no doubt the *aedes*. No remains of the floor survived (BAATZ 1973, 32–35).

The second phase of this building started with the complete demolition of its predecessor. The new *principia* was constructed using same technique as the first one, but it was slightly larger (occupying a little less than 250 m²). Otherwise the plan remained the same as before, with the exception of the *aedes*, which now slightly projected beyond the rectangular plan of the building to the southwest (Pl. 20). A cistern with a diameter of almost 1,5 m was dug into the courtyard, from which a channelled drain led through the *principia* to the *retentura* (BAATZ 1973, 46–50). At some point later, the *aedes* back wall was reconstructed so that it was no longer projecting to the southwest, and there were also some repairs at the corners of the building, since some of the posts were apparently later replaced by new ones (BAATZ 1973, 62–63).

Although direct evidence is lacking, it seems that the *principia* was ultimately demolished, but not burned while still standing, and the nails particularly were removed from the timber structure. This may have been either dismantled and used for something else or burned in an orderly fashion, as was in case for at least one of the barrack blocks (BAATZ 1973, 63–66).

To the southwest of the headquarters was a building which can be identified as the *praetorium*. Its foundations revealed that it was built using the same construction technique as the *principia*. In its first phase it occupied only 150 m² and was apparently entered from the side facing the *principia*. The plan is reminiscent of a minimalised version of the standard *praetorium* in auxiliary forts – up to six rooms surrounding a small atrium formed by four posts almost exactly in the middle of the house. One more small room was inserted in the rear area

of the building, which the excavator interpreted as a latrine. The building was furnished with heating via a hearth in at least one of the rooms in the first phase of house's existence (BAATZ 1973, 31–32). This building was also once completely reconstructed (Pl. 20). The second phase was even smaller than the preceding one – the commandant's house now occupied an area of only 125 m². The entrance was again to the northeast but instead of an atrium only a central corridor was provided, flanked on each side by three rooms. In the southwest stood again a small room, interpreted as a latrine. The evidence for heating was later clearer – four hearths were found in individual rooms, which each occupied ca. 15m² (BAATZ 1973, 45–46). The change in the type of the house was probably due to the impracticality of an atrium house in the semi-Mediterranean fashion in the relatively cold and humid environment of the Odenwald mountain range.

No classical granary was found during the excavations of the Hesselbach fort, but three enigmatic buildings were found in the *praetentura*, which could have served as stores, workshops or even accommodation. Their interpretation is hampered not only by the unusual shape and size of these buildings, but also by the fact that soil erosion significantly destroyed the archaeological layers in the *praetentura*. The largest of these buildings was located in the eastern corner of the fort (Pl. 20). Almost nothing survived from the first phase of its existence (BAATZ 1973, 35). The subsequent building occupied roughly 272 m² and was of irregular layout, consisting of at least of eight rooms of varying size. No finds to help the interpretation were attested during the excavations, and no dwarf walls, underfloor pillars or external buttresses were located at all. A storage function was attributed by the excavator to this building principally due to the absence of an *armamentaria* in the *principia* and that although the function of all the other buildings in the fort interior was more or less evident, no obvious storehouse seemed to have been provided (BAATZ 1973, 50–52).

Again, almost nothing survived from the first phase of two buildings in the left part of the *praetentura* (north corner of the fort) thanks to soil erosion (BAATZ 1973, 35–36). Only some of the more substantial foundations of the two successive buildings survived in-situ (Pl. 20). The closer to the *via praetoria* occupied 76 m², and that closer to the *via sagularis* only 58 m². No internal partitions or flooring were detected. Their width corresponded to the width of barrack blocks in *retentura*. Water tanks were found in vicinity of these buildings (on the side facing *porta principalis sinistra*) and the remains of ovens (on the side facing *porta praetoria*). Both buildings were too small to be independent barrack blocks, and since no evidence pointed to the industrial or storing activity in either of them, the excavator was inclined to the conclusion that these two buildings were stables, principally because of the proximity of the water tanks

and also because of a gutter running nearby, which could have helped when cleaning the stables (BAATZ 1973, 52–53). Between the two narrow buildings and the fort wall near the *porta praetoria*, one further small shack-like structure was identified (22 m²), which could have been a shelter for the baking ovens –evidence for the exact purpose of this particular building is again missing (BAATZ 1973, 53).

Only four more buildings were identified in the interior of the fort at Hesselbach, standing in pairs on each side of the *principia* and *praetorium*, thus occupying the better part of *retentura*. There can be little doubt that these long strip buildings were barrack blocks, each occupying an area around 152 m² in the first phase of their existence. No officer quarters were provided at either end of the contubernial blocks in the first period of their existence (BAATZ 1973, 28–31). Again, the barrack blocks all suggested two periods of existence, divided by a complete reconstruction. The construction technique was the same as that of all the other buildings in the fort – posts connected with each other via sleeper walls. Only one hearth was found in the interior of the barrack block immediately to the southeast of the *principia* and *praetorium*. The second period barracks left many more traces for identification, and the destruction rubble from the first period barracks contained valuable dating evidence in the form of pottery, which dated the construction of the fort to the Trajanic period (KORTÜM 1998, 34). The second period barracks all had similar plans to the first, further enhanced by a 1,6 m – 1,7 m wide portico facing the neighbouring barrack block (Pl. 20). Three of the four barrack blocks had special wider rooms for the officers in the second period, as was common in Roman barrack blocks (see p. 53–57). The area occupied varied between 184 m² and 256 m², and the disparity in size manifested itself in the width, since the individual barrack blocks had an almost uniform length. The size of individual blocks for groups of soldiers could thus vary between 12,5 m² and 20,8 m² (these are still conjectural values since the width of individual partitions cannot be reconstructed with certainty). The officer's blocks were always situated at the southern end of the respective barrack blocks. Few foundation sections of the barrack block walls were reinforced by drystone masonry, no doubt because of the general wetness of the site in antiquity. The internal divisions of individual blocks are at least partially known from the second phase of the barrack blocks, and they indicate that six to seven rooms were reserved for ordinary soldiers and one to two for the officers, with exception of the barrack block immediately northwest of the *principia* and *praetorium*, which was divided into nine equal blocks, apparently without any extra space for officers. Although heating was attested only in the westernmost of the barrack blocks, it is reasonable to assume that each room was furnished with its own hearth for both heating and cooking, and that smoke vents made of clay and stone were

also further provided. The question of the floor type provided in the accommodation for ordinary soldiers cannot be resolved from the excavated remains. This was probably either beaten earth or a wooden floor may have been installed, of which unfortunately nothing survived. Drainage ditches were provided next to the respective roads outside individual barrack blocks. The roofs were probably made of shingles (BAATZ 1973, 38–44).

Although no bathhouse was found in the vicinity of the Hesselbach fort, latrines were apparently provided in the barrack blocks; at least they were attested by characteristic drainage gutters in the easternmost two barrack blocks in their respective southern ends, where officer's accommodation was provided. The latrines therefore should be considered private ones, like that attested in the *praetorium* (BAATZ 1973, 43–44). Latrines for the common soldiers could be expected in the vicinity of the so called "*porta decumana*", since all the drainage ditches ended there and flushed to the outer ditch of the fort beyond that gate (BAATZ 1973, 53–54).

The area of the fort was apparently used for industrial activity when the unit stationed there abandoned the post. In the barrack block immediately to the northwest of the *principia* and *praetorium* several successive pits were dug after the demolition of the former barrack block. Debris characteristic of iron smelting and metal processing activity was found, together with one oven. Several other waste pits were documented across the interior of the fort. They all intersected the foundations of fort buildings, and thus post-dated them. No permanent buildings were erected in the interior of the fort after the Roman army abandoned the site (BAATZ 1973, 63–67).

The garrison of Hesselbach was almost certainly numerous from the very beginning of the fort, or at least the overall layout and size of the fort strongly indicates this. Although the unit name is not known, a specifically British type of fibula (*Polden Hill* type) found in the fort (FRERE 1974, 495) indicates that it was a unit of initially British origin, as was the case in a plethora of other forts of similar size on ORL (REUTER 1999, 385–389). Rough estimates of garrison size vary between 130 (BAATZ 1973, 60) and 160 (REUTER 1999, 459) foot soldiers. The stables in the northern corner of the fort can thus be interpreted mainly as a shelter for pack animals.

The general chronology of the Hesselbach fort can be specified as follows: the construction of the first phase of the fort, initially dated to the reigns of Emperors Domitian and Trajan, is now dated to 110 AD/115 AD (based on a re-evaluation of the Terra Sigillata from the 20th century excavations – KORTÜM 1998, 34; REUTER 1999, 385; SCHALLMAYER 2010, 104–106; SCHALLMAYER 2012, 101–102). Since there is no clear stratigraphic relationship

between the construction of defences and the building programme in the interior of the fort, it is not entirely certain whether the first stone wall can be related to the wholesale reconstruction of the fort interior, which was attested in practically all buildings. Nonetheless it is most realistic to assume that these two events took place simultaneously, because more specialised craftsmen were required for both than were available in normal numbers, at least in the position of foremen. The excavator dated both these reconstructions to the reign of Hadrian, specifically to the period when the palisade was built, since the initial buildings and defences apparently didn't stand for long prior their replacement (BAATZ 1973, 79–80). Conversely it is reasonable to assume that later alternations, like the reconstruction of the second phase of the *principia*, took place simply when the old buildings were in need of repairs, which could have been practically any time before the definitive abandonment of the site. The second reconstruction of defences in stone is frequently connected with the construction of the stone watchtowers on the Odenwald Limes. The concurrence of these two events would make more sense than if they were be isolated – furthermore this change can be related to the general shift in the distribution of manpower on the frontier in *Germania Superior* (SCHEUERBRANDT 2012, 34).

The abandonment of the Hesselbach fort was marked by the organised demolition of the internal buildings (BAATZ 1973, 63). The orderly destruction of the interior was probably not accompanied by wholesale burning down of the remains of buildings, as was common when Romans deserted their posts, retreating from an occupied region (see p. 88–91). It is, on the contrary, assumed that numbers serving at Hesselbach was moved to one of the new forts in the east, on the Vorderer Limes, and thus left the former base in allied territory. Only isolated remains of fire were documented in one of the barrack blocks (BAATZ 1973, 63–66). Current evidence of a corroborative nature indicates that this orderly shift took place certainly after 155 AD, and most probably 159 AD (see p. 195–198). The absence of Terra Sigillata of the *Rheinabern* type at the Hesselbach fort supports this dating (BAATZ 1973, 85). Some stone watchtowers remained in operation even after the majority of Odenwald Limes forts – some of the units or their detachments may have remained on the Odenwald Limes. There is, however, no evidence that this happened at Hesselbach (SCHALLMAYER 2012, 101–107). The activity that took place in the former barracks after the abandonment of the fort can be related to the yet undiscovered vicus in the vicinity of this fort.

3.2.4 Forts – Wörth

The first fort on the studied section at Wörth was slightly different in layout to the one at Hesselbach. It also occupied a slightly larger area, of ca. 0,8 ha (SCHALLMAYER 2010, 73). The

19th century excavations revealed the course of late stone defences, all four fort gates together with four corner towers (CONRADY 1900, Taf. 2, Fig. 1). These excavations also uncovered a section of fort wall, collapsed into the ditch. Its original height was around 2,5 m, further enhanced by a 1,6 m high parapet (CONRADY 1900, 9–12). It is reasonable to assume that the final phase of defences at Hesselbach and other forts reached a similar height (SCHALLMAYER 2010, 72). Apart from the mentioned, only the apsidal *aedes* of *principia*, which was constructed in stone, was found during the 19th century excavations. One ditch encircling the fort was also uncovered.

Further information was acquired via geophysical research conducted at the beginning of the 21st century. The fort had two ditches in fact, and the collapsed wall was similar in construction to the final defences of Hesselbach and was preceded by a wall of similar construction as the first stone wall at Hesselbach (LÜDEMANN 2008, 68–75). No trace of an earthen mound with palisade was found at Wörth during the 19th century excavations, nor during the investigations in the 21st century. This suggests that this fort was constructed slightly later than the other forts on the Odenwald Limes, probably in the period when the first reconstruction at Hesselbach and Würzburg took place (SCHALLMAYER 2012, 117). Non-destructive investigation also revealed that the fort had an exceptionally large *principia* (Pl. 21), which was only partially detected in the 19th century. The overall plan can be hardly reconstructed, but the *aedes* was defined by a substantial apse and one of the rooms in the eastern range had rows of pillars instead of the normal floor, which indicates that it originally served as a granary (CONRADY 1900, 13).

All the other buildings attested in the interior were of timber construction. One building located in the *praetentura* was reminiscent in proportions and positioning inside the fort to the storehouse at Hesselbach, however, where stables stood at Hesselbach there were apparently two barrack blocks divided by a narrow alley at Wörth (Pl. 21). The exact dimensions are hard to estimate from geophysics, but they seem to be $\frac{1}{3}$ smaller than the examples excavated at Hesselbach. The *praetorium* probably stood to the northwest of the *principia*, but the function of the remaining buildings (and their exact shape) cannot be determined from the geophysics (LÜDEMANN 2008, 75, Abb. 9). Furthermore, it is not certain if all the buildings indeed stood in the fort at the same time, since geophysics offers no stratigraphic relationships. The fort was reduced to an outpost in its late phase, which occupied the southern corner of the fort. This probably took place at the same time as at Miltenberg, and therefore after the Alemannic raids in 233 AD (SCHALLMAYER 2010, 74).

A bathhouse of ca. 200 m² was excavated to the south of the fort, beyond the *porta principalis sinistra*, in the 19th century. The bathhouse was apparently reconstructed several times, but the excavations in the 19th century could not properly capture the relationship between individual phases. All that can be reconstructed is that a large *caldarium* probably stood in the south at a certain point, from which one could enter into the much smaller *caldarium* to the east and later/earlier but not contemporary *apodyterium* in the west. Beyond the *caldarium* to the north there was almost certainly a large *tepidarium*, beyond which stood the *sudatorium* to the north, from which one could enter another room of probably the same type to the west. North of this room another room without a hypocaust was added at some point, which could thus only serve as a *frigidarium/apodyterium* (CONRADY 1900, 14–19). These foundations were still visible in the results of electric resistivity measurements at the beginning of the 21st century (LÜDEMANN 2008, 73, 76–77), but their correct interpretation is impossible without further excavations. Non-destructive prospection identified traces of *vicus* further south of the bathhouse and possible parade ground, in the vicinity of which several inscribed stones and sculptures were found (AE 2008 963–966, LÜDEMANN 2008, 77–79). A presumed port was located just north of the *porta praetoria*, but nothing specific was ever found or measured there (SCHALLMAYER 2012, 117).

3.2.5 Forts – Seckmauern

The fort at Seckmauern was never excavated after the brief 1901 investigations. It occupied 0,6 ha, and it appears that this fort existed for only a very brief period since its defensive walls were never rebuilt from the timber and earthen phase to more substantial stone construction, as the two later phases of defences were at all the remaining forts on the studied section of the Odenwald Limes. The rampart was 6 m wide, comprising a v-shaped ditch varying between 9 m and 7 m in width, while the berm was only 1 m wide (ANTHES – JACOBS 1903, Taf. 1, 2–8). The palisade probably later ran through the fort (ANTHES – JACOBS 1903, Taf. 1, 2–8; SCHALLMAYER 2010, 76–77), although this identification has been questioned since the “palisade ditch” remained in fact much more the drainage gutter than a ditch for the palisade found on the Odenwald Limes elsewhere (FARBICIUS 1935, 16; WAGNER 1994, 141–142). It seems that the fort was eventually abandoned prior to the construction of the palisade, and possibly related reconstruction of the Odenwald Limes other fort’s defences (SCHALLMAYER 2010, 76–77). Detailed interpretation is hampered by the fact that the timber building identified in the centre of the fort belonged to the later *villa rustica*, together with several structures west and east of the fort, the last one of which was previously identified as the fort bathhouse (Pl. 22). The villa was built in the interior of the fort, apparently after the demolition of all the

military buildings, and was occupied until the 3rd century AD (BAATZ 1973, 127–128). No relevant traces of extramural civilian settlement were found, and due to the short period of the fort's existence, it is doubtful whether any evolved in vicinity of the Seckmauern fort. Without further excavations it is impossible to relate the known, expected or excavated features either to the villa or the preceding fort. Further suggestions are offered in the chapter dedicated to the spatial analyses (see p. 224, 229, 235, 257–258).

3.2.6 Forts – Lützelbach

The fort at Lützelbach was severely damaged by the stone robbing in 18th and 19th century. The excavations at the end of the 19th century could not document anything other than the defences of the small fort (Pl. 23). The v-shaped ditch was 8,5 m wide and at least 1,35 m deep, and the berm was 0,85 m wide. Stone walls of apparently the same type as the final defences of the Hesselbach fort encompassed an area of 0,52 ha (KOFLENER 1904, Taf. 1). The fort had only three gates, and it seems rather improbable that a small entrance was provided in the rear. The Lützelbach fort defences obviously went through several periods of alterations, which, however, cannot be verified today thanks to the robbing of the site (SCHALLMAYER 2008a, 77–78), but a general similarity in the development of ramparts at Lützelbach and Hesselbach was noted already in the old excavation reports (KOFLENER 1904, 4, Taf. 1, Fig. 3; BAATZ 1973, 18). Two relief stones were found at Lützelbach, one with Silvanus and a relief depicting Victoria from the *porta praetoria*. Two small statues, one of a boar and the second of a Roman soldier, were found in the vicinity of the fort in an unspecified context (SCHALLMAYER 2008a, 78).

Nothing is known from the fort's interior, but a well-preserved bathhouse was detected in 2008 via non-destructive survey, ca. 60 m northwest of the *porta principalis sinistra* (Pl. 23). The stone-built bathhouse occupied roughly 120 m², and an *apodyterium* of timber construction and unknown dimensions, which was barely recognizable on the survey results, stood at the south-eastern end. Northwest of this was another room, which probably shared the function of a *frigidarium* and *apodyterium*, from which one could enter from the southern direction into the small *sudatorium*. North of the *frigidarium/apodyterium* was a room with a cold bath, while further northwest of the *frigidarium/apodyterium* was no doubt a *tepidarium*, beyond which a *caldarium* was located, still in the north-western direction. The last room in the northwest, beyond the *caldarium*, can be interpreted as a hot water basin because of its proximity to one *praefurnium*, which was located immediately to the northwest. Another *praefurnium* was located south of the *sudatorium*. According to the non-invasive survey results, only *tepidarium* and *caldarium* appeared to have a hypocaust (SCHALLMAYER 2008a, 78–80). Whether a

channelled hypocaust was located in other rooms, or how many phases or reconstructions the baths underwent cannot be determined without physical excavation of the site. The bathhouse was practically identical to the baths excavated in the late 19th century in the vicinity of the fort at Hainhaus (KOFLE 1897, Taf. 1, Fig. 10). The structures running roughly parallel to the walls of Lützelbach bathhouse and standing right next to it can be interpreted as the foundations of buildings belonging to adjacent *vicus* (SCHALLMAYER 2008a, 80).

3.2.7 Forts – Hainhaus

The interior of Hainhaus fort was severely damaged due to the construction of a hunting lodge in the middle of the fort in the 18th century. The only archaeological examination of the site took place in 1895, and at least revealed some information about the defences and extramural bathhouse (Pl. 24). The fort itself occupied 0,56 ha, and apparently a ditch (*fossa punica*, 1,4 m – 1,9 m wide) was located in front of a 0,75 m – 1,20 m wide berm, the width of which varied between 6,4 m – 7,7 m (KOFLE 1897, Taf. 1). The limited evidence again suggested a resemblance in the development of defences between Hainhaus and Hesselbach (BAATZ 1973, 18, SCHALLMAYER 2010, 85–87). Like Hesselbach, the fort had only three gates and one small entrance in the west instead of a proper *porta decumana*.

The bathhouse located 180 m northwest of the camp was excavated at the beginning of the 19th century (KNAPP 1813, 119–120). It occupied roughly 150 m² and on current evidence it is impossible to tell how many changes and alterations it went through (Pl. 24). An *apodyterium/frigidarium* was located in the southeast, flanked on the southern side by a cold bath and on the northern by a *sudatorium*. Further northwest beyond the *apodyterium/frigidarium* were the *caldarium* and *tepidarium*, and the *praefurnium* stood further behind them. The *caldarium* itself was divided by an internal partition into two halves, and a small niche was attached to it in the north (KOFLE 1897, Taf. 1).

3.2.8 Forts – Eulbach

The fort in the vicinity of the former village at Eulbach was excavated at the beginning of the 19th century (KNAPP 1813, 52–55). The construction of Eulbacher Park by Count Franz I of Erbach–Erbach brought further destruction to the site, and so the methodologically imperfect excavations by RLK at the end of the 19th century could hardly document anything more than the overall size of the former fort (0,54 ha) and the proportions of the v-shaped ditch (6 m to 7,5 m wide and up to 1,6 m deep). The courses of the fort roads were documented, as well as the positions of gates (Pl. 25), and what was examined was again reminiscent of the situation

at Hesselbach (KOFLE 1896a, 4, BAATZ 1973, 27). The fort's bathhouse was located ca. 100 m southwest of the fort and was completely destroyed without documentation during the construction of a restaurant near the entrance to Eulbacher Park (SCHALLMAYER 2010, 90). No traces of the *vicus* were ever found at Eulbach.

3.2.9 Forts – Würzburg

The fort at Würzburg was investigated at the beginning of the 19th century, and its remains served as inspiration for romantic reconstructions displayed in Eulbacher Park (KNAPP 1813, 36–52). In 1895 the fort was excavated by RLK, which measured its dimensions (Würzburg occupied 0,6 ha) and the positions of three fort gates, together with the course of internal roads (Pl. 26), continuing outside the fort towards the course of palisade in a similar manner as at Hesselbach (KOFLE 1896b, Taf. 1). The most invaluable were the limited trial excavations in the southern corner of the fort, performed by Professor Dietwulf Baatz in 1963. A section through the defences there discovered the same structural sequence as was observed at Hesselbach, with three distinctive phases of development of the fort defences, again first consisting only of an earthen mound and fronting palisade, which was succeeded by two stone walls. The interior of the fort was barely excavated at all, but a trial trench nearby the sectioned walls revealed drainage accompanying the *via sagularis* and sleeper walls of possible barrack block, which was built on top of possible previous barracks. The occupation sequence based on these findings seems to be the same as at Hesselbach (BAATZ 1973, 115–118). The finds from both the 1895 and 1963 excavations roughly corresponded to the finds from Hesselbach and dated the existence of the fort to between 110 AD/115 AD and 155 AD (BAATZ 1973, 118–119).

The bathhouse at Würzburg was located 55 m southwest of the *porta principalis dextra* (Pl. 26) and the stamped tile (AE 1896, 00127) from 19th century excavations suggests that it was either built by soldiers from the *Cohors XXIV Voluntariorum*, who was originally stationed at Heidelberg-Neuenheim. Alternatively, this unit at least supplied the material for the construction (SCHALLMAYER 2010, 98). The building was originally entered from the north, where a timber *apodyterium* apparently stood. South of this was the *frigidarium*, to which a small cold-water basin adjoined to the east and to the west a substantial *sudatorium* of almost circular plan, beyond which stood an independent *prae-furnium* of only timber construction. South of the *frigidarium* was the *tepidarium*, two *caldaria* and one more timber *prae-furnium*. Another room with the same function was attached to the east of the *tepidarium*, only much smaller (KOFLE 1896b, Taf. 2, Fig. 1–5). Since the site was first excavated in the early 19th

century and then again in the very end of it, no stratigraphic relationships are known, and successions of alterations were not detected. The whole structure, together with timber extensions, occupied roughly 175 m². The bathhouse was restored in 1980 (GÖLDNER 2001, 1–11) and further conserved between 2007 and 2010 (WEIDMANN 2009, 109–113).

3.2.10 Forts – Schlossau

Fort at Schlossau occupied 0,58 ha according to the 19th century excavations and was surrounded by a v-shaped ditch of 5 m to 6 m width and 1,5 m depth (SCHUMACHER 1900, Taf. 2, Fig. 1). It was investigated by Count Franz I of Erbach–Erbach at the beginning of 19th century (KNAPP 1813, 14–16, 85), and by Buchener Altertumsverein in the mid-19th century, who was responsible for the complete excavation of the bathhouse (TRUNK 2007, 72). It seems that the defences were practically identical to those identified at Hesselbach and so the same sequence of development is expected here (BAATZ 1973, 26, 49). The position and dimensions of gates were non-destructively investigated in 2009 and the results largely confirmed that they were of similar construction as those in the Hesselbach fort (OSTEN–WOLDENBURG 2010, 133). Nothing is known about the interior buildings except for the existence of 25 m² stone-built *aedes* in the *principia* (Pl. 27). The late 19th century excavations were not able to detect anything more (SCHUMACHER, K. 1900, Taf. 2, Fig. 1).

The fort was exceptional on the Odenwald Limes, due to the find of an altar in the mid-19th century, which clearly suggested that the garrison consisted of men from *Numerus Brittonum Triputiensium* under the command of legionary centurion Titus Manius Magnus of the Twenty-Second Legion from Mainz (CIL XIII, 06502 originally found near Schlossau but displayed permanently at Eulbacher Park).

The fort bathhouse was located ca. 60 m southeast of the *porta principalis dextra* and resembled the one described near the Würzburg fort in shape and size (occupying ca. 180 m²). Bricks from both the Eighth and Twenty-Second Legion were used during its construction (SCHALLMAYER 2010, 116). The baths were entered from the north, where a timber-framed apodyterium possibly stood, which was not detected during the excavations in middle of the 19th century and its existence cannot be further verified since the baths were not excavated after this (RABOLD 2012, 52). South of this was a modest *frigidarium*, adjacent to a large *sudatorium* of semi-circular plan in the west, and with a small room reserved for a cold basin in the east. South of the *frigidarium* there was a narrow hall, beyond which the *tepidarium* and *caldarium* were located (Pl. 27). The *praefurnium* was located in the southernmost corner of the building, and was apparently of part-stone, part-timber construction. Only the *sudatorium*, *tepidarium*

and *caldarium* were equipped with a tile hypocaust. On the eastern side, the bathhouse was supported by small buttresses (SCHUMACHER, K. 1900, Taf. 1, Fig. 2).

It wasn't the fort itself that was most comprehensively excavated at Schlossau, but the adjacent civilian settlement immediately south of it, beyond the bathhouse (Pl. 27). The core and axis of the *vicus* was formed by a 3 m – 4 m wide road, repaired and widened several times, leading from the fort's *porta principalis dextra* towards the Oberscheidental fort (RABOLD, B. 2005a, 125–129). The complete extent of the settlement throughout its various phases was not determined during the successive excavations between 2003 and 2010 (RABOLD 2012, 49–52).

The oldest phase of the *vicus* can be related to the period shortly after the construction of the fort, and consisted of traces of several rectangular buildings in the vicinity of the bathhouse, as well as southwest of it, in which a brick and tile production with stamps of Twenty-Second Legion was apparently housed. The building in the vicinity of the bathhouse was apparently equipped with a channelled hypocaust and whether a *mansio* or maybe a temporary *praetorium* stood there is still a matter of unresolved discussion (BAATZ 1973, 31 Abb. 14, SOMMER 1997, 161, RABOLD 2003, 103–107). It is therefore reasonable to assume that in the earliest phase the area of the *vicus* was in fact occupied by soldiers from the fort, who either lived there or used it for activities not appropriate for the interior of the fort, such as crafts.

After some time, the workshop facilities and the enigmatic building were both demolished and replaced in the area east of the road with strip-plan buildings. These were of relatively uniform layout (occupying in average 240 m²), or at least it appears that their dimensions did not vary considerably (Pl. 27), and hearths or ovens were usually placed in the interior of individual houses at the same place. On the other hand, there is no apparent general uniformity, since the depth of foundations in individual examples varied, and construction methods differed also. Some houses had sunken sleeper walls, others were based only on massive posts connected by apparently thicker walls (RABOLD 2006, 136–137). At least six examples were discovered during the successive excavations (RABOLD 2012, 53 Abb. 3).

On the western side of the road stood an apparently much larger public building. Its entire dimensions are unknown, since it was not excavated completely. It consisted of an entrance hall and a row of rooms of almost uniform size; evidence of fire pits and cellars could indicate either a storage house or a market (RABOLD 2009, 130–134). This house was still occupied in the period after complete reconstruction, when the majority of the regular strip houses had been abandoned, since some of the four pottery ovens and a grain kiln belonging to

the later phase of this building intersected the foundations of an older strip house north of it. Some of the pottery found in the context of this house can be counted among the youngest finds on the Odenwald Limes/oldest material on the Vorderer Limes. Further finds of grain processing and pottery confirmed extended civilian occupation during the second half of the 2nd century AD (RABOLD 2010b, 144–149). *Vicus* thus apparently post-dated the abandonment of the Odenwald Limes.

The *vicus* was probably accompanied by a burial ground, which is expected southeast of the civilian settlement (Pl. 27). It was never excavated but a Roman tombstone was found there in 1848 (CIL XIII, 06508).

3.2.11 *Fortlets*

Only three fortlets stood on the studied section, and none was extensively excavated after the 19th century investigations directed by RLK. The internal layout of the fortlets on the Odenwald Limes is practically unknown and the chronological sequence of their modifications and alterations is poorly understood. The only relevant information about them is available from excavation reports concerning similar structures on the Odenwald Limes beyond the studied sector and in fact from excavation reports from other parts of ORL. Principally these were the fortlets at Robern (FABRICIUS 1935, 101, Taf. 12–13; BEHRENDT 1987, 560–563; KORTÜM 1998, 34; SCHALLMAYER 2010, 125–127) and Trienz (FABRICIUS 1935, 103, Taf. 13; SCHALLMAYER 2007a, 49–54; SCHALLMAYER 2010, 129), where the dating of defences points positively to the existence of a fortlet in the late period of Odenwald Limes. But almost nothing there, still, could have been found from expected earlier phases of their existence. The nearest example of a documented fortlet from the Trajanic–Hadrianic period in the vicinity of the Odenwald Limes is the second phase of the fortlet at Pohl bei Kemel in Taunus, where there were even some internal features documented (FABRICIUS 1936, 28, 78; FLEER 2004, 75–92).

The fortlet at Windlücke is the smallest identified freestanding fortlet on the whole ORL, occupying only 160 m² (FLEER 2004, 77). No ditch was found encircling it during the excavations of RLK and only the 1 m wide exterior wall and one gate facing the palisade were documented. A large sherd of decorated *terra sigillata* found somewhere in the interior cannot help with dating of the site since excavator gave no indication of the find context (FABRICIUS 1935, 45, Taf. 4, Fig. 1 a–e, Taf. 19, Fig. 13). No inscribed stones were found and no trace of architecture was detected inside the fortlet. The limited amount of space in the interior suggests that no more than 20 men could have been accommodated there (SCHALLMAYER 2010, 82), and therefore only one double *contubernium* at best. This, however, seems to be still much

optimistic value since the usual size of the garrison for such types of fortlets is only 16 men (BAATZ 2007, 11). Nothing is known about the internal arrangements at the Windlücke fortlet (Pl. 28).

Even less is known about the fortlet at Zwing. Although its remains were still visible at the beginning of 19th century (KNAPP 1813, 22, 30–32), almost nothing survived by the time the site was documented by RLK. The documented surrounding wall of the fortlet was supposed to be even thicker than at Windlücke (0,75 m); one gate was documented in the southeast and another one was only suspected in the northwest. The fortlet occupied 380 m² and the only notable find was a relief panel with Mars, and currently lost inscription (CIL XIII 6513, FABRICIUS 1935, 69–71). Nothing is known about internal arrangements at the Zwing fortlet (Pl. 28), but the area occupied by this fortlet is almost the same as the area occupied by Kinneil fortlet and therefore the estimates about the maximum size of the garrison should be the same – 32 men at best (BAILEY – CANNEL 1996, 341).

The last studied fortlet at Seitzenbuche probably had the same dimensions as the one at Zwing (Pl. 28). The exterior stone wall was documented ca. 0,8 m thick, two entrances were provided; one to the northeast can still be called a gate (2,3 m wide), while the south-western 1,7 m wide entry probably only served as a service gate. No ditch was provided and there were no finds except for sculptured masonry (FABRICIUS 1935, 79–80). The size of the garrison did not vary from what is expected at Zwing.

The fortlet at Robern was also similar in plan to the last two examples and occupied only the slightly larger area of 420 m². One main and one rear gate were provided. Again, no ditch was found, and no foundations of internal buildings were observed (Pl. 28), but fragments of wattle confirmed the existence of some buildings in the interior (FABRICIUS 1935, 100–102, RABOLD 2005b, 278). They indicated the presence of simple timber and wattle-and-daub constructions, which are known from similar frontier features up to the beginning of the 3rd century (FLEER 2004, 80–81). These would have originally stood in the interior of Windlücke, Zwing and Seitzenbuche fortlets. Later excavations confirmed that the final wall was ca. 1 m wide and essentially of the same construction as the final phase of the stone part of the defences at Hesselbach fort (BEHRENDTS 1987, 560–563). The size of the garrison did not vary from what was expected at the Zwing or Seitzenbuche fortlets.

Trienz fortlet was significantly larger than other fortlets on the Odenwald Limes, and it is questionable whether this site represented anything comparable to the small fortlets at Windlücke, Zwing or Seitzenbuche. It occupied 0,2 ha (just like the fort at Duntocher on the

Antonine Wall – see p. 29) and was encircled by a 0,85 m wide stone wall, that was at least in the southwest corner of the fort accompanied by a parallel wall of the same thickness, which presumably formed the support for an earthen rampart such as that in Hesselbach. The fort was furnished with two gates of significantly larger proportions. The front gate was 3,4 m wide and the rear one was 2,9 m wide. As the only fortlet on the Odenwald Limes, Trienz was protected by a simple ditch, that encircled the whole fortlet with the exception of the area in front of the gates (FABRICIUS 1935, 103–104 Taf. 13, Fig. 2–6; SCHALLMAYER 2010, 129). The find of an inscription from the *Numerus Brittonum Elantiensium*, which gives the only documented evidence for the garrison of fortlets on the Odenwald Limes is also exceptional (CIL XIII 6498). All in all, this fortlet has practically nothing comparable with Windlücke, Zwing or Seitzenbuche fortlets.

An exceptional fortlet at Pohl bei Kemel in Taunus was apparently different in construction to the Odenwald fortlets. Its second phase could be firmly dated to the Trajanic–Hadrianic period, and the provision of a double ditch is immediately striking. Beyond it stood a palisade wall and 3 m wide earthen rampart, not dissimilar in construction to the Seckmauern or first phase of the Hesselbach forts defences. The interior of the 925 m² enclosure apparently housed a building with courtyard, around which two rows of rooms may have been located (FABRICIUS 1936, 28, 78). The overall plan is still, however, not well understood and any reconstruction should be seen as relatively speculative (FLEER 2004, 79). Still, this fortlet at least gives a hint how could have the earthen and timber predecessors of the Odenwald Limes fortlets looked like – generally one should suspect structures of more substantial proportions and accompanied by a ditch.

The evidence presented makes it abundantly clear that fortlets remain one of the most enigmatic features on the Odenwald Limes. With current archaeological evidence it cannot be said with certainty whether the fortlets were part of the original plan of the Odenwald Limes or not. The absence of ditches, which makes them similar to the later added stone watchtowers, is especially problematic. If the fortlets went through the same phases of construction as the forts, ditches should be found, at least in backfilled form, in their immediate surrounding area, or they should have been at least noted by antiquarians, who could still see the substantial remains of these structures in the 19th century. None were found, however, with the exception of Trienz fortlet, which was double the size of Zwing or Seitzenbuche (FABRICIUS 1935, 103–104 Taf. 13, Fig. 2–6; SCHALLMAYER 2010, 129). Ditches were usually provided for the earthen-and-timber fortlets (WILKES 1974, 51; NEWALL 1976b, 111; FLEER 2004, 75–92), and their apparent absence cannot be explained by the fact that later reconstruction of the sites destroyed them –

the original fortlets could hardly have been so small as to be completely overlain, with their several metres wide ditches, by such small fortlets as that at Windlücke. There were therefore either no timber-and-earthen predecessors of the stone fortlets on the Odenwald Limes; or they were not equipped with detectable ditches (which seems improbable due to the reasons noted above); or the original fortlets of timber and earthen construction, characteristic of the early existence of the studied sector of the frontier, stood on entirely different locations than their stone-built Antonine successors. This matter will be discussed further in the interpretation of Odenwald Limes via spatial analyses (see p. 258)

3.2.12 *Watchtowers – types and model examples*

Thirty-nine watchtower sites are included in the study, and the majority were detected but never excavated. There were at least two watchtowers on each site, a timber and stone one, although three could be expected almost everywhere. Even though there may have been some variation between individual types, for example in the positioning of the entrance or the type of roofing, in general plan they all represented two types – the timber watchtower and the stone one – and in the archaeological record each look more or less the same as the others in its category. The best documented examples of completely excavated watchtower sites will therefore be presented initially (Wp 10/8 and Wp 10/25), the documented archaeological remains of the thirty-seven remaining individual watchtower sites will be presented and then the possible reconstructions will be discussed together with a summary of the presented evidence.

The best documented watchtower site so far is Wp 10/25, also called Auf dem Roten Buckel. The site has been known since the 19th century and was documented briefly by the RLK during preparation of the report about the Odenwald Limes (FABRICIUS 1935, 55). A stone inscription was found on this site, but it was lost before the brief investigation performed by Fritz Kofler, who in fact documented only the position of the visible remains of the two watchtowers (FABRICIUS 1935, 55, Kartenbeilage 1). The complete excavations took place in the autumn of 1975 under supervision of Dr Paul Wagner.

The foundations of what appeared to be only two watchtowers were discovered, separated from each other only by 12 m. Both timber watchtowers (one directly replaced by the another inside the mentioned circle ditch) originally stood north of their stone successor and their position was apparent thanks to the well preserved 26 m wide ring-ditch. The first timber watchtower was obviously once reconstructed and the ditch was re-dug during this rebuilding – the original *fossa punica* (1,5 m deep and of unknown width thanks to the disturbance via its successor) was later, after some period without maintenance, replaced with a standard v-shaped

ditch. This *fossa fastigata* was originally ca. 3 m wide and 1,35 m deep. In the middle of the entrenched area stood the watchtower itself, from which nothing except the rubble of roughly cut drystone masonry remained (Pl. 29). The later phase of the watchtower occupied ca. 25 m² but the foundations were so disturbed that limited excavation could not bring any further information (WAGNER 1994, 135–138). The evidence, however, clearly indicated the existence of two timber watchtowers in succession at Wp 10/25.

The stone watchtower was not accompanied by any ditch, it was of rectangular shape and occupied 29 m² only (Pl. 29). The walls consisted of roughly cut mortared masonry of ca. 0,8 m – 0,9 m width, while the foundations were slightly wider. The floor of the interior consisted of crushed masonry mixed with clay (WAGNER 1994, 120–129).

The course of palisade was documented east of the watchtowers, of which only the foundation ditch survived. Immediately west of the palisade ran the Military Way, which confused the excavator regarding whether the ditch flanking the road to the east was roadside drainage or the much-eroded foundation of palisade. If the second theory is accepted, the ditch was slightly wider than examples documented elsewhere (see p. 187–189) but its remains, and those of the Military Way, were so severely damaged by erosion that the results of excavations are in fact hard to interpret. The Military Way itself was approximately 6 m wide, and its body consisted of a ca. 0,3 m thick layer of broken sandstone, which was originally covered by a thick layer of gravel, of which only a little survived (WAGNER 1994, 138–142). Alternatively, the palisade could have run further east of the course of the Military Way and all its remains were destroyed by erosion.

Several pottery sherds were found, comfortably datable to the Trajanic–Hadrianic period. The pottery assemblage, including *terra sigillata* as well as coarse wares, corresponded to the finds from Hesselbach although no stratigraphic sequence could have been constructed at Wp 10/25. Cooking ware predominated over all other types of pottery and finds datable to the Antonine period were scarce but not absent (WAGNER 1994, 156–159). The presence of burnt nails in demolition debris was expected, and the finds of bones of cattle, pigs, sheep and goats only proved that cooking took place at the watchtower sites (WAGNER 1994, 155). The stone watchtower was burned down after its abandonment (WAGNER 1994, 159–160).

Another example of a well-documented watchtower site is Wp 10/8, also called Im Lützelbacher Bannholz (Pl. 29). It was repeatedly investigated by Fritz Kofler, Wilhelm Soldan and Eduard Anthes between 1888 and 1897. Two timber watchtowers and one stone one were attested on the site. The northern timber watchtower, interpreted as the older one thanks to the

intersection of its ditch with a ditch of the southern watchtower, was surrounded by a v-shaped ditch almost 2 m deep and 7 m wide. Its diameter between the bottoms of the ditch was 17,5 m. In the middle of entrenched area stood the watchtower itself, which was constructed of drystone masonry and occupied 32,5 m². Extra space was provided in the corners of superstructures for massive posts, which originally carried the weight of the watchtower. Apparently, this watchtower burned down during a massive fire (SCHALLMAYER 2010, 81–82).

The second timber watchtower was located 15 m south of the northern example and was entrenched by a ditch of the same proportions as its neighbour, but the stone superstructure occupied a slightly smaller area of only 27 m² (Pl. 29) As far as the archaeological record is concerned, it was a replica of the northern one.

The stone watchtower on the site was located 9 m southeast of the first timber one and 12 m northeast of the second, occupying 29 m². The original width of its walls, as well as any detailed information about the interior arrangement of its two timber predecessors, is unobtainable due to disturbed remains following the 19th century archaeological methodology.

All three watchtowers were originally enclosed by a simple timber fence encompassing an area of 0,3 ha. Three gravelled entrances were provided into this enclosure, through which the Military Way also passed. Nearby the Military way the fireplace was located. The course of the simple fence was later cut by a palisade. A cut through its foundation trench revealed a funnel shaped ditch with its bottom filled with smaller stones and the remains of original palisade timber posts (FABRICIUS 1935, 42–44, Taf. 3, Fig. 1-2).

3.2.13 Watchtowers – documented archaeological remains

Watchtower sites Wp 10/1, Wp 10/2 and Wp 10/3 were never excavated or even surveyed with confidence and almost nothing can be seen of the remains of their potential watchtowers on LIDAR. The position presumed by RLK for Wp 10/1 was destroyed during the construction of the embankment for B 469 (Fig. 115). Although certain anomalies can be found on LIDAR at the presumed position of Wp 10/2, these could be of natural origins (Fig. 116). Nothing is visible (Fig. 117) and nothing was ever surveyed at Wp 10/3 (FABRICIUS 1935, 37–39; LÜDEMANN 2008, 82–83; SCHALLMAYER 2010, 75–76). Wp 10/4 was expected by RLK in the interior of the Seckmauern fort or in its immediate vicinity; it was apparently constructed after the demolition of the fort, and its remains were apparently utterly obliterated by the construction of the *villa rustica* (FABRICIUS 1935, 39). No trace of a possible watchtower was ever found around Seckmauern (LÜDEMANN 2008, 82–83, 86), and two terrain humps west of the fort (the

position is traditionally called “Bei der feuchten Mauer”) do not resemble the characteristic ring ditch of a timber watchtower or the square plan of a stone watchtower (Fig. 118). The course of the palisade and Military Way between the fort at Wörth and Wp 10/5 are entirely conjectural, and were never verified by any excavations, nor can either be seen on the LIDAR.

The stone watchtower at Wp 10/5 (Auf der Seckmaurer Höhe) is the northernmost documented example of a tower on the studied section of the Odenwald Limes (Fig. 119). The still visible remains were identified in 1876 and excavated with a limited amount of documentation in 1883. Watchtower foundations occupied approximately 46 m² (FABRICIUS 1935, 40). The site was again examined using non-destructive methods in 2007, when geomagnetic measurement clearly identified the rectangular shape of stone foundations of the watchtower, occupying roughly the same area as recorded by RLK. No ditch was detected, and since local farmers in the 19th century stated that fragments of processed stone architecture were found on site, identification as a stone watchtower is more probable, since such elements were common on these structures and were not attested on the timber watchtowers (see p. 193–195). Professor Schallmayer suggested that if ever a timber watchtower stood on Wp 10/5, it could have been on the very same spot at which a later stone watchtower was identified (SCHALLMAYER 2007b, 89–90), and therefore the succession could have been similar, but not the same as in the case of two timber watchtowers at Wp 10/25. The traces of ring-ditch could have been destroyed by ploughing, and the remains of a stone superstructure are still visible on the LIDAR today as a pile of stone rubble (Fig. 119).

The watchtowers at Wp 10/6 (Im Hannsbatzenfeld) were only expected for a long time and their positions in the proceedings of RLK were only approximate (FABRICIUS 1935, 40–41, Kartenbeilage 1). They were located with certainty in 2004, and their prospection via non-destructive methods followed in 2007, which revealed two circular structures, between which was located a dark square structure (Fig. 120). There was no doubt that the circular objects were the ditches of two wooden watchtowers and the nearby anomaly was a stone watchtower. The alignment of individual features resembled the positioning of individual watchtowers at Wp 10/8. The outer diameters of the timber watchtowers were 17,5 m and 18,5 m, and they were similar in dimensions to ditches of watchtowers at Wp 10/8. The northern timber watchtower was obviously destroyed by fire, as the dark anomalies on the visual representation of non-destructive research proved. Traces of timber fence were also detected in the vicinity of the watchtowers, but not in sufficient amounts to estimate the dimensions of the enclosed area. The stone watchtower occupied 27 m², the structure of two timber watchtowers did not manifest

itself in the geophysics clearly enough to make an estimate of their original proportions – no doubt they were similar to the examples excavated at Wp 10/8 (SCHALLMAYER 2007b, 90–91).

Trial excavations at Wp 10/7 (Im Hoffeld) in the 19th century confirmed the position of a watchtower occupying 31 m² (FABRICIUS 1935, 41–42), and the site (Fig. 121) was re-investigated in 2005 via geophysics. Apart from the already known stone watchtower, much shallower traces of its timber predecessor were discovered. The characteristic ring ditch had a diameter of 17,5 m and its visible width varied between 2 m and 2,5 m. The interior of the timber watchtower could not have been evaluated since it was intersected by a modern road, which manifested effectively on the geophysics results as a bright anomaly. The stone watchtower position and dimensions were only confirmed via non-destructive survey (SCHALLMAYER 2007b, 91–92).

As Wp 10/8 has already been discussed, the next watchtower site in question is Wp 10/9 (Im Breitenbrunner Bannholz). This site was searched several times via trial excavations without documentation during the 19th century (FABRICIUS 1935, 44–45, Kartenbeilage 1). It was never excavated or surveyed after that, but the remains of two timber watchtowers and one stone one are still visible at the location and also on LIDAR imagery (Fig. 122). The ditch of the northern timber watchtower (ca. 17 m in diameter) seems to be less substantial than the ditch of the southern one (ca. 26 m in diameter), but many factors other than the original proportions could have played a role there, including the trial trenches in the 19th century. Thus, any evaluation of this site is impossible although the existence of watchtowers at Wp 10/9 can be considered confirmed.

Watchtower site Wp 10/10 was excavated by RLK in 19th century. The excavations revealed the northernmost stone watchtower (occupying 28 m², with 0,8 m wide walls) and two timber watchtowers to the southwest (Fig. 123). They were separated from each other by 20 m and 36 m, the northern timber watchtower survived in much better condition than the one at Wp 10/25, and so it was documented that it occupied 28 m² and its walls were 0,75 m thick. The ditch of the northern timber watchtower was backfilled in the antiquity but the southern example, which was identical with its northern neighbour, had a still well visible ditch 16,9 m in diameter, 9 m wide and 2 m deep. The slots for corner timber beams holding the superstructure of the timber watchtowers were documented 25 cm x 25 cm. The palisade in the vicinity of Wp 10/10 was located 28 m to the east of the timber watchtowers, and the Military Way ran ca. 21 m east of the timber watchtowers, but its remains were so disrupted that the overall course could not have been followed. At least the western side of the Military Way was

accompanied by a drainage ditch, and a fireplace was located between two timber watchtowers, which wasn't further documented (FABRICIUS 1935, 45–46, Kartenbeilage 1).

A stone watchtower at Wp 10/11 (Auf der Sellenplatte) was excavated with limited documentation in the 19th century. It occupied 26 m² (FABRICIUS 1935, 46–47, Kartenbeilage 1), and during the preservation works in 1987 the position of a presumed timber watchtower was confirmed immediately south of the stone predecessor (SCHALLMAYER 2010, 84–85). It was never excavated but the shape and size of the mound indicates that at least the ditch had originally similar proportions to the ditch of Wp 10/8 (Fig. 124). Neither a palisade nor the Military Way were traced in the vicinity of this watchtower site.

Wp 10/12 (In den Dickhecken) was identified and mapped in the 19th century during the preparations of the RLK report on the Odenwald Limes (FABRICIUS 1935, 47, Kartenbeilage 1). The ditch of the timber watchtower (diameter 22 m) is still visible on LIDAR, as well as a mound indicating the stone watchtower occupying ca. 50 m² (Fig. 125). This figure does not represent the area occupied by the watchtower, but an area occupied by a mound formed by the rubble of the former structure ca 20 m south of the timber watchtower. The course of the palisade ditch can be also followed for a while in the vicinity of the watchtower site; it passes by both the timber and stone watchtower 25 m distance to the east.

Wp 10/13 (In den Erlen) was also never excavated. When the RLK report was composed, the unimpressive mound and remains of ring ditch were identified and mapped (FABRICIUS 1935, 47, Kartenbeilage 1). They are almost invisible today in the terrain and also on LIDAR. The contours of the ditch of the timber watchtower are only visible with a very high amount of contrast (Fig. 126). The position of the stone watchtower, unidentified by RLK, is however clearly visible on the LIDAR, 15 m southeast of the edge of the timber watchtower ditch, occupying an area of 65 m². The course of the palisade is barely recognisable on LIDAR, but it ran ca. 60 m east of the position of the timber watchtower.

The history of Wp 10/14 is practically the same as the history of Wp 10/13. It was also never excavated, and only the position of the timber watchtower was identified in the 19th century. The ring ditch was of standard proportions, similar in width to the ditch at Wp 10/12 (FABRICIUS 1935, 47, Taf. 5, Fig. 1a, Kartenbeilage 1). The site is clearly recognisable on LIDAR, and again the position of the stone watchtower can be identified, this time 52 m to the west of the known timber predecessor. Nothing was ever documented of the course of the palisade or Military Way, or traced in the vicinity of this site, and nothing can be seen of either of these on the LIDAR (Fig. 127).

Wp 10/15 (Im oberen Haspel) is predominantly known for the replica of a timber watchtower, which will be discussed below. The site was briefly inspected by RLK, which documented that the stone watchtower was completely destroyed during the construction of L 3349, which also intersected the position of the timber watchtower. Nothing except the terrain profile above the unexcavated remains of the timber watchtower was documented (FABRICIUS 1935, 48–49, Taf. 5, Fig. 1b, Kartenbeilage 1) and nothing can be seen on LIDAR (Fig. 128).

The exact position of Wp 10/16 (Bei Vielbrunn) was located in 2009 via geophysics more or less exactly on the spot postulated by RLK as a watchtower site (FABRICIUS 1935, 49, Kartenbeilage 1; SCHALLMAYER 2009, 103–108). Two timber watchtowers were identified, both surrounded by ring ditches of ca 20 m in diameter (Fig. 129). The non-destructive investigation could not reveal anything except the anomalies caused by the four beam corner-supports of the former watchtowers, which were ca. 4,8 m and 5,5 m apart (both towers occupied ca. 22 m² – 26 m²). Both timber watchtowers resembled those found at Wp 10/6 in plan and proportions, although their spatial relationships to each other were different, and again the disparity in the number of anomalies indicated that the northern watchtower was destroyed by a massive fire. A significant anomaly was located approximately in the middle of the two timber watchtowers, separated from each other by 25 m, which represented the stone watchtower, occupying ca. 25 m². Again, very shallow traces of a timber fence around the whole site were detected but no general plan of its course could be reconstructed. No trace of the Military Way or palisade in the vicinity of Wp 10/16 were found in the 19th century or in 2009 (SCHALLMAYER 2009, 103–108).

The history of Wp 10/17 is practically the same as the history of Wp 10/13 and Wp 10/14. Its position was surveyed by RLK and the terrain profile of a known ring ditch for the timber watchtower was documented. The stone watchtower ca. 42 m southwest of the edge of the ditch of the timber watchtower had been robbed for stone before the late 19th century prospection (FABRICIUS 1935, 49, Taf. 5, Fig. 1c, Taf. 17, Fig. 1, Kartenbeilage 1), but the disturbed remains can still be seen on LIDAR (Fig. 130). No trace of a palisade or the Military Way were documented in the vicinity of Wp 10/17.

Only the timber watchtower is known from Wp 10/18 (Im Strichherrenwald), since the stone one again fell victim to stone robbing during the construction of L 3349. Its ruins are visible on the LIDAR, ca. 56 m south of the known timber watchtower, which was otherwise of standard proportions (ring ditch ca. 26 m wide, Fig. 131). No excavations ever took place at Wp 10/18, and the site was simply surveyed and mapped, like Wp 10/17 (FABRICIUS 1935, 50,

Taf. 5, Fig. 1d, Taf. 17, Fig. 2, Kartenbeilage 1). The course of the palisade is easily distinguishable on the LIDAR, running ca. 21 m east of the ring ditch of the timber watchtower. Immediately south of the timber watchtower is a much-disturbed terrain anomaly that could represent the remains of a ditch of another timber watchtower, but there is no specific evidence for this.

Wp 10/19 (An der Lichten Platte) was never excavated properly. It consisted of a timber and stone watchtower, and the latter was completely destroyed in the 1842 during the construction of L 3349. Apart from the inscription recovered during the demolition work (CIL XIII 6518) nothing is known about the site (FABRICIUS 1935, 50, Taf. 5, Fig. 2a, Kartenbeilage 1, SCHALLMAYER 2010, 89–90). Nothing of Wp 10/19, the palisade or the Military Way in its proximity can be seen on LIDAR (Fig. 132).

The timber watchtower at Wp 10/20 (Am Kutschenweg) was excavated in 1896. The watchtower itself occupied 27 m² and it was encircled by a ditch of only 15 m in diameter. At corners of relatively well-preserved stone superstructure 35 cm x 35cm postholes for the corner support beams were detected, and space was also left for three further horizontal beam supports on each side of the stone superstructure. The corner support beams were sunk 1,3 m under the original terrain. The stone watchtower stood ca. 20 m south of the timber one, but it was like many others on this section of the frontier, completely robbed before the 19th century excavations (FABRICIUS 1935, 51, Taf. 5, Fig. 2, Taf. 17, Fig. 3, Kartenbeilage 1). The course of palisade can be traced on LIDAR ca. 27 m east of the timber watchtower, but no trace of the Military Way was found in the vicinity of Wp 10/20 (Fig. 133).

Watchtower site Wp 10/21 (In der Heumatte) was never archaeologically investigated. RLK in the 19th century documented a ring-shaped ditch with a diameter of 26 m, in the middle of which the timber watchtower is only expected (FABRICIUS 1935, 52, Kartenbeilage 1). Terrain unevenness can be seen on LIDAR ca. 30 m south of it, which could be the ruins of a successive stone watchtower (Fig. 134). No trace of a palisade or the Military Way were detected in vicinity of Wp 10/21.

Two watchtowers were originally located on Wp 10/22 (Am Vogelherdschlag). The stone one was excavated in the first half of the 19th century and some stones were moved to Eulbacher Park, where a romantic reconstruction of the watchtower was made (KNAPP 1813, 49–52). Even though the precise plans are missing and the antiquarian records may be misleading, it is curious that this watchtower apparently had a 1,5 m wide entrance on the ground level from the west, which was confirmed by the 1986 re-excavations (FABRICIUS 1935,

53–54; SCHALLMAYER 2010, 94). The stone watchtower occupied 29 m². A simple building inscription dedicated by *Numerus Brittonum Triputiensium* was found on site, firmly dating the construction of the watchtower to 145 AD (CIL XIII 6517). A surprisingly large quantity of nails (91 in total) was found during the examination of the site at the beginning of the 19th century. The timber watchtower standing ca. 20 m north of the ruins of its successor was only briefly documented in the 19th century (FABRICIUS 1935, 53–54, Taf. 5, Fig. 3), and nowadays its ring ditch is 26 m in diameter according to the LIDAR (Fig. 135).

No excavations or successful survey ever took place in positions where RLK suggested Wp 10/23 and Wp 10/24. Only stray finds were reported from the position of Wp 10/24, of possibly processed sandstone blocks, which could indicate the presence of a Roman watchtower (SCHALLMAYER 2010, 95). Several areas of terrain unevenness can be found on LIDAR in the vicinity of the position suggested by RLK (FABRICIUS 1935, 55, Kartenbeilage 1), but their nature cannot be assessed without trial trenching or non-destructive survey (Figs. 136 and 137).

Wp 10/25 (Auf dem Roten Buckel) has been discussed above. Comprehensive excavations of Wp 10/26 (Im Sack) took place in 1895. They revealed two watchtowers separated from each other by 25 m. The northern one was encompassed by a ring-ditch of 18 m diameter, which was apparently executed in the *fossa punica* style (unfortunately no profile sketch was ever made during the excavations – FABRICIUS 1935, 57). Otherwise a relatively standard timber watchtower was uncovered, with stone foundations occupying 27 m². The gaps for horizontal beam supports were easily recognisable, as were the postholes for massive corner support beams. The stone watchtower was similar to the other excavated stone watchtowers on this section of the Limes, occupying 29 m² and having a wall thickness of 0,95 m. The palisade was documented during excavations 28,4 m east of the timber watchtower (FABRICIUS 1935, 57, Taf. 5, Fig. 4, Kartenbeilage 1) and its course is still somehow visible on the LIDAR (Fig. 138). The course of the Military Way was probably identical with the course of the medieval road passing by the watchtower site almost immediately to the east, and therefore nothing could have been documented of it.

Wp 10/27 (Im Gescheid) was almost identical to Wp 10/26. Both watchtowers at this site, separated from each other by 24 m, occupied 27 m². The northern timber watchtower was encircled by a 1,4 m deep ditch, of 17,5 m in diameter. It was preserved up to a height of 1 m and in plan and dimensions it was identical with the one excavated at Wp 10/26. The stone watchtower, on the other hand, was severely damaged by stone robbing in the 19th century and not much of it could have been documented except its apparent similarity to the example

excavated at Wp 10/26. The palisade ran 33 m east of the timber watchtower, which seemed rather excessive to the excavator and later researchers (FABRICIUS 1935, 57–58, Taf. 5, Fig. 5, Kartenbeilage 1; SCHALLMAYER 2010, 100). Both watchtowers and the course of the palisade are still visible on the LIDAR (Fig. 139), and the course of the Military Way was documented in the 19th century ca. 15 m east of the timber watchtower and limited excavations showed that it was 4,75 m wide. No trace of side ditches was found (FABRICIUS 1935, 58). The positioning of this watchtower site is dealt further in the chapter dedicated to the spatial analyses (see p. 214–215, 231).

Watchtower site Wp 10/28 (Im oberen Seeschlag) was another locality excavated in the late 19th century, which was severely damaged by the time of its inspection by RLK. The stone watchtower located 15 m north of the timber one was so disturbed that the excavator did not consider it worthy of documentation and only a sketches of the cornice and original masonry were made (FABRICIUS 1935, 58–59, Taf. 6, Fig. 1d, f). The timber watchtower was better preserved: it occupied 26 m² and was encircled by a ring ditch 1,75 m deep with a diameter of 14 m (Fig. 140). The posts of corner support beams were not examined although space in the corners of the structure was clearly allocated for them (FABRICIUS 1935, 58–59). The course of palisade was detected and sectioned ca. 30 m east of the timber watchtower. A classical funnel shaped ditch was revealed, 0,4 m wide at the bottom. The remains of palisade posts were still visible on the profile, but no stone or gravel bedding was detected at the bottom (FABRICIUS 1935, 58–59, Taf. 6, Fig. 1c). The course of the Military Way was located ca. 15 m east of the timber watchtower ditch edge, but again nothing was documented in detail since the course of the ancient road was disrupted by the later medieval road (FABRICIUS 1935, 59).

Wp 10/29 (Im unteren Seeschlag) was excavated twice in the 19th century. Timber and stone watchtowers were located there, almost 50 m apart (Fig. 141). The northern stone watchtower was relatively large, occupying 34 m², its walls were 0,98 m thick at the plinth and 0,9 m thick in the still surviving upper levels. Two building inscriptions (CSIR-D-02-13, 00242, CSIR-D-02-13, 00243) together with dressed masonry (FABRICIUS 1935, 59–60, Taf. 6, Fig. 2c) were recovered during the successive excavations. The inscriptions dated the construction of the watchtower to 145 AD. The unit responsible for the inscription and construction of the watchtower was again the *Numerus Brittonum Triputiensium*. The timber watchtower, encircled by a ditch with a diameter of almost 20 m, was repaired at least once during its existence – it was apparently reinforced on the western side, where the horizontal beam supports were absent and instead the wall superstructure was 1,5 m wide, while on all the other sides the gaps for horizontal beam supports were provided in the 1 m wide walls. In its final stage the watchtower

occupied 28 m². The palisade ran 22 m east of the timber watchtower's ditch edge, and the course of the Military Way was detected 18 m east of the timber watchtower's ditch edge, running parallel with the palisade (FABRICIUS 1935, 59–60, Taf. 6, Fig. 2, Kartenbeilage 1).

At Wp 10/30 (In den Vogelbaumhecken) two watchtowers were again documented (Fig. 142). The stone watchtower occupied 23 m² and it was located 15 m north of the timber watchtower. The masonry of this stone watchtower was particularly well preserved, as well as fragments of stone plate with aedícula and currently lost inscription. The timber watchtower occupied 28 m², its outer walls were 0,65 m wide, and it was apparently modified during its existence – the interior was divided in half by a 0,9 m wide partition wall (FABRICIUS 1935, 60–62, Taf. 7, Fig. 1c). This may be related to the perhaps almost complete reconstruction, and was also observed in the other timber watchtowers (Wp 10/25, Wp 10/29 etc.), or it could be interpreted as an attempt to provide access on the ground level (SCHALLMAYER 2010, 102–103). Again, the corners were reinforced by massive support beams. Traces of a fence around the site were detected at Wp 10/30 but again they were too shallow and confirmed only sporadically, and therefore the amount of space enclosed this way cannot even be estimated. The Military Way ran 22 m east of the timber watchtower, while the palisade was located 8 m even further away. The Military Way was unusually wide near Wp 10/30, varying between 7.5 m and 9 m where its width was excavated in two areas. The palisade was sectioned twice, and the sections again revealed a funnel shaped ditch with the bottom filled with smaller stones. The posts were apparently 25 cm – 30 cm wide, and the ditch was dug to 0,4 m width and 1,4 m deep and was reinforced by broken sandstone rubble (FABRICIUS 1935, 60–62, Taf. 7).

The position of Wp 10/31 (Im Saufeld) was still matter of debate at the publication of this thesis. No trace of it was known during the publication of the RLK report (FABRICIUS 1935, 62). Professor Dietwulf Baatz found fragments of dressed sandstone in the vicinity of the suspected course of the palisade near Saufeld in 1966 (BAATZ 1967, 74–77). LIDAR imagery shows only very shallow traces of any structure there, but the position of at least one timber watchtower can be identified on the terrain profile (Fig. 143). No excavations ever took place at Wp 10/31, no traces of Military Way were mapped or surveyed there, and the course of the palisade is not clearly visible on the LIDAR in vicinity of the suspected site. The positioning of Wp 10/31 is further discussed in the chapter dedicated to the spatial analyses (see p. 215, 222, 231).

The position of Wp 10/32 (Höhenbuckel) was surveyed at the beginning of the 19th century and excavated by the end of it. The stone watchtower occupied 25 m², and its walls

were mortared and 1 m thick. An inscription on brick (CIL XIII 6515) was found in the demolition rubble, together with a broken window column and stone slab, which probably also once bore an inscription (executed in paint, not carved), although it was lost by the time of excavation. The timber watchtower was located ca. 26 m northwest of the stone watchtower. It was severely disrupted when excavations took place in the 19th century and not much could have been documented save the fact that it occupied 38 m², its walls were originally 1 m thick and postholes still indicated the position of the massive corner support beams. The surviving ring ditch nowadays has a diameter of 26 m on LIDAR (Fig. 144). The course of the palisade is also visible on LIDAR, ca. 37 m east of the timber watchtower and 33 east of the stone one. The course of the Military Way followed the palisade at ca. 5 m in distance, no side-ditch was found and only shallow traces of gravel were identified during the investigations of the Military Way, only 4.25 m wide, in the vicinity of Wp 10/32 (FABRICIUS 1935, 63–65, Taf. 7, Fig. 2, Kartenbeilage 2).

Wp 10/33 (Auf dem Kahlen Buckel) was excavated three times during the 19th century. One stone and two timber watchtowers were discovered there. The northern timber watchtower occupied 25 m² and the width of its walls varied between 0,9 m and 0,95 m. Although no profile was recorded, the encompassing ring ditch of the first timber watchtower can be seen to have a diameter of 24 m and a width ca. 2,5m (FABRICIUS 1935, 65–68, Taf. 8, Kartenbeilage 2). The northern timber watchtower was separated from the stone watchtower by 20 m and from the southern timber one by 15 m (Fig. 145). The southern timber watchtower occupied 33 m². If the documentation can be trusted, this watchtower must have been of a different construction type than the remaining timber watchtowers on the Odenwald Limes, since its walls were documented as only 0,4 m – 0,5 m wide, and therefore half the thickness that was usual on the Odenwald Limes. The corner support beams were of standard design (30 cm x 30 cm, sunken 1,2 m under the original terrain). The stone watchtower was the northernmost structure on the watchtower site; it occupied 26 m² and its walls were nearly 1 m thick. Several cornices and window columns were found in the rubble of the stone watchtower, as well as a sculptured rosette and window bezel with a building inscription of *Numerus Brittonum Triputiensium*, dating the erection of the watchtower to 146 AD (CIL XIII 6514). The palisade was documented 25 m east of the stone watchtower tower, 26.5 m east of the northern timber watchtower and 28,5 m east of the southern one (FABRICIUS 1935, 65–68, Taf. 8, Kartenbeilage 2).

A small section of the palisade between Zwing fortlet and Wp 10/34 proved to be unique in the context of the Odenwald Limes. Since the terrain on the slopes of Hochwald Hill apparently made it too difficult to dig the palisade ditch there, the Romans instead built a section

of ca. 110 m long stone wall, made of locally accessible sandstone, which was carefully hewn only on the western side, facing the Military Way, which ran parallel with the wall at a 4 m distance westwards. The original height of the structure was probably between 2 m and 3 m (SCHALLMAYER 2010, 110–111).

At least two watchtowers probably originally stood at Wp 10/34 (Im Hohen Wald), a timber and stone one. Thanks to stone robbing, almost nothing survived from the former, except a building inscription recovered in the early 19th century (KNAPP 1813, 85), which mentioned the *Cohors I Sequanorum et Rauracorum* (CIL XIII 6512), which was originally stationed at Oberscheidental. Whether this inscription truly belonged to the timber watchtower or whether it was found in the vicinity of its stone successor cannot be verified. The stone watchtower was excavated by RLK. It stood 13 m south of the timber one, originally occupied 27 m² and except for the remains of red plaster and window columns only stray finds of ballista projectiles are attested from it. The palisade ran ca. 30 m east of both watchtower positions, and faint traces of the Military Way were discovered ca. 10 m east of the watchtowers (Fig. 146), but it was already much eroded in the 19th century (FABRICIUS 1935, 74–75, Taf. 9, Fig. 1–2, Kartenbeilage 2).

Two timber watchtowers and one stone one were located at Wp 10/35 (Am Klosterwald). The easternmost, and therefore first on the course of the frontier, was the stone one. It occupied roughly 28 m², its walls were 0,9 m thick and the most important find from the 19th century excavations came from its ruins – a building inscription from the *Numerus Brittonum Triputiensium*, dating the construction of the watchtower to 146 AD (CIL XIII 6511). The masonry of the watchtower was well preserved up to the level of 1,2 m above the original surface and a plethora of other architectural parts made of local sandstone survived, including the inscription and fragments of bezel or window column/pillar. Among the finds were again recorded several ballista projectiles. Two neighbouring timber watchtowers were never excavated; the diameter of their ring ditches still looks impressive, both during a personal visit and on LIDAR, as it is ca. 19 m in diameter (the eastern one) and ca. 22 m in diameter (the western one – Fig. 147). The palisade ran 30 m north of the stone watchtower and the Military Way followed its course ca. 4 m south of it (FABRICIUS 1935, 75–77, Taf. 9, Fig. 9, Kartenbeilage 2).

The amount of evidence uncovered at Wp 10/36 (Am Fischerspfad) is practically the same as in the case of Wp 10/35. Only the stone watchtower was excavated on this site as well. It occupied 33 m² and its stone walls were 0,8 m thick (FABRICIUS 1935, 77–79, Taf. 10, Fig.

1, Kartenbeilage 2). Several fragments of cornices and lintel were found during the 19th century excavations, although the timber watchtower located 20 m west of the stone one was never excavated. Its ring ditch had a diameter of 23 m (Fig. 148). The course of the palisade is not entirely known in the vicinity of Wp 10/36 but the limited evidence from the 19th century excavations together with local topography indicates that it ran more or less on the natural ridge, ca. 20 m north of the stone watchtower (SCHALLMAYER 2010, 112). The Military Way followed its course ca. 4 m to the south (FABRICIUS 1935, 77–79, Taf. 10, Fig. 1, Kartenbeilage 2).

Two stone watchtowers and one timber one were uniquely found at Wp 10/37 (In der Schneidershecke). Since the secondary stone watchtower served as a sanctuary and was apparently still used in the 3rd century AD, it won't be discussed in detail in this thesis. It occupied 44 m² and was equipped with a staircase – therefore it was obviously entered from the ground level. A dedicatory inscription from the *Cohors I Sequanorum et Rauracorum* to Jupiter (CIL XIII 6509) was walled up into the staircase, which together with a find of three statues of Victoria, Mars and Salus effectively dated the existence of this watchtower to the period after 213 AD (based primarily on the handle of the sword of Mars – OLDENSTEIN 1980, 788; SCHALLMAYER 2010, 114). The sanctuary had tiled roofing and apparently tiles with stamps of the Eighth Legion, as well as of the *Cohors XXIII Voluntariorum civium Romanorum equitata* were used during its construction (BAATZ 1973, 138–142, OLDENSTEIN 1980, 782, 788). Apart from the sanctuary, two remaining watchtowers at Wp 10/37 were fairly standard in plan and dimensions. The westernmost of all three structures was the only briefly examined timber watchtower with a ring ditch of ca 20 m in diameter. Nothing except eroded dry masonry was documented there (FABRICIUS 1935, 80–81) and nowadays the watchtower's stone foundations are heavily disturbed by amateur investigations of the site. All that can be said about this watchtower is that it originally occupied 30,25 m² and otherwise was of fairly standard design (RABOLD 2010c, 150–152). The stone watchtower was 33 m east of it, occupying 36 m². Apparently, material from this watchtower was reused during the construction of the sanctuary (SCHALLMAYER 2012, 127–128), which was located 37 m east of the 2nd century stone watchtower (Fig. 149).

The exact position of Wp 10/38 (Am Rotkreuz) was never identified with certainty. An approximate position near the top of the Rotkreuz hill was chosen when the RLK report was compiled, based on finds of dressed sandstone masonry, presumably of Roman origin (FABRICIUS 1935, 93). Antiquarian observations also confirmed that a Roman installation stood on the Rotkreuz hill (KNAPP 1813, 22–23). The gentle mass of possibly stone ruins can still be seen on LIDAR and could represent the stone watchtower (Fig. 150). Ca. 65 m southwest of it

a circular feature was identified via magnetometry, which could have been a ring ditch (OSTENWOLDENBURG 2010, 134–135). This feature is also visible on LIDAR and may represent the missing timber watchtower on this site. Ca. 40 m west of the stone watchtower position a similar anomaly can be detected on LIDAR, but it was never investigated via geophysics.

The evidence for Wp 10/39 is based solely on the observation of possible Roman stonework in a strategic position from which there was a good line of sight in the southern direction, as well as to the fort at Schlossau (FABRICIUS 1935, 94, SCHALLMAYER 2010, 119–120). The possible watchtower is counted as a stone one, but there is actually no evidence for this attribution or in fact for its existence. Only unconvincing terrain unevenness can be detected via LIDAR on the very edge of the modern housing of Schlossau, where W 10/39 is expected (Fig. 151).

3.2.14 *Watchtowers – summary and possible reconstructions*

All the excavated evidence from the Odenwald Limes, and in fact from the rest of ORL, suggests that watchtowers were of relatively standardised design, at least from the point of view of excavated remains. The area occupied by timber watchtowers on the Odenwald Limes varied between 26 m² and 38 m². The best reconstruction of a timber watchtower at hand is currently the one at Wp 10/15 from 2010 (HUTHER 2012, 77). The structure of a timber watchtower in fact consisted of timber and stone – drystone masonry was apparently intersected with horizontal beam supports on alternating axes in individual layers (Wp 10/20, Wp 10/25, Wp 10/29). The basis of the whole construction were the corner support beams (20 cm to 37 cm wide), sunken deeply into the post pits filled with gravel and rubble to ensure further stability (Wp 10/20, Wp 10/25, Wp 10/26, Wp 10/30, Wp 10/32, Wp 10/33). These supports kept the whole structure together. The upper parts were apparently of timber construction – brick finds are so rare from the watchtower sites that their large-scale use is unimaginable. The exterior was also apparently not plastered but just planked – which corresponds to the unusually large quantity of nails in the debris of tower remains at some watchtower sites on Odenwald Limes (Wp 10/22, Wp 10/25) as well as on the ORL in general (HUTHER 2012, 78–79). The height cannot be reconstructed from the excavated remains with certainty, but it was, except for the stability of the construction, limited by the length of corner support beams. Traditionally a minimal height is considered to be 7,6 m (FABRICIUS 1935, 27, 44; SCHALLMAYER 2010, 41, 82), but the foundations would not have had a problem supporting a 10 m high structure. The corner posts are usually considered to have been at least 11,5 m tall, and at some sites on ORL were sunk up to 1,9 m below the original terrain (HUTHER 2012, 78, 83–84). Three storeys are

usually reconstructed, with the middle one serving as an entrance, which was approached by a ladder. Movement between storeys must have also been enabled via ladders since no trace of a staircase was ever found, not only on the Odenwald Limes but on the whole ORL (HUTHER 2012, 85–87). Although windows are expected, there is no evidence for them. Roofs probably had a tent shape but again there is no evidence that this was uniform across the Limes. Traditionally it was believed that shingle roofs were provided for the timber watchtowers, but these seem to be impractical for tent-shape roofs. Instead the majority of the reconstructions work with simple horizontally laid timber, trimmed, butted and grooved planks laid on a wooden frame, at least based on the evidence from Osterburken (HUTHER 2012, 88–90). Fences were probably provided around the early watchtowers (Wp 10/6, Wp 10/8, Wp 10/16, Wp 10/30) but this solution was apparently abandoned with the construction of the palisade.

The locally obtainable material was predominantly used for the construction of stone watchtowers, so the majority in the Odenwald region were constructed from either red or grey sandstone. Although some stone watchtowers may have had a shallow encircling ditch (none was ever attested in the studied area, but stone watchtower at Wp 10/81 had one – SCHALLMAYER 2010, 153–154), no evidence for this was found in the studied sector and generally one should not expect ditches around structures like these very often – even ditches around timber watchtowers served primarily as a means of drainage, which was unnecessary for the stone-founded-only stone watchtowers. The area occupied by stone watchtowers varied between 25 m² and 36 m², although certain exceptions to this existed not far from the studied sector (e.g. Wp 10/44 – FABRICIUS 1935, 97–98, Taf. 2, Fig. 2). The stone watchtowers were predominantly constructed of stone, possibly with some timber bracing. No massive employment of tiles was documented with the exception of Wp 10/37. The majority of stone watchtowers were probably accessed like the timber ones – via a ladder into the middle floor (with the exception of Wp 10/22). The absolute height of the stone watchtowers is shrouded in the same uncertainty as their timber predecessors – but it is most logical to assume that they were of similar height, taking into consideration that they probably served the same purpose. Windows were certainly provided since their sculptured central pillars were found among the rubble of Wp 10/11, Wp 10/33, Wp 10/34 and Wp 10/35. Other parts of watchtowers were obviously adorned with sculptured architecture such as lunettes or cornices and building inscriptions, although the exact positions of these on the structures are unknown. Usually they are expected above doors or in the vicinity of/above the windows. The walls of the watchtowers were laid in mortar and plastered, although the general evidence for that is poor (Wp 10/34). The foundations were ca. 1,2 m thick while the thickness of stone walls themselves varied

between 0,75 m and 1 m. The roofing was probably the same as for the timber watchtowers, or at least the depictions of stone watchtowers on Trajan's Column suggest this (ANTONESCU 2009, 118, Fig. 2 = Scene I).

The garrison of both timber and stone watchtowers can only be roughly estimated – there is currently no archaeological evidence for its strength. One should consider only the middle floor of both timber and stone watchtowers as habitable, space must have been scarce here since watchtowers were not provided with external storehouses and soldiers must have lived there with all their belongings and perhaps even some of the supplies. For that reason, the size of the watchtower crew is estimated as only four people, possibly with one extra man – a senior soldier in command of the watchtower – at best (BAATZ 1976, 42–45).

The living conditions on watchtower duty cannot be reconstructed based on the evidence at hand obtained via archaeology. It is certain that soldiers were cooking their own meals on fireplaces outside the watchtowers (see Wp 10/10), that they were surprisingly well supplied not only with common kitchen ware but also with *terra sigillata* and that their diet was relatively varied (Wp 10/25).

3.2.15 *The abandonment of the Odenwald Limes*

The abandonment of the Odenwald Limes was traditionally believed to have taken place between 148 AD and 161 AD, and at least the majority of forts, fortlets and watchtowers were not occupied after the second date. One of the last datable activities on the Odenwald Limes took place in 148 AD, when the officer of the Eighth Legion erected an altar at Heilbronn–Böckingen fort (CIL XIII 6472, CIL XIII 6469), well outside the studied sector of Limes. The last known building activity took place in the studied sector between the forts at Wörth and Schlossau in 146 AD (construction of several stone watchtowers) but it should not be expected that the frontier was immediately abandoned after that.

The fort at Wörth was certainly exceptional in the context of the Odenwald Limes, since it was occupied until the fall of the Limes. It was rebuilt in a similar manner as the eastern Milternberg fort, for which the time of reconstruction is well dated to the period after 233 AD (SCHALLMAYER 2010, 74). The positioning of this fort alone means that it should naturally be included to the riverine frontier on Main (Mainlimes, Strecke 6), which was simply extended to the eastern Milternberg fort after the abandonment of the Odenwald Limes and of forts like Hesselbach. Although there is no exact dating for Wörth, during the limited excavations and non-destructive survey was never found any indication that the site was at least temporarily

abandoned. The existence of an extensive vicus and building activity after the Alemannic raids in 233 AD indicates that this site continued to be part of the Roman frontier system well after the general abandonment of the Odenwald Limes.

The Odenwald Limes was apparently not deserted. For a long time it was accepted that it was left because of general push forward, practically into the *Agri Decumantes* in *Germania Magna*, which may have taken place in the late reign of Antonine Pius (SHA, *Historia Augusta*, Antoninus Pius 5.4), possibly under the governorship of Gaius Popilius Carus Pedo (ALFÖLDY 2004, 7–21). The oldest construction activities from the Vorderer Limes were for a long time dated to 161 AD (CIL XIII 6561), and since several units were attested on both these frontiers, the push forward must have taken place between these two dates.

The reason for the abandonment of the Odenwald Limes may have varied. Although the traditional preferred the explanation is that the frontier in *Germania Superior* was reorganised in order to locate the army in the vicinity of a large density of Germanic settlements in nowadays Baden-Württemberg and Bavaria (SCHALLMAYER 2010, 29; BREEZE 2011, 76–79), there are also other possible explanations. The push forward could have been a reaction to the growing weakness in control of the frontier zones in *Germania Superior* and emerging struggles with Germanic societies that defined most of the interactions between the Romans and Germanic tribes in the late 2nd and entire 3rd century AD. The annexed area was largely depopulated (THIEL 2009, 138), and therefore this shift of the frontier line could hardly be called a conquest. A new line went through more easily controllable terrain, and it was also much shorter, which allowed a greater density of frontier posts (FABRICIUS 1933, 12–14; BAATZ 1975, 177–192). The ultimate reason for the reorganisation or “retreat forward” could have been the actual depletion of the garrison of *Germania Superior* in the form of vexillations to other provinces, most notably *Britannia*, in the respective time period (SCHEUERBRANDT 2012, 34). This logic may sound odd, but the formation of a new frontier with more densely spaced outposts could have been a relatively logical reaction to an acute shortage of manpower.

The current archaeological evidence suggests that the abandonment of the Odenwald Limes took place in 159 AD. Some units remained for a period of time on the old line, some temporarily occupied two posts at the same time and some posts on the former frontier were occupied for a slightly longer period than the others. That is more or less what would be expected in the orderly abandonment of a frontier. The erection of the timber station of *Beneficari* at Osterburken on Vorderer Limes can be dated to 159 AD (SCHALLMAYER – KORTÜM 2005, 246), while the absolutely last erected altar at Neckarburken (well beyond the

studied sector but still part of the Odenwald Limes, Strecke 10, but still part of the frontier abandoned apparently together with studied section of the Odenwald Limes) can be dated to 158 AD (AE 1986, 00523). The Osterburken fort could have hardly stood alone on the Vorderer Limes, so it is reasonable to assume that the building activity there can be connected with the emergence of a new frontier, which from a tactical point of view made the string of sentry posts on the Neckar, as well as in the Odenwald mountain range, obsolete. The Military Way may have been used by some travellers, but the Main was certainly better for the reinforcing capacity of the Roman army and its supply, and the new frontier line was established south of the last fort on the Main (Miltenberg East), which could have easily operated as the connecting line. Despite the area of the former frontier slowly “Romanised” (see the case of villa at Seckmauern on p. 170–171), Roman army apparently did not care about the security of the traffic in the Odenwald mountain range after the more convenient supply and reinforcement route for it was established eastwards.

If one at least partially accepts the traditional point of view that the Odenwald Limes was acting as a controlled corridor for effective communication between large assemblages of the Roman army in Wetterau and on the Neckar (THIEL 2009, 140–141), then its wholesale immediate abandonment would not be expected. Instead, it would be logical that certain nodal outposts outlived the frontier, as did the existence of a road (Military Way), which the whole section of the Limes may have originally been built for. So far, the evidence for prolonged occupation of at least some military sites on the Odenwald Limes is piecemeal at best. Finds from Wp 10/54 speak for a prolonged occupation of this site (DIEMER – SCHALLMAYER 1992, 108). *Vicus* at Schlossau was only partially abandoned with the departure of the fort garrison (RABOLD 2005a, 125–129; RABOLD 2007, 105–112), as probably also happened at Hesselbach. A certain amount of activity was identified in the post-occupation period at both sites (see p. 167–168, 175–176). This still only points to an insubstantial occupation of the studied sector of the Odenwald Limes and this occupation is not even military. Whether Wp 10/37 was reoccupied in the late 2nd century AD or sentries kept their presence there continuously and eventually enhanced the sanctuary built in the vicinity of the old watchtower sites cannot be determined with certainty (SCHALLMAYER 2012, 107–109). It is important to note the logic that with the establishment of a new frontier line, which enabled communication between large accumulations of units in *Raetia* and *Germania Superior*, a military presence was unnecessary from the Roman point of view. The Odenwald Limes thus existed solely for the army to have secure communication lines, and when these were secured outside the Odenwald region, the Roman army ceased to care about the security there/the region was already pacified enough that

no military presence was needed there. The second point is actually more probable because the civilian settlement grew in the late 2nd and 3rd century AD at several locations on the former Limes (SCHALLMAYER 2010, 55–58).

Optimistic estimates suggest 185 AD as a time when all the sentry posts on the Odenwald Limes were definitively abandoned (with the exception of the fort at Wörth, SCHALLMAYER 2012, 104), but there is actually little evidence for the sector of Odenwald Limes studied in this thesis. 185 AD is valid only for the fort at Neckarburken, where the prolonged presence of *Numerus Brittonum Elantiensium* is attested. This unit remained for longer at Neckarburken (AE 1986, 00523 – SCHALLMAYER 1984b, 453–464), but whether only a detachment remained there cannot be verified. It is certain that it was completely moved to Osterburken by 185 AD at the latest (SCHALLMAYER – KORTÜM 2005, 246).

No further exact dating, can be offered for the studied section of the Odenwald Limes, and therefore, it seems that the majority of the troops in question moved in 159 AD (SCHALLMAYER 2012, 105) although some building activity at Vorderer Limes may still have predated their arrival (ALFÖLDY 2004, 13–16). This, however, can be presented only as an estimate based on limited evidence – the majority of forts, fortlets and watchtowers on the studied section of the Odenwald were never excavated enough to yield more information than an approximate date for their abandonment.

Physically the abandonment manifested itself via demolition works. The evidence from Wp 10/25 indicates that stone watchtowers were eventually burned down (WAGNER 1994, 159–160), but this may not have been the solution always applied– certainly the material from the stone watchtower at Wp 10/37 was in a condition which allowed its reuse in the construction of the sanctuary (SCHALLMAYER 2012, 127–128). Evidence from excavated forts clearly indicates that leaving was orderly, and the buildings were salvaged for reusable material, such as nails (BAATZ 1973, 63–66). Apparently, the walls were not levelled. Civilian settlements survived in a reduced form, at least for a short period of time (RABOLD 2010b, 144–149, SCHALLMAYER 2012, 101–107).

3.3 Interpretation via spatial analyses

3.3.1 *Introduction*

In order to provide a comparison of two Roman frontiers, the author initially tried to use a similar methodology for spatial analyses of the Odenwald Limes. But because the frontiers had different histories, certain decision making and eventually also alterations in approach had to be made when it came to the interpretation via spatial analyses.

While the Antonine Wall was built, probably more or less as it was planned and then underwent through only certain small changes (see p. 83–88), the Odenwald Limes had quite a more colourful history and developed over decades from a simple Military Way to a string of outposts and forts fronted by a linear barrier (see p. 157–161). The longer period of existence of the Odenwald Limes seemed to be a special challenge, because up to three watchtowers stood on certain watchtower posts in succession. They were not located on entirely identical spots, but nearby each other (see p. 157–161 and Table 11).

Therefore, to keep the methodology similar to subchapter 2.3, the Odenwald Limes is studied below in its early phase of existence, when the frontier consisted of a string of timber watchtowers, forts and (possibly also, see p. 258) fortlets connected by a road. From point of view of spatial analyses the abandonment of timber watchtowers succeeded by construction of the stones ones brought no change to the frontier control except of the northernmost part of the studied sector, where the fort at Seckmauern was replaced by fort at Wörth (see p. 168–171).

The palisade was generally not included in any study, and if mentioned, it was put in the context of the course of the Military Way following it and results of the cost path, or the question was asked as to whether its approximate course (based on FABRICIUS 1935, Kartenbeilage 1–2 and remains visible on LIDAR) was visible from individual sites. That is also the reason why the Antonine Wall itself was not studied in detail via spatial analyses in a previous chapter, because there would have been no comparison provided (p. 15–16, 97–98, 268–269). Because at certain watchtower sites a multitude of watchtowers has either been excavated or they can at least be expected there, the author initially studied separately each attested tower as an independent feature via the analyses mentioned below. But because the results were almost always identical for all the towers on one watchtower site, the viewshed results summarized below are always valid for the whole site if not stated otherwise, while the distances mentioned in cost path analysis are always from the most central watchtower on the watchtower site, either on a north–south axis or an east–west axis if not mentioned otherwise.

One of the fundamental differences between the Odenwald region and the Forth-Clyde isthmus was the form of vegetation coverage, specifically the forestation of the Odenwald region. Unlike the largely deforested Antonine Wall and its environs (p. 93), the landscape of the Odenwald Limes was heavily forested prior to the establishment of the Limes (HAVERSATH 1984, 22, SCHALLMAYER 2010, 24, 35, see p. 157). Despite the fact that Romans probably did some woodland clearance during the construction of the frontier (Frontinus, *Stratagems* I.3.10), its extent can be only poorly reconstructed (TRUNK, B. 2007, 51, BAATZ 1975, 40, SCHALLMAYER 2007, 13–14). In theory a stretch of forest at least 150 m wide had to be cut eventually on both sides of the Military Way to accumulate enough seasoned oaks in average central European forest to build the palisade added during the reign of Emperor Hadrian. The author of this thesis was kindly provided with this information by Dr Andreas Thiel (pers. comm. 2019), who received it from forestry officials of Baden-Württemberg already in 2003. For construction of a plethora of watchtowers as well as forts and fortlets even more material was needed, and so landscape clearance at least at the magnitude of a 300 m-wide corridor can be expected at later stages of existence of the frontier. Because of the absence of any other good data for the amount of woodland clearance on the Limes in general, visibility studies initially used the 300 m-wide corridor alongside the known course of the frontier in area analyses performed where no tree coverage was allowed, if not stated otherwise. In other cases, when the Odenwald Limes was following a natural ridge in the landscape, the forest-blocking function was also ignored because the trees would have had to be unnaturally high to block the intervisibility between Roman sites beyond the corridor. In other cases, the tree coverage could have had an influence on the visibility and the intervisibility, and these cases are discussed via detailed terrain profiles, which further explains the extent to which the trees could have obstructed the lines of sight.

3.3.2 *Spatial analyses and the Odenwald Limes – questions and goals*

Certain types of questions were the same for both the Antonine Wall and the Odenwald Limes. Were forts, fortlets, and watchtowers on the Odenwald Limes intervisible with each another? To what extent was the intervisibility important for planners and surveyors of the frontier? For the Odenwald Limes, were there conditions just for lateral signalling, or also for direct signal communication, as specified by Dr D. J. Woolliscroft (WOOLLISCROFT 2001, 109–111). Does the distribution of sites throughout the landscape indicate that they were positioned only to be intervisible, or was there any other spatial pattern operable, such as alignment of the sites to one or more lines? Were the individual features distributed alongside the frontier on a regular pattern?

In contemporary conditions, the question of visibility between individual frontier features cannot be verified in any other way than via spatial analyses in an artificial environment, because the area of Geo-Naturpark Bergstrasse-Odenwald, where the studied sector of Limes is located, is today covered by dense coniferous forest, which blocks the lines of sight between sites. At the time of their construction, they were located on cleared stretches of land inside mixed forest.

Another set of questions also asked in the case of the Antonine Wall concerns the visibility to the landscape in general. What kind of landscape observation offered the spots chosen for watchtowers, forts and fortlets? In which areas did the sentries at the respective sites have the best view? Were any areas out of the line of sight for sentries from permanent installations? And if yes, can we suspect some yet unidentified Roman sites, most probably watchtowers, to have existed on spots with favourable views in these neglected areas? Could fortlets, attested archaeologically only in the last phase of existence of the Odenwald Limes (see p. 157–161, 176–179), fit to any intervisibility pattern present on the Limes already in its early period of existence? Should we thus expect timber–and–earthen predecessors of stone fortlets on the Odenwald Limes?

Another group of questions concerns how well positioned the individual frontier sites were in terms of accessibility. The Odenwald region is today and no doubt was in antiquity topographically different than the Forth-Clyde Isthmus. The complexity of the terrain may have required the frontier surveyors to adapt to the landscape more than would be necessary in the flat areas where achieving good visibility was not that laborious a task. That is one of the main reasons why this study includes not the whole Strecke 10, as defined by RLK, but only the mountainous stretch of the frontier between the Wörth and Schlossau forts. Otherwise similar questions of accessibility are asked in the case of the Odenwald Limes as in the case of the Antonine Wall. Were the forts, fortlets, and watchtowers located where they were to block the movement on the north–south axis or on the east–west one? Were they located near convenient river or stream crossings or on higher ground, which offered sentries better views of what was going on in the landscape and also eventually provided the garrison with a better defensive position? Specifically, one theory is tested: the primary function of the Odenwald Limes may have been to guard a safe and well defined passage for troops stationed in the vicinity of the river Main, when reinforcing the army stationed on the Neckar, and vice versa (FABRICIUS 1935, 12; BAATZ 1973, 9–12; TRUNK 2007, 50–51; SCHALLMAYER 2010, 26). So the positioning of individual features of the frontier is specifically tested with regard to their proximity to the ideal north–south communication or access to it from the outside.

The main goals can therefore again be summarized as the spatial interpretation of the Limes. The potential answers cannot be taken as more than suggestions or logical implications, which can point to a way the frontier was surveyed or to the prerequisites for the positioning of individual installations on the frontier, based on their landscape setting. The actual comparison with the Antonine Wall is offered in a further chapter.

3.3.3 Spatial analyses and the Odenwald Limes – methodology of viewshed analysis

Practically the same methodology was used for the Odenwald Limes as for the Antonine Wall in terms of the viewshed analysis. As terrain data set were utilized again LIDAR data (for intervisibility of individual sites), in combination with ALOS World 3D data (for visibility to the broader stretches of the landscape, principally beyond the borders of present-day Hessen; see Appendix II on p. 237–241). All the analyses were performed in ArcGIS 10.4.

The viewsheds for watchtowers were again calculated from one central point, for fortlets from the main gate facing the frontier line, and for forts from the position of three or four respective gates. The majority of precise site positions was deduced from image analysis of LIDAR data. Only in a few instances was it necessary to employ either RLK (FABRICIUS 1935) or more recent excavation reports (see Table 11).

Individual viewsheds were calculated from a position of 9 m above the model surface, compensating for the elevated position of the observer on a tower (OFFSETA). A similar compensation (9 m) was also used for the positions of the observed (OFFSETB, see p. 96) in order to calculate the mutual intervisibility between elevated points. A value of 9 m as a height of the watchtowers was chosen as a compromise between the traditionally stated 10 m on ORL and the suggested minimal height of 7,60 m by RLK (FABRICIUS 1935, 27, 44; SCHALLMAYER 1984, 41). For verification, viewsheds were calculated for several sites with different offsets, but the results, in terms of both the general visibility and intervisibility between sites, were more or less the same with reasonably higher offsets and also with lower ones until the offset value was decreased below 7 m in the case of watchtowers and below 5 m in the case of forts.

3.3.4 Spatial analyses and the Odenwald Limes – methodology of cost path analysis

The model mentioned above was altered for cost path analysis. The main goal of these alterations was to remove the manmade features added to the landscape in the late middle ages and modern era and thus simulate how the landscape could have looked prior to the Roman period. In this artificial landscape the standard cost path was calculated between known traces of Roman road near Wp 10/5 and the fort at Hainhaus and between the Würzberg fort and Wp

10/32. In this project was studied the proximity or distance of a calculated ideal road to other traces of Military Way on the Limes as well as the proximity of the calculated path to individual forts, fortlets and towers (see Table 12 and p. 230–232).

In terms of local topography, the accessibility of individual sites was studied in the same way as in the case of the Antonine Wall. The slope model was interpreted in radii of 0,3 km, 1 km, and 1,5 km, and two or more profiles were exported, one on the approximate course of the Military Way and the palisade, mostly in a north–south direction, and the other, mostly on an east–west axis, symbolizing the elevation change when trying to cross the Limes.

3.3.5 *General visibility to the landscape*

The majority of sites on the Odenwald Limes offered relatively restricted line of sight to the broader landscape. Some sites were practically “blind”, and the 9 m elevation above the ground did not help to increase their capacity to offer views beyond their immediate vicinity. Watchtowers had generally better lines of sight than forts and fortlets (see area observable in a 5 km perimeter in Table 13).

The fort at Wörth was oriented towards the river Main. It had the best line of sight on that river and on its right bank, where the town of Erlenbach am Main now stands (Fig. 152). Apart from what has been mentioned, the general line of sight from all the fort gates was restricted to only the immediate vicinity of the fort, and therefore only an area of 7 km² was visible from the site in a 5 km perimeter (see Table 13).

The fort at Seckmauern shows even worse results. Except for its immediate vicinity, from the fort gates one could not see more than a 0,7 km-wide stretch of the landscape to the east and to the west. The line of sight immediately to the north and to the south was restricted by complex terrain. The only area where the sentries could have had any meaningful line of sight was a probable course of the palisade to the south-west of the fort (Fig. 153), where in present-day Hansbatzenfeld lay Wp 10/5 in 0,7 km distance (see Table 13).

From the fort at Lützelbach the sentries had clear line of sight to a 0,5 km perimeter around the fort (Fig. 154). Still, this fort had better line of sight beyond the frontier than most of the other forts, extending to fields in present-day Kirchsberg, 1,2 km east of the fort, as well as to western slopes of the Hardsteinshecken hill.

The edges of direct line of sight from three gates of the fort at Hainhaus lie 0,3 km – 0,5 km away from the fort. From the site one had a generally better view to the north and to the south, while to the east the visibility was limited and potential sentries had no line of sight to

the west at all (Fig. 155). The Unterstriet and Oberstriet hills to the north-east of the fort and the western slopes of the Schwedel hill to the east were well visible. In the south-eastern direction, the sentries could in theory see the northern outskirts of present-day Vielbrunn village. All in all, less than 9 km² of landscape was visible from this fort in a 5 km perimeter.

From the location of the Roman fort at Eulbach, the sentries had the best line of sight to the course of frontier in the northern and southern directions over a distance of 2,5 km (Fig. 156). Immediately east the line of sight was slightly restricted beyond the border of present-day Bavaria, so in theory one could see only up to 1,5 km without obstruction from trees. To the north-west, west, and south-west the sentries from this fort had almost no line of sight.

From the position of the Roman fort at Würzberg, the line of sight was very restricted except in the south-western direction, where one had fairly good views of the eastern slopes of the Baurück hill and the location of present-day Bullau village (Fig. 157). In other directions the line of sight was restricted to a distance less than 1 km beyond the frontier line as it was demarcated by palisade. All in all, 7,26 km² of landscape were visible from this fort in a 5 km perimeter.

From the fort at Hesselbach, the course of the eponymous stream was observable up to 1 km south-west of the fort. Apart from that, one could see to the boundary of present-day Bavaria and Baden-Württemberg 1 km east of the fort (Fig. 158). Despite the fact that the view to the north was good up to 1,5 km in distance, to the south the horizon for sentries at Hesselbach lay 0,7 km away from the fort. Only 5,5 km² of landscape was observable from this fort in a 5 km perimeter.

From the gates of the last fort in the study, at Schlossau, the whole present-day eponymous village was visible to the south. Not much could have been seen in the northern direction because the Rotkreuz Hill blocked the view. The fort sentries had good line of sight to the 3 km stretch of the Teufelsbach river valley to the north-east and east, but not much more (Fig. 159).

If the lines of sight of forts can be described as inferior, the visibility from three fortlets on the Odenwald Limes was really poor. Only the Windlücke fortlet had any meaningful line of sight to the landscape. Despite the fact that one could not see from the position of this installation immediately east beyond the frontier, where present-day Haingrund village now lies in the valley, sentries had good line of sight further in that direction on the western slopes of Boxberg Hill in present-day Bavaria. Good line of sight was at hand also in the south-eastern

direction on the slopes of Dickhacken Hill up to 2 km from the fortlet (Fig. 160). Visibility was also good to the west, in the whereabouts of present-day Breitenbrunn village and the course of Breitenbach stream. Thanks to all of this, the sentries on the Windlücke eastern gates could view 10 km² of landscape in a 5 km perimeter.

Topographical positioning of the fortlet at Zwing effectively blocked any line of sight to the north and south (Fig. 161). Beyond the course of the palisade, the sentries from this site had good line of sight only to the area where present-day Waldleiningen Schloss stands, 1 km from the fortlet. Apart from that, only the confluence of Hesselbach and Itterbach streams could have been seen from the site in the west, at a distance of 1,2 km from the fortlet.

Similarly inferior viewshed results can be established for the Seitzenbuche fortlet. From its position not much more than 0,6 km to the east and west was visible, and only a narrow stretch of area beyond the frontier to the north was observable (Fig. 162). Apart from that, only the course of Waschklinge stream was visible to the south and south-west. For that reason, only a 5,6-km stretch of land was observable from this fortlet in a 5 km perimeter.

The quality of lines of sight of individual watchtowers varied considerably. Wp 10/1 is not included in this study for reasons mentioned in the previous chapter (p. 181–182). Wp 10/2 had good line of sight to the area where the fort at Wörth stood and beyond it where present-day Erlenbach am Main, Klingenberg am Main, and Trennfurt villages are located to the south-east. The area of present-day Seckmauern village was visible from the site as well as the broader stretch of land to the west, where the eponymous fort stood. One also had fairly good line of the sight to the north to the valley of Main up to 3 km away from this possible watchtower (Fig. 163).

Practically the same could have been seen from the Wp 10/3 with the exception of the view to the south-west, which was blocked by the hill on which the Seckmauern fort stood (Fig. 164). From any possible watchtower around the location of Wp 10/4, practically the same could have been seen as from the Seckmauern fort or less (Fig. 165). The viewshed was calculated from the position “Bei der feuchten Mauer” (see Table 11) but practically the same results would have an observation platform located at the very centre of the former Seckmauern fort, where actually the watchtower or small fortlet should be expected (see p. 257–258, 269).

From the position of Wp 10/5 the line of sight was relatively restricted. The course of palisade was visible up to the position of 0,7 km distant Seckmauern fort and more or less the same distance to the south-west, towards the position of other watchtower sites. Apart from

that, sentries from the position of Wp 10/5 had an average line of sight to the north and west up to 1 km from the site (Fig. 166). To the south, beyond the frontier, the slopes of Geisberg and Kammerschlag hills were visible at a distance of 2,5 km.

These hills were visible also from the position of both towers at Wp 10/6, with practically the same distance (Fig. 167). Apart from that, the site offered only limited line of sight to the north, and in the eastern direction not much could have been seen beyond 1 km from the site, while to the south and south-east the horizon lay on the summit of Kirchberg hill.

From Wp 10/7 sentries could see the frontier area to the south, up to the position of Wp 10/8 beyond the Lützelbach fort, so in theory a 1,5 km-wide stretch of land in the vicinity of the palisade. To the north only the 1 km stretch of frontier was visible in the Hansbatzenfeld area. Further beyond the Limes, the area between present-day Haingrund and Seckmauern villages on the border of Hessen and Bavaria was visible from Wp 10/7. In closer distance, the sentries must have had a comfortable view of the Kirschberg hill immediately east of the watchtower's position (Fig. 168).

From the position of Wp 10/8 the potential sentries had line of sight only to 0,25 km² of the landscape in the immediate vicinity of individual watchtowers. To the north the position of the fort at Lützelbach was visible as well as the position of the present-day eponymous village 2,5 km further to the north-east. The area beyond the frontier immediately to the east was not visible from the watchtower site, but again, a wide stretch of hills between present-day Hainhaus Park für grüne Technologien and Seckmauern village was visible in the area of the current border between Hessen and Bavaria. To the west, the sentries had some line of sight to the valley of Lützelbach stream, so the general visibility from the watchtower site was not unduly restricted (Fig. 169).

Wp 10/9 had fairly good line of sight to the west, south, and east, to the areas where today lie the villages of Breitenbrunn, Haingrund, and Seckmauern. The area visible in a 5 km perimeter was almost 19 km² (see Table 13), despite the fact that the direct line of sight to the north ended 0,25 km north of the watchtower site (Fig. 170).

Wp 10/10 had inferior line of sight in comparison to Wp 10/9. To the north not much more than a stretch of land between present-day Breitenbrunn and Haingrund villages was visible (somewhere in the middle between those two stood the Windlücke fortlet). To the south less than 1 km of the landscape was observable from the Wp 10/10 and altogether less than 10 km² of landscape was observable from Wp 10/10 in a 5 km perimeter (Fig. 171).

Wp 10/11 also had very restricted line of sight. Only to the north-east, the area of present-day Haingrund was visible from it apart from the immediate 0,3 km-wide perimeter around the watchtower's site. A certain amount of line of sight at this position was also offered to the west, beyond present-day Hainhaus Park für grüne Technologien, and to the east, beyond the frontier on the northern slopes of the Dickhecken hill (Fig. 172).

From Wp 10/12 Roman sentries had practically no line of sight beyond the palisade to the east. This was compensated by a relatively fair view on the fort at Hainhaus to the south and the area immediately west of it. Further south, the position of the fort at Eulbach together with a certain amount of surrounding landscape was still visible 6,8 km in the distance. A certain amount of line of sight at this position was also offered to the west, beyond present-day Hainhaus Park für grüne Technologien, just like at Wp 10/11. Sentries had a surprisingly good view to the north, where the area between today's Breitenbrunn and Haingrund villages was visible together with the position of the fortlet at Windlücke (Fig. 173).

Wp 10/13 offered good views only to its immediate surrounding area. The watchtower's line of sight covered a roughly elliptical area on the map, 1,5 km wide on the north-south axis and stretching on either side of the palisade to more than 2 km in the distance. To the south-east the outskirts of present-day Vielbrunn were visible at a distance of 2 km (Fig. 174).

From Wp 10/14 the sentries had good line of sight for the area of the palisade and beyond it in the south-eastern, eastern, and north-eastern direction up to a distance of 2 km from the watchtower site. Not much more was visible from this spot except for the broader surroundings of Eulbach fort (Fig. 175).

Two-dimensional graphical representation of viewshed results for Wp 10/15 provides no coherent pattern except for the fact that the site offered no meaningful line of sight anywhere except its immediate surroundings in a 0,5 km perimeter (Fig. 176). Beyond that, not much could have been seen in the east, where Vielbrunn currently lies. To the west almost nothing was visible at all, and in the northern and southern directions only the positions of other watchtowers were visible, with no line of sight to the broader stretches of the landscape surrounding them.

Both watchtowers at Wp 10/16 had similarly inferior line of sight (Fig. 177). Again to the east and west one could not see from the watchtower position more than 0,3 km away, but on the north-south axis the lines of sight went as far as 0,7 km away from the watchtower site and ended more or less precisely on the positions of neighbouring watchtowers.

It was the position of Wp 10/17 that offered possible sentries a meaningful line of sight to the surrounding area (Fig. 178). To the north-east, the area of present-day Vielbrunn village was visible up to 2 km in the distance while the line of sight directly to the east, beyond the palisade, was restricted only to 1 km. To the south and south-east, the frontier area was in visual contact with the positions of the watchtowers in discussion up to 1,5 km in distance, and directly to the south, one had a good view as far as to the position of the Eulbach fort, 3 km away. At the same distance to the north stood Hainhaus, which lay more or less on the edge of the line of sight from Wp 10/17 (Fig. 178).

Wp 10/18 had better line of sight to the north and to the south than to the east. To the west almost nothing could have been seen from its position. In the southern direction, the Eulbach fort and its surroundings were visible, while in the northern direction, the view was more restricted to the area of present-day Vielbrunn village and positions of nearby watchtowers on a low ridge. Directly to the east one had good line of sight on the southern slopes of the Frankfurter Rain hill and on the current border of Hessen and Bavaria (Fig. 179).

The general line of sight from Wp 10/19 was again more localised. This position offered the observers a view only to the position of Eulbach fort some 1,5 km to the south, while to the east the horizon lay no further than 0,3 km away from Wp 10/19. Only to the north did one have a better view, as far as to the position of Wp 10/17, a distance of 1,5 km (Fig. 180).

More or less the same was visible from Wp 10/20, with the exception of the eastern direction, where the horizon lay a bit further away, 0,8 km from the watchtower site (Fig. 181).

The area observable in a 5 km perimeter from Wp 10/21 km constituted only a small elliptical section covering 2,6 km², which represented the nearest vicinity of this watchtower site. Beyond that, nothing substantial was visible (Fig. 182).

Wp 10/22 was slightly better in terms of landscape observation, having limited (but at least some) line of sight to the location of present-day Ernsbach village to the west, as well as to the location of today's Würzberg village in the south-east. Apart from that, the course of the palisade was visible from this spot as far as to the position of the fort at Eulbach, 1,6 km to the north. Because the watchtower's position was chosen 0,2 km west of the Mangelsbach hill, sentries had no meaningful view to the east (Fig. 183).

The position of the possible watchtower site Wp 10/23 offered relatively good views of the local topography to the east up to almost 2 km in distance, where the boundary between present-day Hessen and Bavaria lies. Thus, the area north and south of today's Würzberg village

was visible as well as the position of this modern settlement itself. To the north, the line of sight was a bit more restricted but still generally good up to the position of the Eulbach fort, while to south, only a 0,7 km stretch of the frontier area was visible together with watchtower site Wp 10/25 on Roter Buckel hill, 1,6 km away. To the west not much more than a 0,3 km wide stretch of the landscape was visible (Fig. 184).

The position of Wp 10/24 offered almost the same view of the landscape as its northern neighbour with the exception of a view to the south-west, on the slopes of the hills above present-day Erbuch village, which was visible from Wp 10/24 but not from Wp 10/23. Both sites had no line of sight to the south, where the fort at Würzberg lay, but both had equally good line of sight to the Eulbach fort, from which Wp 10/24 was separated by 3,3 km (Fig. 185).

Wp 10/25 was another example of a watchtower site with an excellent view of the landscape. An area of almost 11 km² was observable in a 5 km perimeter. In the line of sight of sentries on this spot the positions of Eulbach and Würzberg forts were visible, although for the first not much more than the fort itself was in the line of sight. A wider stretch of frontier area from Wp 10/25 was visible 1,5 km to the north, while to the south, one could see as far as 2,7 km away, to the position of Wp 10/27. Immediately to the east of the site, the summit of the Wasserlöcher hill blocked any further view, 1,5 km in the distance. The naturally good position of Wp 10/25 offered a view on the hills to the south-west of the site as far as to the location of present-day Bullau village at a distance of 4 km (Fig. 186).

The further watchtower site Wp 10/26 stood already in present-day Bavaria, and it was once again a clear example of a site with only local line of sight. The area visible from the watchtowers on this site had a width of almost 2 km on the east–west axis but a breadth of only 1 km on the north–south axis. The only reason why the amount of area observable in a 5 km perimeter was not utterly inferior in this case was the view to the south-west of the site, where today's Bullau village lies (Fig. 187).

Wp 10/27 was in the result of the viewshed analysis similar to its northern neighbour, but it had comparatively better line of sight to the north and south, precisely on the course of the palisade (Fig. 188). To the north one could see as far as to the current boundary of Hessen and Bavaria near the Würzberg fort, while to the south the elevated sections of frontier were visible as far as Saufeld hill, 3,5 km away. In the area beyond the frontier, some elevated landscape features were visible in the east as far as 1 km from the site, but coherent line of sight ended 0,3 km away from the watchtowers.

From both watchtowers at Wp 10/28 the sentries had equally good views to the course of the palisade and the Military Way, especially to the south, as far as to the Saufeld hill and then after a certain gap also to the Hesselbach fort and the broader stretch of landscape east of it. To the east, the sentries had only limited line of sight, but results of the viewshed analysis cannot be entirely followed in this case, because the edge of the LIDAR section of the model is less than 0,3 km east of the watchtower's site. The reason why in a 5 km perimeter 8 km² of the landscape was observable from Wp 10/28 is based on the fact that the sentries had relatively good line of sight to the south-west, west, and north-west, principally to the area 2 km away, where the current village of Bullau lies (Fig. 189).

Almost the same line of sight as Wp 10/28 was available at Wp 10/29 (standing directly on the current Hessen/Bavarian border), which had further a slightly better view to the area east of the Hesselbach fort, while its line of sight to the broader surroundings of Bullau village was more restricted (Fig. 190). The watchtowers had good line of sight to the valley of Breitenbach river, immediately east of it, and not much further beyond that.

Wp 10/30 again had good line of sight only immediately east of the respective watchtowers to the valley of Breitenbach river (Fig. 191). The view to the north was mostly restricted by terrain, just like it was to the west and south with the exception of the area where the fort at Hesselbach stood, and further east of it, where already several preceding watchtower sites had good line of sight. To the north-west, the area of present-day Bullau village was visible, as well as the valley of Itterbach stream in the west.

The observable section of landscape from Wp 10/31 can be described as the nearest vicinity of the possible tower itself (ca. 0,4 km perimeter) and the broader surroundings of the Hesselbach fort, including the location of the present-day eponymous village and the western slopes of Der Kolli hill to the east (Fig. 192). Of the broader landscape not much more than the surroundings of Bullau village to the north-west and the slope of Kohlebuckel hill to the south-west were visible.

South-east of the Hesselbach fort lay Wp 10/32, on the western slopes of Hohe Langhalde hill, thus having superior views to the north and north-west as far as to the position of Wp 10/28 some 4,5 km away (Fig. 193). The spot offered almost no line of sight to the east. Line of sight to the south was restricted by hills, on which Wp 10/33 and Wp 10/33 stood. The view to the west was blocked by slopes of terrain depression created by Hesselbach stream 1,2 km to the west.

Wp 10/33 was located in present-day Baden-Württemberg, close to the ridge of Kahl-Buckel hill. For that reason, the areas immediately around the watchtower site were not visible, because of sharp slopes of the ridge. From Wp 10/33 one had a fairly good view to the broader landscape around present-day Hesselbach and also beyond the course of the palisade to the broader surroundings of Waldleiningen Schloss and well beyond it up to 2 km from the watchtower (Fig. 194). The position of the next watchtower, Wp 10/34, on Hochwald hill was visible together with that hill, and the same can be said about the position of Wp 10/37 and Roterberg Hill 2,5 km away. The Gartenfeld hill to the south-west of Wp 10/33, at a distance of 2,5 km, was also in good line of sight from this watchtower.

Wp 10/34 had one of the best lines of sight on the Odenwald Limes. From its spot more than 19 km² of landscape was visible in the 5 km perimeter, which made it second only to the sites with clear visibility on the broader Main valley in the north. Despite this, the immediate vicinity of this watchtower site was not visible for its sentries except for the narrow perimeter on the top of the hill on which two successive watchtowers stood. The site offered a formidable view north-east, to the broader surroundings of Waldleiningen Schloss. At the same time the location of Hesselbach and its broader surroundings up to Wp 10/31 were visible from Wp 10/34 up to a distance of 3,5 km to the north-west. Immediately to the west the visibility was restricted to the valley of the Itterbach river. The best view from the site was to the east on Roterberg Hill and further beyond it to the north-east, to the position of the present-day village of Ernsttal 2,7 km away. South of the Roterberg Hill, the Waschklinge stream was also visible up to 3,6 km away from Wp 10/34 (Fig. 195).

The position of Wp 10/35 offered an excellent view only to the east. Nothing beyond the position of Wp 10/34, roughly 0,6 km to the north, was visible from there, and to the west and south the line of sight was even more restricted. In the eastern direction the course of the Limes was under comfortable visual control from this watchtower site as far as to the summit of Rotkreuz Hill, on which Wp 10/38 stood at a distance of 2,4 km. All the slopes of Kinzert hill in the south-east as well as the slopes of Roterberg Hill to the east and the location of present-day Ernsttal village to the north-east were visible from this site, at an approximate distance of 2 km. That is also why the area of observable landscape from this site was more than 10 km² in a 5 km perimeter (Fig. 196).

Wp 10/36 had practically the same line of sight as the fortlet at Seitzenbuche (Fig. 162), with the exception of a better view on Roterberg Hill, due to its more elevated position (Fig. 197).

Wp 10/37 stood on an unfavourable position roughly in the middle of the frontier ascent from the Seitzenbuche fortlet on the Rotkreuz Hill. For that reason, the line of sight to the east was restricted to a 0,4 km wide stretch of land, while the sentries from this watchtower site had at least some view in the opposite direction on the broader surroundings of Wp 10/36, Wp 10/35, and Wp 10/33. Not much could have been seen to the north, except for the slopes of Roterberg Hill at a distance of 0,5 km, while to the south a similar barrier for the line of sight was formed by the elevated banks of Waschklinge stream 1 km away (Fig. 198).

The position of one of the possible stone watchtowers at Wp 10/38 (Wp 10/38c) offered a relatively better view of the broader landscape than most of the watchtower sites on the Odenwald Limes. Although directly to the west not much was visible except for the immediate vicinity of the watchtower and then the hill on which Wp 10/34, Wp 10/35, and Wp 10/36 stood, sentries of the stone watchtowers at Wp 10/38 had exceptionally good line of sight to the east to the area of present-day Schlossau village as well as beyond it up to 2 km from the site position. The line of sight from Wp 10/38e was also good in the southern direction up to present-day Boppenfeld, 2 km away from Wp 10/38 in the valley of Waschklinge stream (Fig. 199). The lines of sight of two more suggested watchtowers, Wp 10/38f and Wp 10/38g, had similar line of sight to the north, east and south but had limited line of sight the west and were thus not intervisible with Seitzenbuche fortlet (Figs. 200, 201).

Wp 10/39 is the last example of a watchtower with localised line of sight. One had a fairly good view from there to present-day Schlossau village, including the position and broader surroundings of the eponymous fort. Apart from that, fairly good line of sight was at hand from the position of this watchtower site only into the valley of Teufelsbach stream, up to 2 km to the north. Generally, the horizon for observers from Wp 10/39 was around 0,4 km–0,6 km away from this watchtower site (Fig. 202).

3.3.6 *Intervisibility between individual sites on the Odenwald Limes*

Due to the average distance of 0,72 km between installations on the Odenwald Limes, it is not surprising that the amount of intervisibility between those sites was abundant, as Table 13 clearly shows. For that reason, detail will be provided only for the intervisibility between forts/fortlets and watchtowers, while the visual connections between watchtowers themselves will be discussed only when having particular relevance to the possible signalling system or positioning of individual watchtower sites. No other forts or fortlets were intervisible with the exception of Hainhaus with Eulbach (Figs. 155, 156) and Würzberg with Hesselbach (Figs. 157, 158).

The topographically first fort on the Odenwald Limes at Wörth had the worst results in terms of intervisibility. No known Roman military installation datable to the 2nd century AD was intervisible with it save for Wp 10/2. Wp 10/1 is not included in this study because its location was disturbed during construction of B 469 to such an extent that no spatial analyses can be applied on that section of the frontier (Fig. 152).

The Seckmauern fort, despite having generally bad line of sight to the broader landscape, stood on a position from which one could see to the tops of watchtowers at Wp 10/2 and Wp 10/3 to the east, while to the south-west Wp 10/4, Wp 10/5, and Wp 10/6 were visible (Fig. 153). The intervisibility lines between these installations and the fort were still inside the projected 300 m-wide corridor alongside the palisade. According to the results of the viewshed analysis, the Seckmauern was supposed to be intervisible also with Wp 10/8, Wp 10/9, Wp 10/11, and Wp 10/12 if there would have been no obstruction via trees. The terrain profile between the fort and Wp 10/8 and Wp 10/9 indicates that trees taller than 5 m could block the line of sight, so this connection without extensive landscape clearance was impractical, but the topography of terrain between the Seckmauern fort and Wp 10/11 with Wp 10/12 was more favourable. Intervisibility between both watchtower sites and the fort was possible because the watchtowers stood on a ridge facing relatively open landscape until the Seckmauern fort.

The fort at Lützelbach was in a relatively unfavourable position in terms of visibility to the landscape, as already mentioned, but still it was intervisible with three neighbouring watchtower sites, Wp 10/6, Wp 10/7, and Wp 10/8. All of these lay inside the 300 m-wide corridor around the palisade, so one should not expect that the intervisibility was hindered by any trees (Fig. 154).

The fortlet at Windlücke was in a slightly better position to be intervisible with nearby watchtowers than was the fort at Lützelbach. It was directly intervisible with Wp 10/9, Wp 10/10, and Wp 10/11 inside the mentioned corridor. In theory, the watchtowers at Wp 10/2 and Wp 10/12 also stood within its line of sight. According to the terrain profiles (Figs. 160, 163, 173), even tall trees should not be obstructing the intervisibility between those watchtowers and the fortlet.

The Hainhaus fort was intervisible directly with towers at Wp 10/12, Wp 10/13, Wp 10/14, Wp 10/15, Wp 10/16, and Wp 10/17. Lines of sight between these and the fort all ran inside the 300 m-wide corridor. In theory, still intervisible with Hainhaus were Wp 10/11, Wp 10/18, Wp 10/19, Wp 10/20, Wp 10/22, Wp 10/23, Wp 10/24, and the fort at Eulbach, but the lines of sight at least temporarily ran outside the 300 m-wide corridor alongside the frontier.

While between the Hainhaus and Wp 10/11, Wp 10/18, Wp 10/23, and Wp 10/24 not even substantial tree coverage could obstruct the direct line of sight, the connections of Wp 10/19, Wp 10/20, Wp 10/22, or the fort at Eulbach with the fort at Hainhaus were themselves on a threshold, and any vegetation on the western slope of the hill on which Wp 10/17 was situated could easily obstruct the line of sight (Fig. 155). In order to make Wp 10/19 and Wp 10/20 intervisible with the Hainhaus fort, the cleared corridor would have to be extended 50 m more to the west of the edge of the already proposed 300 m wide corridor near the Wp 10/17. To achieve intervisibility between the Eulbach and Hainhaus forts, the corridor would have to be extended at the same place not by 50 m but by 100 m more, and to make the Hainhaus fort intervisible with Wp 10/22, the cleared area would have to be extended to 300 m away from the palisade.

The results of the viewshed analysis show that the Eulbach fort was also rich in the number of visual connections. Its (non)intervisibility with Hainhaus was already discussed, but aside from this there was a plethora of watchtower sites in direct line of sight of the fort, with their visual links going inside the 300m-wide corridor around the Limes. Principally these were Wp 10/15, Wp 10/16, Wp 10/17, Wp 10/18, Wp 10/19, Wp 10/20, Wp 10/21, and Wp 10/22. Outside of the corridor the visibility could not be obstructed even by tall trees for Wp 10/23 with Wp 10/24, while for the Wp 10/12, Wp 10/13, Wp 10/14, and Wp 10/25 higher vegetation could form an obstacle for direct line of sight from the Eulbach fort (Fig. 156). To make this fort intervisible with Wp 10/12, Wp 10/13, and Wp 10/14, the landscape clearance had to be extended again west of Wp 10/17 in a similar way as was necessary in the case of intervisibility between the Hainhaus fort and Wp 10/19, Wp 10/20, and Wp 10/22. To achieve intervisibility of the Eulbach fort with Wp 10/25, the stretch of landscape clearance would have to be extended to 250 m from the palisade to the east of Wp 10/24.

The fort at Würzberg was to the north intervisible with Wp 10/24 and Wp 10/25 and to the south with Wp 10/26, all inside the 300 m-wide corridor alongside the palisade (Fig. 157). A plethora of sites was intervisible with the fort outside of the corridor, namely Wp 10/22 and Wp 10/23 to the north. To the south, the positions of Wp 10/27, Wp 10/28, Wp 10/29, Wp 10/30, Wp 10/31, Wp 10/32, Wp 10/33, and Wp 10/34 as well as the location of the fort at Hesselbach were in theory intervisible with Würzberg. None of these would be intervisible with the fort without further landscape clearance. Direct line of sight between Würzberg and Wp 10/22 went as far as 0,5 km away from the frontier, so without extensive landscape clearance east of the Wp 10/23 and Wp 10/24 the intervisibility between these sites remained unattainable. For the line of sight between the Würzberg fort and Wp 10/23 the already mentioned extension

of cleared corridor near Wp 10/24 would be enough. The intervisibility between Würzberg and Wp 10/27, Wp 10/28, Wp 10/29, Wp 10/30, Wp 10/31, Wp 10/32, Wp 10/33, and Wp 10/34 as well as the location of the fort at Hesselbach was achievable if the cleared corridor immediately south of the Würzberg fort were to have been extended 50 m further to the south-west to a distance of 200 m from the line of the palisade. For the lines of sight from Wp 10/28 and Wp 10/31 one obstacle would remain—possible vegetation on the slopes of a hillock on which Wp 10/27 stood. For both of them the extension of cleared corridor to 250 m west of the palisade would be enough to make them intervisible with the Würzberg fort, and for Wp 10/28 in fact only the extension of cleared corridor to 200 m west of the palisade would be enough.

Intervisibility between the Hesselbach and Würzberg forts was just discussed. Apart from that theoretical link, the Hesselbach fort could have been in theory intervisible with Wp 10/24, Wp 10/25, Wp 10/27, Wp 10/28, Wp 10/29, Wp 10/30, Wp 10/31, Wp 10/32, Wp 10/33, and Wp 10/34. Of those, inside the 300 m-wide frontier corridor the fort was intervisible only with Wp 10/31 and Wp 10/32 (Fig. 158). Watchtower sites Wp 10/24, Wp 10/25, Wp 10/27, Wp 10/28, Wp 10/29 and Wp 10/30 all had lines of sight obstructed by the position of potential vegetation on Saufeld Hill near Wp 10/31. If taller vegetation had been allowed there, the sites would not be intervisible with Hesselbach. The area which would need further tree clearance was around 50 m distant from the edge of the 150 m wide cleared section in front of the course of palisade to the east of Wp 10/31. Wp 10/33 and Wp 10/34 would be intervisible with Hesselbach only if tree clearance were provided up to 300 m south-west of the palisade near Wp 10/32.

The Zwing fortlet was located in the middle of a gorge between Kahlen Buckel and Hochwald hills and had in line of sight only the watchtower sites on each of these hills – Wp 10/33 and Wp 10/34 – which were comfortably intervisible with the fortlet inside the 300 m wide Limes corridor (Fig. 161).

The positioning of the Seitzenbuche fortlet was not as inferior in terms of the view to the landscape as was the case for Zwing, but still its location offered visibility only to the positions of nearby Wp 10/34, Wp 10/35, Wp 10/36, Wp 10/37, and Wp 10/38. Between these and the fortlet the lines of sight went all through the 300 m wide Limes corridor with the exception of Wp 10/34. Not even very tall vegetation could obstruct the intervisibility between the last-mentioned sites and the fortlet. Intervisibility between Seitzenbuche and possible stone watchtower at Wp 10/38e was possible only on a threshold, with applied OFFSETB. The positions of two more possible watchtower sites east of the stone watchtower (Wp 10/38f, Wp

10/38g – see Table 11) were not visible from Seitzenbuche (Fig. 162), and even the tops of their respective platforms would still be beyond the horizon for observers from the Seitzenbuche northern gate. The positions of all three possible watchtowers at Wp 10/38, on the other hand, were comfortably visible from Wp 10/37 and from the fort at Schlossau.

The Schlossau fort was intervisible only with Wp 10/38 and Wp 10/39. A plethora of watchtower sites south of the Wp 10/39 were in fact intervisible with the fort as well, but they are not part of the study. Wp 10/39 was inside the Limes corridor, while the line of sight between the fort and Wp 10/38 went outside of the 300 m wide strip alongside the frontier and could have been blocked by vegetation taller than 6 m if the section of landscape ca 250 m north-west of the fort were to not have been cleared. All the possible watchtowers on the WP 10/38 were visible from location of Schlossau fort (Fig. 159).

3.3.7 *Conclusion I.*

General visibility from the sites on the Odenwald Limes was bad due to the difficult terrain in which forts, fortlets and watchtowers were situated. Planners of the frontier made no attempt to position any fort or fortlet on prominent spot from which the sentries would have good line of sight to the broader landscape. In fact, in case of several sites the positioning itself prevented any meaningful line of sight beyond the immediate vicinity fort/fortlet. Most apparent is this decision in the case of all three fortlets and forts at Lützelbach and Schlossau.

If the lines of sight of all the forts and fortlets are combined, the reasons for the positioning of individual sites becomes clearer (Fig. 203). Despite the fact that the general landscape coverage remained haphazard, and that even significant stretches of the course of the palisade and the presumed Military Way as well as areas immediately east and west of those were sometimes outside of the combined lines of sight, the positions of the watchtowers were all in highlighted areas which were visible from forts/fortlets (with exception of Wp 10/1, see p. 181–182). Either forts/fortlets or watchtowers were positioned in order to be intervisible with their neighbours on the frontier.

The amount of intervisibility between forts/fortlets and individual watchtower sites is surprisingly abundant if one takes into consideration the generally bad visibility from not only forts/fortlets but also from many watchtowers. Again, many of them had line of sight only to their immediate surrounding area. The lateral signalling as it was defined by Dr D. J. Woolliscroft on the Wetterau Limes or on the Upper German/Raetian border (WOOLLISCROFT 2001, 109–111) could certainly work on the Odenwald Limes because of the amount of

intervisibility between neighbouring installations (see also Table 13). Sites were in fact intervisible with each other on the frontier even beyond the neighbouring sequence, so in theory direct signalling could have worked on the Odenwald Limes (Fig. 204). The lines of sight even between more distant sites usually went around the edges of the presumed 300 m-wide cleared corridor in the landscape, where one should not count on the presence of any terrain obstacle in the form of vegetation.

In a certain number of cases the landscape clearance would have to be extended to keep the sites intervisible. Apart from the 300 m wide corridor, which was necessary just to amass enough wood for the construction of the palisade and timber watchtowers, not more than several hundred meters more were needed to be cleared of vegetation only in the vicinity of Wp 10/17, Wp 10/24, Wp 10/27, Wp 10/31, Wp 10/32, and the Würzberg and Schlossau forts. If that were to have been accomplished, each fort/fortlet would have been intervisible with almost all the watchtowers between its position and the next fort/fortlet (see Figs. 203, 204 and Table 13 for exceptions). Therefore, not only was lateral signalling possible on the Odenwald Limes, but also direct signalling on a hierarchical level could have operated there – forts and fortlets were intervisible with a sufficient number of watchtower sites (Fig. 203).

Most of the watchtower sites on the Odenwald Limes had better line of sight on the course of the frontier than anywhere else. Based on the visibility to the broader landscape and intervisibility between individual sites, the watchtower sites can be divided roughly into three categories: those with localised line of sight, those that could serve as communication hubs (with an exceptional amount of intervisibility with neighbouring sites), and those with good line of sight to a broader landscape. To the first group belonged Wp 10/4, Wp 10/10, Wp 10/13, Wp 10/15, Wp 10/16, Wp 10/19, Wp 10/20, Wp 10/21, Wp 10/22, Wp 10/23, Wp 10/26, Wp 10/31, Wp 10/35, Wp 10/36, Wp 10/37, and Wp 10/39. The common denominator for them was the inferior visibility to the broader stretch of landscape; often the view was restricted only to the immediate vicinity of the site and the slopes of nearby hills. These sites can also be described as interval watchtower sites because they were located on spots of overlaps of lines of sight from nearby forts—if they were to have been moved, the intervisibility with one of the neighbours would be lost. Excellent examples of that were Wp 10/22 (Fig. 205) and Wp 10/23 (Fig. 206) between the Eulbach and Würzberg forts and Wp 10/16 (Fig. 207) between Hainhaus and Eulbach. The most inferior watchtower sites had only localised line of sight and were intervisible with only one fort, like for example Wp 10/21, which stood exactly in the middle between the Eulbach fort and Wp 10/22, having both installations on the very edge of the line of sight (Fig. 182). Similar was Wp 10/10, which stood directly on the edge of line of sight of

the Windlücke fortlet. Due to the unfavourable position, the sentries from this spot had visual contact only with four more nearby standing watchtower sites and nothing more.

Other watchtower sites had entirely opposite qualities and were true watchtowers with good line of sight to a broader landscape. These can be relatively easily recognized by the area observable in a 5 km radius in Table 13. Principally all the remaining sites can be included in this category, which means the Wp 10/2, Wp 10/3, Wp 10/5, Wp 10/6, Wp 10/7, Wp 10/8, Wp 10/9, Wp 10/11, Wp 10/12, Wp 10/14, Wp 10/17, Wp 10/18, Wp 10/24, Wp 10/25, Wp 10/27, Wp 10/28, Wp 10/29, Wp 10/30, Wp 10/32, Wp 10/33, Wp 10/34 and Wp 10/38. Usually their line of sight was better along the course of the frontier rather than beyond it, but some of these viewshed results could also have been influenced by limitations of the model in which their visibility was tested (see p. 199–200, 238–241).

Some of these watchtower sites are also assignable to the third group or subgroup of installations, that could serve as communication hubs. These were principally the sites in which generally good visibility to the landscape could have been only coincidental or secondary, because they were above all intervisible not only with two or even three forts/fortlets but also with a plethora of other watchtower sites. The principal members of this category are Wp 10/2, Wp 10/6, Wp 10/8, Wp 10/12, Wp 10/17, Wp 10/24, Wp 10/29, Wp 10/33, Wp 10/34 and Wp 10/38. These sites would be as important as any other if only lateral signalling was used on the Odenwald Limes, but if a more direct system was employed, these could have played a nodal part in it as multifunctional relays. That is why their spatial distribution is most curious – they were either positioned roughly in the middle between two forts or between fort and fortlet from which at least some line of sight to the broader landscape was at hand (Wp 10/2, Wp 10/6, Wp 10/17, Wp 10/24 and Wp 10/29), or they were direct neighbours of sites which had such bad general line of sight that for any significant line of sight to the broader landscape and also for signal communication with sites beyond their immediate vicinity they simply needed a relay or outpost nearby. Among these are Wp 10/8, Wp 10/33, Wp 10/34 and Wp 10/38 (Fig. 114)

What remains to be answered is why individual installations were so often located on spots with such bad line of sight to the broader landscape. Why were the intervisibility lines often on the presumed edges of forest-cleared corridors? What other qualities did the positions of these forts and fortlets offer other than intervisibility with neighbouring watchtower sites?

3.3.8 Distance alignments

There is a chance that distance alignments were used on the Odenwald Limes during the surveying phase of the frontier. However, one has to be careful in making interpretations because the course of the Odenwald Limes was in certain sections much straighter than the course of the previously studied Antonine Wall, so many of the detectable alignments could have been coincidental, especially when taking into consideration the fact that on one watchtower site several watchtowers successively stood in proximity with each other, and the average distance between installations was 0,72 km (Table 9). All the listed examples include timber watchtowers or probable watchtowers, with the exception of Wp 10/5, where there is a certain chance that timber watchtower preceded the stone one on the site (see p. 182). Two alignments including two successive watchtowers have not been found on one watchtower site.

The first group of detectable alignments can be described as links between fort/fortlet gates and central positions of the watchtowers. A direct line projecting from Wörth *porta praetoria* to the position of the known timber watchtower at Wp 10/7 goes through the approximate position of the expected watchtower at Schneesberg, Wp 10/2. Distances between mentioned features are most curious, because Wörth *porta praetoria* and Wp 10/7 are separated by $2\frac{3}{4}$ Roman miles while Wp 10/2 and Wp 10/7 are separated from each other by $2\frac{1}{3}$ Roman miles (Fig. 209).

If one would connect via a line the position of Lützelbach *porta principalis dextra* with the position of the Windlücke eastern/main gate, at a distance of $\frac{1}{2}$ Roman mile from the first site one finds two successive timber watchtowers at Wp 10/8 lying almost exactly on that line (Fig. 210). Furthermore, the overall distance between these two points on the line is almost exactly $1\frac{1}{3}$ Roman miles (see Table 14). Lützelbach *porta principalis dextra* can also be connected by a direct line with a timber watchtower at Wp 10/11. On this line stood a timber watchtower at Wp 10/9, 1 Roman mile distant from the first one and $1\frac{1}{3}$ Roman miles distant from the second (Fig. 210). If the direct line from Lützelbach *porta praetoria* is followed to the position of a timber watchtower at Wp 10/16, the aligned installation is the timber watchtower at Wp 10/15, separated from the first one by $4\frac{1}{2}$ Roman miles and $\frac{1}{2}$ Roman mile from the second (Fig. 211).

Only one watchtower seems to have been aligned between the positions of gates of non-intervisible forts at Eulbach (*porta principalis dextra*) and Würzberg (*porta principalis sinistra*). This is the timber watchtower at Wp 10/21, lying $\frac{1}{2}$ Roman mile from Eulbach *porta principalis dextra* (Fig. 212).

To the second studied group belongs the alignments between individual watchtowers. On a direct line between the possible tower at Wp 10/3 and the northern timber watchtower at Wp 10/10 lies the eastern/main gate of Windlücke fortlet. The overall distance between watchtower sites was almost 4 Roman miles, and the fortlet was separated from Wp 10/3 by 3,57 Roman miles and 0,39 Roman miles from Wp 10/10 (Fig. 213).

If the position of the western timber watchtower at Wp 10/6 is connected by a hypothetical line with the northern timber watchtower at Wp 10/10, the positions of timber watchtowers at Wp 10/7 and Wp 10/9 are almost exactly on this line. The distances dividing individual features on this alignment are not close to complete Roman mile(s) or its fractions (see Table 13, Fig. 214).

On the direct line connecting positions of one of the possible watchtowers at Wp 10/24 and the known timber watchtower at Wp 10/30 lies the timber watchtower at Wp 10/25, at a distance of $\frac{2}{3}$ Roman mile from the first one and 3,71 Roman miles from the second (Fig. 215). This possible alignment should be, however, interpreted with great caution since the position of possible watchtower at Wp 10/24 is only presumed.

The last possible long-distance alignment between watchtowers consists of the only one timber watchtower at Wp 10/29 and one of the timber watchtowers at Wp 10/35. The aligned is the timber watchtower at Wp 10/32, which is separated from the first one by $2 \frac{1}{2}$ Roman miles and from the second by $1 \frac{1}{4}$ Roman miles (Fig. 216).

The third type of detected alignments were cases when the watchtowers stood on the line projecting from one lateral gate through the centre of the fort and the second lateral gate beyond, usually to the north or south. Surprisingly, several timber watchtowers stood exactly on extensions of lines which were originally used for positioning of the fort gates and internal roads. This type of alignment was already observed in the case of Glasgow Bridge fortlet on the Antonine Wall (see p. 126, 140), but in the case of the Odenwald Limes it seems that it was much more common. A first example is the only known watchtower at Wp 10/5, which stood almost exactly on the line projecting from Seckmauern *porta principalis sinistra* through the same fort's *porta principalis dextra* to the south-west. The watchtower site was 0,52 of a Roman mile from the first one and 0,47 of a Roman mile from the second, so the theoretical central point of the fort was exactly $\frac{1}{2}$ of a Roman mile from it (Fig. 217).

The line projecting similarly from the Lützelbach fort lateral gates to the north went exactly through the position of the western timber watchtower at Wp 10/6. The distance

between the watchtower and the central point inside the Lützelbach fort was almost exactly 1 Roman mile (see Table 13, Fig. 218).

The direct line projecting through the middle of both of the Hainhaus fort's lateral gates to the north went through the centre of the Windlücke fortlet and the timber watchtower at Wp 10/9. While the distance between the centres of these installations was 2,18 Roman miles, the distances to the fort and fortlet from Wp 10/9 were more rounded; to the Windlücke it was almost exactly $\frac{1}{3}$ of a Roman mile while to the central point of Hainhaus it was $2\frac{1}{2}$ Roman miles (Fig. 219).

The most complex example of possible long-distance alignment was found in the environs of the Eulbach fort. The line projecting in the above-mentioned manner to the south went exactly through the position of the timber watchtower at Wp 10/25, while the line projecting in a similar manner to the north of the fort went through the positions of the timber watchtowers at Wp 10/19 and, Wp 10/18 to the position of the timber watchtower at Wp 10/17. The distance between the timber watchtower at Wp 10/17 and the central point of the Eulbach fort was almost exactly 2 Roman miles, and the timber watchtowers at Wp 10/17 and Wp 10/19 were separated from each another by 1 Roman mile (Fig. 220, for the rest of distances in this alignment, see Table 13).

The line projecting between Würzburg *porta principalis sinistra* through the same fort's *porta principalis dextra* to the south-east went exactly through the position of the timber watchtower at Wp 10/26 (Fig. 221). The distance between the watchtower and the central point of the fort was 0,59 of a Roman mile. The line projecting in similar manner and direction from the Hesselbach fort went through the position of one of the possible watchtowers at Wp 10/31. The central point of the fort was separated from the watchtower by 0,57 of a Roman mile (Fig. 222). Finally, for the relationship between the possible watchtower site at Wp 10/39 and the nearby Schlossau fort, the line projecting to the south through the *porta principalis sinistra* from the central point of the fort and *porta principalis dextra* went through the position of a tower suggested at Wp 10/39, roughly $\frac{1}{3}$ of a Roman mile from the central point of the fort (Fig. 223).

3.3.9 Conclusion II.

The alignments above make no coherent pattern at first glance. The principal problem is the fact that only a fraction of known or conjectured watchtowers was positioned on any kind of alignment – from the overall total of 39 watchtower sites included in the study only 17

individual watchtowers exhibited any correlation with the mentioned alignments (see Table 10). Moreover, some of the alignments described above could have been coincidental, especially the long-distance ones between otherwise non-intervisible sites (see Table 13).

According to the author's belief, the last group of alignments directly connected with the positioning of fort gates was by far least coincidental. It is tempting to interpret the positioning of watchtowers at Wp 10/5, Wp 10/26, Wp 10/31, and Wp 10/39 in relation with initial surveying of the frontier – surveyors demarcating from the central point of the future fort the positions of individual gates simply used the very same surveying spot for positioning of the first interval watchtower in the vicinity of the already constructed fort. However, not only the positions of watchtowers with localised line of sight were based on these alignments and not even a majority of the watchtowers with localised line of sight were situated on any alignment.

The visibility must have been to a certain extent a priority because the majority of the sites with good line of sight or fitting well into the intervisibility pattern stood outside of the exact alignment. Because the Odenwald Limes was a linear barrier, sites were not located very far away from the ideal line projecting from nearby fort gates, either. Although the distances between aligned watchtowers and nearby forts oscillated around $\frac{1}{2}$ of a Roman mile, no distance constant was apparently applied along the frontier in general, either among individual sites or at least among aligned ones (see Table 13). The most promising in this regard was the repetitive occurrence of distances around $\frac{1}{2}$ Roman mile between individual sites, but that still represented only $\frac{1}{3}$ of all the distance values between individual sites, and the overall regularity would decrease further if the distances were calculated only for example between individual timber or stone watchtowers.

One could therefore imagine that when surveying this frontier, the surveyors had a certain list of priorities for the attributes the individual watchtower site should have had. One of these was visibility to the landscape and intervisibility with other sites, as specified above, and so some watchtowers can be described as true observation platforms with good line of sight to the landscape while others fulfilled the function of relaying stations with good line of sight to the tops of a plethora of neighbouring watchtowers/forts/fortlets. It is reasonable to assume that frontier planners wanted to have at least one watchtower site between principal installations like forts and fortlets, which had superior line of sight to the broader stretch of landscape than others (see Table 10, where these watchtower sites are highlighted in bold). The other sought attributes of individual watchtowers are discussed below, but when the demand for strategic or

nodal watchtowers between forts and fortlets was met, it seems that the positions of the remaining ones were chosen on (not always) regular intervals from several surveying spots on a direct line, and this could be the explanation for the seldom repeating distance constant of $\frac{1}{2}$ Roman mile between watchtower sites with marginal or average line of sight. The mentioned surveying spots can be described as either the fort gates or positions of already chosen nodal watchtowers. In order to achieve such complex spatial distribution of sites, the landscape must have been deforested at least in 300 m wide corridor alongside the course of the Military Way. The distance alignments thus could be (if at all) only a part of the answer to the question of why the individual frontier features on the Odenwald Limes were situated where they were. The alignments were obviously not the important prerequisite, because they were not used widely on this frontier. What seems to be clear is that the positions of forts had an influence on the positioning of watchtowers, not the other way around.

3.3.10 *Interpretation of the Odenwald Limes sites via slope analysis – the goals*

The primary reason for the use of slope analysis in the interpretation of the Odenwald Limes was just stated above: the positioning of forts, fortlets, and in fact a lot of watchtower sites cannot be fully explained by visibility to the landscape, intervisibility with other sites, or via any constant distance or alignment formula. Therefore, the slope analysis is used to determine the accessibility of the frontier features on the Odenwald Limes, similarly to its usage on the Antonine Wall (see p. 133–140). The principal question is whether the forts and fortlets were located on the frontier in accessible/inaccessible places and from which direction the access was the easiest.

The methodology is thus similar to the one used in subchapter 2.3.14. The landscape around individual forts, fortlets and watchtowers is studied in radii of 0,3 km, 1 km and 1,5 km and the results are summarized in Table 10. Again, two profiles are offered, one roughly on the course of the frontier (in the case of the Odenwald Limes that means alongside the course of the palisade and parallelly running Military Way) and one roughly across it. Due to the short distances between individual watchtower sites, these are not studied individually but in clusters between individual forts and fortlets. The terrain model and its creation are further described in Appendix II (see p. 238–241).

3.3.11 *Interpretation of the Odenwald Limes sites via slope analysis – the results*

The fort at Wörth was topographically best accessible via the Main river and alongside its course. Around 0,4 km west of the fort, the water meadow of the river ended, and the landscape

started to ascend towards a gentle hill, on which the Seckmauern fort stood. The fort was best accessible from the south and south-east, from the banks and broader water meadow of the Main river (Fig. 224).

The positions of Wp 10/1, Wp 10/2, and Wp 10/3 were all located on the ascent of the terrain from the Main valley to the position of the Seckmauern fort. If it ever existed, Wp 10/1 was destroyed during the construction of B 469 together with landscape in which it stood. As specified above, there is no point in evaluating the position of Wp 10/1 via any spatial analysis (see p. 181–182). Wp 10/2 stood on a plateau just above the sharp ascent from the Main valley to the east and Steinbach river to the south. It was fairly well accessible from the north-west, where the Wp 10/3 stood. Wp 10/3 was located on a ridge on the north–south axis; the terrain gently ascended towards it from the north, only to start to descend more rapidly from it to the south, to the area of present-day Seckmauern village. On the east–west axis the terrain generally ascended alongside the course of the palisade from the fort at Wörth to the Seckmauern fort (Fig. 225).

The Seckmauern fort was located on a small hill, which was more prominent on the north–south axis than on the east–west one. The fort was not positioned on the summit of the hill but had its *porta praetoria* ca. 0,11 km north of it, thus being positioned on the hill's northern slope. The position of the fort was best accessible from the east and the west, roughly from the areas where the course of the palisade ran. To the north the slopes were sharp due to the existence of several local streams in that direction, while further north only more hills and generally impassable terrain were located. South of the fort the terrain descended towards present-day Seckmauern village and Steinbach river, while to the south-west the terrain quickly ascended again on Kirschberg hill (Fig. 226). Whether the Wp 10/4 existed or not, the position suggested for it, ca 80 m north-west of the Seckmauern *porta principalis dextra*, was in terms of accessibility and topography the same as the position of the fort.

Between the Seckmauern and Lützelbach forts stood Wp 10/5, Wp 10/6 and Wp 10/7. After a relatively rapid ascent to Wp 10/5, the landscape slowly but evenly rose from the north-east to the south-west until reaching the Lützelbach fort. All the watchtowers stood on a ridge, because the landscape to the north and west of them descended similarly, as it did in the south-eastern direction into the valley of Steinbach river. All the watchtowers were best accessible from the positions of their neighbours with the exception of Wp 10/7, which was also well accessible from Kirschberg Hill immediately east of it (Fig. 227).

The Lützelbach fort was positioned on a plateau between two local rivers, Lützelbach and Steinbach, which formed steep terrain depressions east and west of the fort, respectively. For that reason, the site was best accessible from the north and south. The worst access route to the fort went from the east, roughly 0,3 km east of *porta praetoria* (Fig. 228).

Two watchtower sites Wp 10/8 and Wp 10/9 between the Lützelbach fort and the Windlücke fortlet stood on one slope of gentle Bannholz hill, which was blocking the view from the fort to the fortlet, and vice versa. To the east the landscape continuously descended to the Steinbach river valley, while in the opposite direction lay the Breitenbach stream valley surrounded by medium-sized hills. Therefore, both watchtower sites were best accessible from the positions of neighbouring Roman sites to the north and south (Fig. 229).

The Windlücke fortlet stood on practically the same plateau as the Lützelbach fort, but the width of this plateau was much narrower in its case. While the Lützelbach fort stood on 1 km of relatively flat land on the east–west axis, the Windlücke fortlet was located on the elevated ridge on the east–west axis. That is important especially if one takes into consideration that on the north–south axis the site was still located in a depression, because the terrain gently descended from positions of neighbouring watchtower sites Wp 10/9 and Wp 10/10 to the position of this fortlet. The landscape to the east offered the best access route, from the valley of Steinbach stream. Any north–south communication in the 1,5 km radius around the fortlet was directed to its location because of sharp slopes of the Breitenbach stream to the west and Steinbach valley to the east (Fig. 230).

From the position of the Windlücke fortlet the terrain alongside the course of the frontier ascended in several steps towards the Hainhaus fort. On this north–south axis at the foot of the first step stood Wp 10/10. Wp 10/11 was located further on top of the same step, while Wp 10/12 stood on top of the second, much gentler step. Wp 10/13 was located practically on the same horizontal level as the nearby Hainhaus fort (see Table 11). Wp 10/10 and Wp 10/11 were in the east still facing relatively sharp slopes of the Steinbach river valley, while the remaining two watchtower sites faced in the same direction a plain between the valleys of the Steinbach and Ohrenbach rivers. Wp 10/10 stood on a well-defined ridge, thus being better accessible from the north as well as from the south, but Wp 10/11 was better accessible from the west, where present-day Hainhaus Park für grüne Technologien stands. Wp 10/12 and Wp 10/13 had to the west of their positions tributaries of Kimbach river, so they were best accessible from the north and the south alongside the course of the frontier and theoretically also from the already mentioned east (Fig. 231).

The Hainhaus fort stood on a relatively flat plateau, from which the terrain descended to the valley of Kimbach river in the west. To the north-east of the fort lay the valley of Steinbach river, and the valley of Ohrenbach river was located to the south-east. The site was best accessible from the north and south, but it was also fairly well accessible from the east (Fig. 232), just like neighbouring Wp 10/13.

From the Hainhaus fort to the Eulbach fort the landscape slowly and unevenly ascended from the first towards the second. Watchtower sites Wp 10/14, Wp 10/15, Wp 10/16, Wp 10/17, Wp 10/18, Wp 10/19, and Wp 10/20 stood on an almost 1 km wide ridge formed by the Ohrenbach river valley to the east and tributaries of Mümling river to the west. All of them were best accessible on the course of the ridge, except that Wp 10/15 and Wp 10/19 had slightly better access to the east than the others. Wp 10/17 stood on a small hillock, while Wp 10/19 was located at the foot of another. Wp 10/16 was located on the lowest point between the Hainhaus and Eulbach forts, while Wp 10/14, Wp 10/18 and Wp 10/20 controlled no prominent positions on any axis (Fig. 233).

The fort at Eulbach stood on an elevated plateau, which was formed in the south-west by the valley of Erdbach river, in the north-west by the valley of Bach aus dem Alten Grund river, and to the east by the valley of Gönzbach river. Again, the site was best accessible from both the north and the south. To the south-east of the fort one could travel on a relatively even and flat ridge to the position of present-day Boxbrunn village, 3 km south-east of the fort (Fig. 234).

Between the Eulbach and Würzberg forts stood Wp 10/21, Wp 10/22, Wp 10/23, Wp 10/24 and Wp 10/25. On the course of the frontier from the north to the south the terrain profile resembled a sine curve, on which the peaks were the positions of individual watchtower sites. The frontier still ran on a ridge, and was thus inaccessible from the west, where tributaries of Erdbach formed a valley. East of the individual watchtower sites the landscape relatively gently descended towards the edges of the Walbach river valley, from which the descent became much sharper. All the sites were thus best accessible from the course of the frontier in the north or south. The only exception to this general pattern was the position of Wp 10/21, immediately south of the Eulbach fort. This spot was also well accessible from the north and south, but likewise from the east, where it faced the gap between the valleys of Gönzbach and Mangelsbach streams, where the present-day Boxbrunn village lies (Fig. 235).

The Würzberg fort stood on an elevated plateau between valleys of rivers Erdbach, Euterbach, and Waldbach, being thus inaccessible from the east and west alike, with the

exception of a narrow stretch of elevated land between the Erdbach and Euterbach valleys immediately west of the fort, which formed natural access corridor for any all the travellers from the west. Otherwise the site was fairly well accessible from the direct north and direct south, where the course of the palisade and Military Way went (Fig. 236).

All the watchtowers between the Würzberg and Hesselbach forts were inaccessible from the west, where immediately behind their positions ran the valley of Euterbach river. Wp 10/26, Wp 10/27, and Wp 10/28 faced in the east relatively open and flat land, while the remaining watchtowers faced descending slopes of the Breitenbach river valley in the east. On the north–south axis the course of the frontier descended unevenly from Würzberg towards Hesselbach. On this axis, Wp 10/27, Wp 10/28, Wp 10/29, and Wp 10/30 stood on prominent positions, while Wp 10/26 and Wp 10/31 stood on less favourable land, which also corresponds with their inferior visibility to the landscape and to the positions of other Roman military installations on this frontier (see Table 13). All the listed watchtower sites were generally best accessible from the north and south—along the line of the frontier (Fig. 237).

The Hesselbach fort was easily accessible only from the north. To the west of the site were the valleys of rivers Itterbach and Euterbach, and east of it stood several hills, beyond which the Breitenbach and Gabelbach streams ran in distinctive valleys. South of the fort the terrain slowly ascended to the Höhe Langhalde hill on which Wp 10/32 stood and from there the terrain descended sharply to the position of the Zwing fortlet (Fig. 238).

Two watchtowers stood between the Hesselbach fort and the Zwing fortlet: Wp 10/32 and Wp 10/33. Each of them stood on the side of the Höhe Langhalde hill, although Wp 10/32 was closer to its summit. To the east they faced the valley in which present-day Waldleiningen Schloss lies, and to the west the slopes of the hill on which they stood sharply descended through Hesselbach river valley towards the eponymous stream. In theory they were both best accessible from the north, but due to their elevated positions, even that path to their locations was steep (Fig. 239).

The Zwing fortlet was located in the saddle between Höhe Langhalde and Hochwald hills. The slopes of both of these descended relatively sharply towards this site, while the terrain to the west of the fortlet descended further to the Hesselbach and Itterbach river valleys. East of the fortlet the landscape was, after one more sharp descent, relatively flat in the broader vicinity of present-day Waldleiningen Schloss. Thus, the site was most accessible from the east, and in fact it stood on a spot which could block convenient access from the west, north, and south on the line of the Limes (Fig. 240).

All three watchtower sites between the fortlets at Zwing and Seitzenbuche were located on Hochwald Hill. While Wp 10/34 stood almost on the summit, Wp 10/35 and Wp 10/36 were located on the descent from the hill towards the Seitzenbuche fortlet. South of the watchtower sites ran the Itterbach river valley, and beyond it was a group of hills, while to the north of it several more hills and Teufelsbach river valley were located. The Military Way and palisade ran on the ridge of the hill, so all the sites were in fact best accessible on its course despite the fact that one had to climb a certain amount of slope when ascending from either of the fortlets towards the watchtowers' sites (Fig. 241, see Table 10).

The fortlet at Seitzenbuche stood at the eastern foot of Hochwald Hill and the western foot of Rotkreuz hill. It was best accessible from these two directions, because south of it the terrain sharply descended to the valley of Waschklinge stream while north of the fortlet stood several hills and beyond them lay a further obstacle – the Teufelsklinge river valley. Still the fortlet position was in definition similar to the Zwing – it was on the most convenient spot to access the line of the palisade and nearby lying Military Way from beyond the frontier, from the north (Fig. 242).

From the position of the Seitzenbuche fortlet the frontier ascended on the Rotkreuz hill. The position of Wp 10/37 was located roughly in the middle of the ascent, while Wp 10/38 stood on the very summit, from which the course of the frontier gently descended towards the position of the Schlossau fort. The first watchtower site was accessible with ease only on the course of the frontier, while the second was located on top of a relatively flat hilltop which sharply descended 0,7 km north-east of the site to the course of Teufelsbach river. Wp 10/38 was relatively easily accessible from the position of the Schlossau fort to the south-east (Fig. 243).

The Schlossau fort was located in a relatively flat landscape, beyond the sharp hills of Odenwald. To the north of the fort position lay the Teufelsklinge river valley as the only hindrance in the surrounding area. The site was fairly easily accessible from the east and south, while to the west of it the terrain was a bit uneven due to the existence of Waschklinge valley. Wp 10/39 south of the fort was also on a relative plain, so it was practically accessible from all directions with ease (Fig. 244).

3.3.12 *Conclusion III.*

The interpretation via slope highlighted several patterns. Positions of some of the forts were excellent in terms of control or the blocking of access to the frontier or behind it from the area

beyond the later palisade or principally beyond Roman direct control. These were primarily the Wörth, Hainhaus, Eulbach and Schlossau forts that were located on convenient access points from/to the area beyond the frontier. Among the group with the same characteristic can be added all three fortlets; the pattern is most evident in the case of Zwing. Other forts were still better accessible from the course of the frontier than anywhere else; most notable was the case of Hesselbach. Würzburg could be evaluated in the same way, but it also stood on an excellent position to block access to the Limes from the west, where a gap in the form of a plain between Erdbach and Euterbach river valleys was located. Positioning of Lützelbach and Seckmauern remains enigmatic because both of these forts were located in a relatively inaccessible part of the frontier instead of being sited roughly in the area between Wp 10/6 and Wp 10/7 in order to control the convenient access route from the north-west to the course of Military Way, similar to the way in which Würzburg controlled access to the Limes from the west. One possible explanation for this oddity could be the generally better visibility to other Roman sites from Seckmauern, but that still does not explain the positioning of the Lützelbach fort, which was marginal in intervisibility with other Roman sites on the Odenwald Limes, and it also was poorly accessible not only from the frontier area but in fact from all directions. The positioning of this fort will be discussed below.

The case of Seckmauern is easier to evaluate – the fort was at certain point abandoned and its garrison probably moved to the Wörth (see p. 168–171). But still it is evident, that it was part of the original layout of the Limes – position of watchtower at Wp 10/5 was in alignment to its gates and several watchtowers (Wp 10/3, Wp 10/4 and Wp 10/5) were not intervisible with any other fort. Due to the fact that the whole interior of Seckmauern was later disturbed by construction of the villa (see p. 170–171), it is impossible to tell whether there was not any installation like watchtower or fortlet in the interior of the abandoned fort prior the construction of *villa rustica* there. This topic is discussed further on p. 257–258 and 269.

The general inaccessibility of most of the watchtower sites from the area beyond and behind the frontier fits well with the results of visibility and intervisibility analysis. Watchtowers were evidently oriented within the frontier, and they had best line of sight to the course of the palisade and to the positions of neighbouring watchtower sites. The line of sight to the area beyond or behind the frontier was in fact not necessary because from these directions the access to the watchtowers was already complicated, and one can imagine that with the existence of the palisade, that problem only worsened for any potential intruders. Furthermore, the broader landscape beyond the frontier line was heavily forested, so there was not much to see there anyway. Notable exceptions to the mentioned formula were several watchtowers with

good line of sight to the broader stretches of the landscape that were already discussed above. Apart from them, watchtowers in the vicinity of forts and fortlets blocking the access to the frontier could fulfil a similar function as their bigger neighbours, as is clear in the cases of Wp 10/13, Wp 10/21, and Wp 10/2. Watchtower sites not neighbouring the nearby fort/fortlet and standing on ground accessible from directions other than the course of the frontier, i.e., Wp 10/6 and Wp 10/7, have already been mentioned.

Based on the evidence presented so far, it seems that the Odenwald Limes mostly had internally focused spatial structure – it was oriented within, unlike the Antonine Wall (see p. 144). The best lines of sight went to the course of the frontier, and it is even hard to evaluate whether the planners of the frontier wanted to prevent easy access to the frontier from a generally eastern direction, beyond the frontier, or whether they positioned individual sites on the frontier with sole relation to the course of the Military Way and good surveillance of it. Because this feature of the Limes has not yet been discussed, it will be evaluated below via spatial analyses in next two subchapters.

3.3.13 *Cost path analysis – the goals*

The pattern revealed in the previous subchapter can be summarized by stating that most of the sites on the Odenwald Limes were best accessible from the general course of the frontier. Before the function of the Odenwald Limes as a corridor for safe/protected/controlled route between the garrisons on the Main and Neckar rivers is accepted, it can be further verified via a cost path analysis.

The question at hand is fairly simple: Were the watchtower sites, fortlets and forts located on the most convenient path between principal points of the frontier? A certain amount of the course of Military Way was excavated in the past 150 years (see Table 11). If there is at least some spatial reference to these sections, their locations are used either as destinations/starting points or for correlation of the known or excavated sections of the Military Way with the course of the calculated optimal path.

The question asked is how much the known remains of the Military Way deviate from the most convenient path between principal forts. How far were the watchtower sites located from this ideal way? If some were standing at relative distance from the most convenient path, what were the qualities of these positions, and why did the Romans neglect the positioning of these watchtower sites on the most convenient path?

3.3.14 *Cost path analysis – the results*

The first case study was focused on the section of frontier between *porta praetoria* of the fort at Seckmauern and attested traces of Military Way near Hainhaus. Results showed that the ideal path largely copied or duplicated the presumed position of palisade as documented by RLK (see Fig. 245 and FABRICIUS 1935, Kartenbeilage 1–2). More striking, however, is the fact that it went in the very vicinity of practically all attested watchtowers there, the fort at Lützelbach and fortlet at Windlücke. The watchtower site furthest from the course of the ideal path in this case study, Wp 10/7, was located just 80 m east of the course of cost path results (Fig. 245 and Table 12). If the traces of excavated or expected Military Way are included in the study (Table 12, Fig. 245, and SCHALLMAYER 2007, 88–92; FABRICIUS 1935, TAFEL 3., TAFEL 4., Kartenbeilage 1), the ideal path on this section of the frontier passed just 22 m in average distance from the fort, fortlet, watchtowers, and attested remains of road.

The second case study between known stretches of Military Way between Würzburg and Wp 10/33 showed a similar pattern, with certain exceptions. Despite median values of distances between the attested Military Way (FABRICIUS 1935, TAFEL 5., TAFEL 6., TAFEL 7., TAFEL 8.; WAGNER 1994, 122, abb. 5) together with watchtower positions (see Table 12) on one side and calculated most convenient path on the other were only slightly higher than in the first case study, the average ones were much higher because of the excessive distance of the Hesselbach fort and especially of the Wp 10/31 from the ideal road. Hesselbach lay 272 m from the calculated path, while Wp 10/31 was even 357 m further from it (Fig. 246, Table 12). As an explanation for this deviation we can again consult the results of the viewshed analysis: if the watchtower Wp 10/31 was moved in closer proximity to the calculated path, the intervisibility with neighbouring sites would be lost. Neither from Hesselbach nor from Wp 10/30 and watchtower sites further north was this section of landscape in good line of sight. However, from the position of Wp 10/31 on a gentle hillside, the theoretical sentry from this watchtower site could see as far as to the fort at Würzburg, 5,4 km away, despite the fact that it is much more logical to take into consideration only the visual links with closer sites like Wp 10/27, Wp 10/28, Wp 10/29, and Wp 10/30 (Fig. 192). Furthermore, if vegetation were allowed to grow in proximity to Wp. 10/31, the intervisibility between Wp 10/24, Wp 10/25, Wp 10/27, Wp 10/28, Wp 10/29 and Wp 10/30 and Hesselbach fort could have been blocked by it (see p. 215, 222). This too can be taken as evidence for the need of the frontier builders to locate Wp 10/31 on a spot a bit further from the most convenient path on the north–south axis; in order to make sites intervisible, they already had to clear the woodland of this section of the frontier. No landscape clearance ca 0,3 km–0,6 km east of the position of Wp 10/31, where the most

convenient path led, would have any effect on the intervisibility on the Odenwald Limes. Similar was in certain way also the position of Wp 10/27, located on a small hillock (Fig. 251), on which the vegetation could block many sightlines. Positioning of a watchtower there provided local sentries with powerful line of sight to the neighbouring and farther sites, while it provided the tree-cleared corridor for the visual links of neighbouring sites between forts at Würzberg and Hesselbach.

3.3.15 *Spatial analyses and the Odenwald Limes – summary, final thoughts*

The use of spatial analyses to study the anatomy of Odenwald Limes highlighted several patterns. Sites were intervisible enough to form a lateral signal chain on the course of the frontier, and if a certain amount of extra woodland clearance were to have taken place, most of the watchtower sites were comfortably intervisible with several principal sites (forts and fortlets) as well as abundantly with each other. The so-called edge connections, initially discussed in the case of the Antonine Wall (p. 104, 122–123), were present in large quantities on the Odenwald Limes, and they could not have been achieved without landscape clearance prior to the construction of the first phase of the frontier.

The corridor of 150 m on each side of the palisade (see p. 200) proposed above would have had to be extended locally to keep the lines of sight unblocked by vegetation, but based on the knowledge at hand from ancient sources (Frontinus, *Stratagems* I.3.10), landscape clearance took place already during the first phase of the Limes' existence – construction of Military Way and the first timber watchtowers. Archaeological evidence from Wp 10/8 (FABRICIUS 1935, 42–44) clearly shows that some amount of landscape was deforested already at the beginning of the Limes, and the value of 150 m should be considered as an additional corridor extension, added to the already cleared landscape during the Hadrianic period (see p. 160–161). Therefore, signalling communication must have been possible by the time of erection of the palisade, but there is hardly any reason to doubt that this was not so from the very beginning. On the contrary, the intervisibility lines clearly indicate that 150 m of cleared area would have been enough on each side of the palisade, with local extensions up to double this width only in certain cases.

Some watchtower sites had fundamentally better line of sight to the neighbouring Roman military installations on the Odenwald Limes than did others. Above these were called “communication hubs”, but they could have also served well as “observation platforms” for broader stretches of the frontier (see Table 10, where they are highlighted in bold). More examples of this second type were identified (see p. 222–223), and if we combine observation

capacities of both of these groups, it is apparent that sentries on Roman watchtowers on the Odenwald Limes had in their lines of sight a significant amount of the area west and east of the course of palisade (Fig. 247). But the best line of sight statistically had the watchtowers on the course of the Military Way alongside the course of the palisade. The forts and fortlets were inferior in the landscape observation, but they were located on spots from which one could see either the positions of watchtowers or at least their upper levels (Fig. 203).

The lines of sight to the broader landscape were thus oriented within the frontier. If these are combined with the course of palisade and the course of the potentially most convenient road connecting individual sites on the Limes, it is self-apparent that Odenwald Limes installations were oriented within what in fact should not be called “the frontier” but rather a guarded path. Watchtowers had in their line of sight the course of the Military Way and neighbouring palisade and to a certain extent also the landscape directly neighbouring their course, while the forts and fortlets were located on the best access points to this “frontier area” (or in other words the guarded Military Way), at least as shown by the presented slope analysis and its interpretation (see p. 223–230). Most of the forts and fortlets were located on the natural access points from the east, where traditionally the “*Barbaricum*” was located, but the Würzberg fort was best accessible from the west, apart from the course of Military Way/palisade, so either the surveyors were concerned about intrusions from that direction or the fort was just an interval installation. Sentries from the Würzberg fort also had the best line of sight in the south-western direction, where present-day Bullau village lies.

Despite there is no archaeological evidence for early existence of fortlets, it was proven that they fitted well to system of observation of the frontier area (see Figs. 160, 161 and 162), they were located on spots blocking the convenient access routes to the Military Way (see p. 225, 227–228) and they were also fitting neatly to the intervisibility pattern on the Odenwald Limes (see Fig. 204). That can be an argument for existence of some sort of timber-and-earthen fortlets or just regular watchtowers on spots of late-period stone-walled fortlets.

The fact that at least some of the forts and watchtower sites were “interval installations”, being positioned on their spots to control certain stretches of the frontier but occupying no favourable land in terms of accessibility or visibility, is apparent especially due to the study of alignments. Some of them were no doubt coincidental, principally those not among neighbouring or intervisible watchtower sites (see Table 14), but those located on the lines projecting through the lateral gates/central positions of certain forts appeared too frequently to be coincidental even on linear frontier. Frequently the aligned installations were only one or

more Roman miles (or fractions of Roman miles) from the centre of the fort (see p. 220–223). Indeed, it seems to be much more probable that when surveying the frontier, the surveyors simply chose positions of several “interval” sites from a single surveying point, similar to what was demonstrated in the case of the Antonine Wall (see p. 140). While some of the aligned watchtowers may have been located where they were because the surveyor planning the fort projected more points in just one line (e.g. Würzberg–Wp 10/26, Hesselbach–Wp 10/31, Schlossau–Wp 10/39), more complicated were the examples of alignments of strategic watchtower sites, which were connected via a line to positions of the fort’s lateral gates but still had superior line of sight to the landscape or other neighbouring installations on the course of the frontier. That could have been the example of alignment between Lützelbach and Wp 10/6. While the watchtower stood near the change of the course of the palisade in relatively open landscape, the fort had very bad visibility even to its environs, and it was positioned oddly, as stated above (see p. 225, 228–229). It is therefore not entirely conjectural to propose that the gates of the fort as well as its central point were not chosen for their tactical or topographical superiority but simply from the position of a future watchtower, which was located on a spot with superior line of sight to the landscape and to the positions of other Roman military installations on the Odenwald Limes. Apart from the alignments summarized in Table 14, no general distance formula was identified between individual installations on the Odenwald Limes.

From all the alignments on the Odenwald Limes, the absolutely unparalleled instance is the one between Eulbach and Wp 10/17, Wp 10/18, Wp 10/19, and Wp 10/25. Here it is beyond question that positions of all the watchtower sites were chosen in relation to the fort gates. But even here it is not a prevailing pattern for positioning of individual watchtowers on the frontier; if one checks the results of the viewshed analysis for the Eulbach fort, it is in fact apparent that Wp 10/23, Wp 10/24, and Wp 10/25 were located on the very edges of line of sight from the Eulbach fort (Fig. 156). Principally the same can be said about Wp 10/14, Wp 10/15, Wp 10/16, Wp 10/17, Wp 10/18, Wp 10/20, and Wp 10/29 (see Figs. 175–179, 181 and 190). So, in theory the lines of sight here could have taken, if not precedence, then at least a significant role, and so individual watchtower positions were chosen on this alignment at the last visible spot during the surveying process. Again, parallels to that can be found on the Antonine Wall (see p. 146–147).

The prevailing precondition for positioning of individual watchtowers on watchtower sites thus appears to be the intervisibility with forts and fortlets. This can be called the most common denominator among all the identified spatial relations. Whether it can be linked solely

to the surveying phase, so that after the positions of most of the nodal forts had been chosen the watchtower sites were then selected based on what was visible from the fort site, or whether maintaining the intervisibility was important to create an operational signalling system, is impossible to decipher via spatial analyses. All that can be stated is the indication that the most significant preconditions for the existence of visual signal communication on the Odenwald Limes were met. In terms of visibility and intervisibility, no more watchtower sites were necessary to complete the signalling system, and no more watchtower sites were needed for the comfortable observation of the frontier as it was surveyed. As the only problematic spot remains the absence of Seckmauern fort in later period of existence of the Odenwald Limes and exact positions of successive watchtowers at Wp 10/38.

On the contrary, certain watchtower sites could have been abandoned without any significant impact on the Roman surveillance capacity or the ability to physically control the Odenwald Limes. Wp 10/13 serves as an excellent example. There, no successive stone watchtower was expected but it appears, that there was located one after all (see p. 184), despite the site seems to be rather redundant thanks to its poor results in terms of visibility, intervisibility and proximity of the Hainhaus fort. The Odenwald Limes could operate with ease without this watchtower site, but it seems that garrison stayed there until late. More such sites can be identified, especially in the vicinity of the forts, but the secondary stone watchtowers are also attested there, so despite such spots were being marginal, a garrison stayed in same deployment for most of the time of the existence of the Odenwald Limes even on these spots.

At several sites only stone watchtowers were detected, which according to the generally accepted chronology were younger than the timber ones. Specifically, these are watchtower sites Wp 10/5, Wp 10/38, and Wp 10/39. In the case of Wp 10/5, the non-destructive investigation confirmed the existence of one until then only possible stone watchtower “Auf der Seckmaurer Höhe”. No trace of any timber predecessor has been found, but Professor E. Schallmayer suggested that one may have stood there, exactly on the spot of the later stone one, the construction of which effectively destroyed all traces of its existence (SCHALLMAYER 2007, 90). The fact that the stone watchtower at Wp 10/5 stood $\frac{1}{2}$ Roman mile from the exact centre of the Seckmauern fort, aligned to the positions of its gates, further strengthens this theory; it appears that the position was chosen during the initial surveying phase together with the positions of the gates. As further support for this theory can be also taken the fact that during the construction of the watchtower there fort at Seckmauern was already replaced by fort at Wörth and only a small outpost existed in its former interior at best (see p. 182, 257–258, 269).

Because the Wp 10/39 proved to be aligned in a similar pattern to the Schlossau fort, the author would dare to suggest that also in this case, the timber predecessor of a possible stone watchtower was destroyed during the construction of its stone successor. Problematic here remains the fact that site is known only thanks to the observations of RLK in 19th century and nothing specific was ever found there (see p. 193). Further investigations, concerning also the Limes south of the Schlossau, are needed to address the positioning of this watchtower site.

In the case of Wp 10/38, one more possible watchtower was suggested by the author himself, based on attested terrain anomalies visible on image analysis of LIDAR data. As the third possible watchtower there can be taken the anomaly found via non-destructive methods in 2010 (OSTEN–WOLDENBURG 2010, 134–135). Whether these indeed represent the remains of timber watchtowers is questionable, because they were not attested by RLK during the mapping of the Odenwald Limes. Only one watchtower at Wp 10/38 seems to be fitting to the intervisibility pattern on the Odenwald Limes (see p. 192–193, 212, 215–216 and Table 11).

One last pattern that should be highlighted in the interpretation of the Odenwald Limes is the correlation of results of the viewshed and cost path analyses. The course of the calculated most convenient path in both case studies largely duplicated or went more or less in the vicinity of the course of palisade as documented by RLK (only small alternations were made to its course by author, all based on the interpretation of LIDAR and more recent investigations – OSTEN–WOLDENBURG 2010, 133–135; RABOLD 2010a, 130–132; RABOLD 2010b, 144–149). Precisely in these areas the sentries from forts, fortlets, and watchtowers had the best lines of sight, as Fig. 247 clearly shows. This puts into question the existence of the so-called Grenzstrasse, the more direct road connecting principal sites, such as forts and fortlets (FABRICIUS 1935, 31–32; SCHALLMAYER 2010, 39–40; see also p. 158–159). This road has been traced only in the vicinity of lateral gates of individual forts on the Odenwald Limes, and despite the fact that it is known from other parts of Roman frontiers as well as from the relative vicinity of the studied section of the Odenwald Limes (FABRICIUS 1935, 32, Kartenbeilage 2), it makes little sense under the conditions of the sector studied here. The cost path analysis clearly showed that the most convenient path went largely in the vicinity of the palisade, and the lines of sight of sentries controlling this road were oriented to the course of palisade and the known course of Limesweg/Beglietweg, here called the Military Way. The addition of another road would make very little sense and certainly would not save an effort for travellers. The lack of sense for its existence sets off especially in sections between Wp 10/8 and Wp 10/11 and between Wp 10/16 and Wp 10/37, where for most of the time the frontier ran on a narrow ridge on which two roads would have been practically parallel. Furthermore, the Military Way went almost

exactly through the course of the cost path results, which highlighted the compromise between the most convenient and the most direct path between principal sites on the Odenwald Limes. Any alternative road would either have had to bypass the problematic areas or take a straighter course through unfavourable slope, which would be both more demanding and time-consuming than using the Military Way. The only alternative would just duplicate the existing Limesweg/Beglietweg, which makes no sense, and there is no archaeological evidence for it. It is therefore the author's assumption that only one road was present on the studied section of the Odenwald Limes: Limesweg/Beglietweg or simply Military Way, which connected all the military installations with ease. The traces of road attested in the vicinity of several fort gates joined this road not far away from the forts, as their general directions in the RLK report indicates in the cases of Hainhaus, Eulbach, Würzberg and Schlossau (FABRICIUS 1935, Kartenbeilage 1–2).

3.4 Appendix II. – technical specification of models used for spatial analyses on the Odenwald Limes

All the presented analyses were performed in an artificial environment in the ArcGIS 10.1–4 programme. The terrain model used for the watershed analysis of the Odenwald Limes consisted of four independent data sets, from which the final raster was made. The first model chosen for this study was the FDGM1 (ATKIS DGM), provided by Goethe-Universität Frankfurt am Main, Institut für Physische Geographie, via a student research license. The data can be downloaded on a commercial basis from HVBG (<https://hvbg.hessen.de>). This model was used for the part of the frontier in present-day Hessen.

The airborne LiDAR was collected since 2007 directly by HVBG. The resulting raster corresponds to a German nationwide standard that was set by the AdV (<http://www.adv-online.de/AdV-Produkte/Standards-und-Produktblaetter/Standards-der-Geotopographie/>). Unfortunately, the density of collected points varied considerably, and the producer of the data does not offer any further information save that all the data have vertical accuracy better than $\pm 0,2$ m and horizontal accuracy better than ca. $\pm 0,5$ m. The processed raster has a resolution of 1 m. The metadata published by HVBG can be accessed here:

http://www.geoportal.hessen.de/mapbender/php/mod_iso19139ToHtml.php?url=http%3A%2F%2Fwww.geoportal.hessen.de%2Fmapbender%2Fphp%2Fmod_dataISOMetadata.php%3FoutputFormat%3Diso19139%26id%3Dddd93aba-541d-81a7-a97b-4697962b1ba6

The second model chosen for this study was the DGM1, provided by Landesamt für Digitalisierung, Breitband und Vermessung, Bayern via Nutzungsvertrag wissenschaftliche Arbeit. The data can be downloaded on a commercial basis from LDBV Bayern (<https://www.ldbv.bayern.de/produkte/3dprodukte/gelaende.html>). This model was used for the part of the frontier in present-day Bayern.

The DGM1 version used here was from 2014. The accuracy of the data set should correspond to a German nationwide standard that was set by the AdV (<http://www.adv-online.de/AdV-Produkte/Standards-und-Produktblaetter/Standards-der-Geotopographie/>). Unfortunately, again the density of collected points varied considerably, and the producer of the data does not offer any further information save that all the data have vertical accuracy better than $\pm 0,2$ m and horizontal accuracy better than ca. $\pm 0,5$ m. The data were offered to the public via ASCII-txt with a density of 1 point per m². The metadata published by LDBV can be accessed here:

<https://geoportal.bayern.de/geoportalbayern/anwendungen/details?0&resId=232bbb29-ea24-3a5c-8b9a-ea05c0d7525b>.

The third model used in this study was the DGM1, provided by Landesamt für Geoinformation und Landentwicklung Baden-Württemberg via a student research license (Auftragsnummer 2802064407). The data can be downloaded on a commercial basis from LGL Baden-Württemberg (<https://geodatenshop.lgl-bw.de>). This model was used for the part of the frontier in present-day Baden-Württemberg.

The DGM1 version used here was from 2008, and the airborne scanning took place between 2000 and 2005. Again, unfortunately, the density of collected points varied considerably, and the producer of the data does not offer any further information save that all the data have vertical accuracy better than $\pm 0,2$ m and horizontal accuracy better than ca. $\pm 0,5$ m. The data were offered to the public via ASCII-txt with a density of 1 point per m^2 . The metadata published by LGL Baden-Württemberg can be accessed here: <https://www.geoportal-bw.de/geonetwork/srv/api/records/fd2e83e8-44cd-c7d6-91a6-eaa8f5c014d1/formatters/xml>.

The fourth model used in the study of the Odenwald Limes was ALOS World 3D – 30m (AW3D30), provided by the Japan Aerospace Exploration Agency via an academic staff license. The data can be downloaded on a non-commercial basis from JAXA (<http://opentopo.sdsc.edu/>). This data set was used as an auxiliary model for simulation of visibility to a wider area beyond the coverage of the rasters mentioned above.

The version used was from 2017, and the satellite survey itself took place between 2006 and 2011 (TADONO – ISHIDA – ODA – NAITO – MINAKAWA – IWAMOTO 2014, 71). Once again, the density of collected points varied considerably, and the producer of the data does not offer any further information save that all the data have vertical accuracy of ca. 5 m and horizontal accuracy of ca. 5 m (TAKAKU – TADONO – TSUTSUI 2014, 244). The processed raster has a resolution of $30 m^2$. The metadata can be accessed here:

<http://opentopo.sdsc.edu/datasetMetadata?otCollectionID=OT.112016.4326.2>

To be compatible with the data mentioned above, the ALOS World 3D – 30m (AW3D30) was transformed into a 30 m grid of points, among which the so-called TIN (triangulated irregular network) was calculated in ArcGIS 10.4 using default settings. This model was then transformed into standard DEM (digital elevation model) using the TIN To Raster tool via the NATURAL_NEIGHBORS method, with an individual cell size of 1 m in

otherwise default settings (<https://pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/tin-to-raster.htm>).

The resulting four rasters were merged via Mosaic To New Raster tool in ArcGIS 10.4 using default settings with the Mean Mosaic Operator (<https://desktop.arcgis.com/en/arcmap/10.3/tools/data-management-toolbox/mosaic-to-new-raster.htm>). The resulting model was used for the visibility and intervisibility analyses. Despite the fact that the differences among horizontal values in first three datasets were maximally in several centimetres, on the boundaries with part of the model based on reclassified ALOS World 3D – 30m (AW3D30) the differences were sometimes on the order of several metres, and therefore the viewsheds were locally imprecise. This is why the results beyond the terrain datasets represented originally by DGM's were used solely for rough estimates of visibility to the broader stretches of the landscape and not for intervisibility, because horizontal errors of possible metres can change drastically the results of intervisibility analyses.

For the purpose of the slope analysis, the resulting model was processed via the Slope tool in ArcGIS 10.4 in a similar manner as was done in the case of the Antonine Wall (see p. 150–151).

The cost path analysis was calculated in the model based solely on FDGM1 (ATKIS DGM). From this model the modern infrastructure was deleted as stated above (see p. 202–203). For this alternation, the model was initially cut by manually made polygons beyond the boundaries of apparently manmade features. The clipped raster was then transformed into a grid of points with resolution of 1 m, in which the deleted areas were forming apparent gaps. New terrain dataset was created from these data via natural-neighbour interpolation in the default setting (SIBSON 1981, 21–36) with a resolution of 1 m. The interpolation calculated the elevation of cells in the gaps based on the trends of Z values in rows of neighbouring cells and did not alter the elevation of terrain where the density of points was identical with the resolution of the primary raster. The resulting model can be specified as an approximation of the landscape without manmade alterations. There is no way to evaluate whether the landscape actually looked like this in the past. The erosion and landscape changes are not included, so the model represents current landscape but without bridges, road embankments, wind power plants, etc., which is as close as one can get when reconstructing the past landscape without working in an environment altered by predictive analysis

(http://downloads.esri.com/resources/defense/Getting_Started_with_the_ArcGIS_Predictive_Analysis_Add-In.pdf).

The cost path was in both case studies calculated in default settings, as was done for the Antonine Wall, except for the use of an additional accumulative cost resistance rate at a value of 0,001.

4. Comparison of the Antonine Wall and the Odenwald Limes

4.1 Introduction

The initial step in every comparison is to define what cannot be compared. A wide variety of the evidence presented so far from the Antonine Wall and Odenwald Limes cannot be compared simply because the comparable information is either missing, or present only in unequal or limited amounts. Although the peripheral areas of the Antonine Wall were extensively studied via spatial analyses, until the publication of this thesis the author was unable to obtain a credible model that would allow him to perform a similar analysis for the section of the Main valley, where the “Mainwachturmen” 1 and 2 stood (SCHALLMAYER 2010, 71–72), and thus determine their relationship to either Obernburg or Wörth forts. Similarly, there could be no comparison of the most convenient access paths from the inhabited sections of the *Barbaricum* to the area of the Odenwald Limes, despite there being a similar model for the Antonine Wall (see p. 129–130). The greatest obstacle to such study was the current state of knowledge, from which it appears that the Odenwald region and areas neighbouring it in the east were largely depopulated during the existence of Odenwald Limes (THIEL 2009, 138). Secondly, the acquisition of a terrain model credible enough for anything other than serving as a periphery for visibility analysis was beyond my financial means. The comparison is thus offered below in terms of regional topography only (see p. 133–140, 223–238).

Sadly, no meaningful comparison of bathhouses can be offered, although a detailed description of these is offered for many sites on the Antonine Wall and Odenwald Limes. Again, the state of research is the main problem. Even though the bathhouses are known from both frontiers, in the vicinity of almost every fort, and in several instances had similar dimensions and plans, the successive periods of reconstruction are known for the Antonine Wall, but all the bathhouses on the Odenwald Limes were excavated a long time before the stratigraphic relationship of the building process was being documented in archaeology. The only comparison at hand is the statement that bathhouses at the Odenwald Limes were of a standard design and of similar proportions to other bathhouses in the Antonine period, including those on the Antonine Wall (REVELL 2007, 230–237; e.g. compare BREEZE 2016, 44, Illus. 3.3.3 and SCHALLMAYER, 2008a, 77–80 and p. 45–53, 168–176). Bathhouses in the context of the Antonine Wall were often connected to the annexes. No general rule about their provision and maintenance has been discovered so far in the context of the Antonine Wall (see p. 62–67), and no annexes are known from Odenwald Limes. Apparently, there was no reason why units on the Odenwald Limes shouldn't have their bathhouse freestanding in the vicinity of the fort. The

baths were apparently not aligned to the course of the *via principalis* on the Odenwald Limes (Pl. 21–27), and in fact this is true of only a minority of baths in the context of the Antonine Wall (Pl. 1–18). A similar disparity was found in the provision of civilian settlements – only one *vicus* has been examined in detail in the context of the Odenwald Limes (see p. 175–176), but there is nothing to compare it with on the Antonine Wall (see p. 67–69). The internal organisation and layout of individual forts on both frontiers also cannot be compared in very general terms, since the majority of forts on the Odenwald Limes were never excavated, and we can only presume that they were the same or very similar to the Hesselbach fort. In this regard only the known sizes of the forts and their positioning on the frontier are comparable, which is discussed below (see p. 248–253). Sadly, the forts on the Antonine Wall that are of comparable size to Hesselbach yielded only limited evidence about their internal arrangement. Still it is noteworthy that, unlike at Hesselbach, at Rough Castle and Bearsden the *praetentura* served as accommodation for the common soldiers. The positioning of the *praetorium* and the absence of granaries at the Odenwald Limes further implies that although the forts were of similar size and a similar number of soldiers were probably accommodated there, the forts in nowadays Scotland and Germany were garrisoned by different types of units.

What can be compared thus is: the construction of both frontiers and their abandonment, the nature and preservation of inscriptions, the surveying of the Antonine Wall and Odenwald Limes, and the way both these frontiers later operated. The implications of these comparisons are further discussed in the last chapter (see p. 254–267). Suggestions about the distribution of the garrison there, and how the frontiers could have been managed are offered and discussed, together with their relationship to the archaeological evidence and results of spatial analyses.

4.2 The construction of the frontiers

The Antonine Wall and the Odenwald Limes were both built after an initial surveying phase. In case of the Antonine Wall there is abundant evidence that all three legions stationed in *Britannia* participated in this task, as the division of labour was recorded in detail via distance slabs and apparently a great deal of effort was invested in the proportionality and equality of built sectors of the linear barrier (see p. 15–17). Epigraphic evidence further indicates that some forts and practically all the fortlets were built at the same time as the Antonine Wall, and that the others were probably added not much later; with few exceptions their positions were chosen before the construction of the Antonine Wall (see p. 25, 144).

Interpretation of the building process of the Odenwald Limes is much more complicated. There is no epigraphic evidence for the construction of a series of timber and

earthen forts and timber watchtowers, no labour division can be identified via epigraphy and although it is traditionally believed that legionaries from two legions in *Germania Superior* were responsible for the construction, there is actually no direct evidence for that. This assumption is based on evidence for the construction of successive stone watchtowers by numeri units in combination with the distribution of the officers on the frontier. Apparently two construction techniques were applied on the Odenwald Limes, one north of the Schlossau fort and the other south of it (see p. 161). The same spatial division can be identified when the inscribed material is more closely examined – the inscriptions dedicated by the officers of Twenty-Second Legion were found north of the Schlossau, while south of this fort apparently the centurions from Eight Legion dominated (see p. 159–160). Since the legions obviously took care of the different parts of the frontier, it is thus assumed that they were also initially responsible for the construction of different parts of the frontier. This can in fact be considered as a similar division of labour as for the Antonine Wall, and only the distance slabs are lacking from the Odenwald Limes.

Both examples of Limes are much more comparable when it comes to the history and execution of modifications and repairs to the existing frontier. Although this must have been a laborious task requiring a certain amount of specialised skills, apparently on the Odenwald Limes the soldiers from numeri units instead of legionaries or auxiliaries were charged with the task of replacing the timber watchtowers with stone ones (see CSIR-D-02-13, 00242, CSIR-D-02-13, 00243, CIL XIII 6498, CIL XIII 6511, CIL XIII 6514, CIL XIII 6517 and CIL XIII 6518 and p. 161). Although inscriptions do not mention them, no doubt the technical support for both the erection of the stone watchtowers and contemporary reconstruction of the fort's defences was provided by specialised craftsmen from legions (*Imunes*). Still the units responsible for construction were the men from numeri units, and if the legionaries had done the job instead, they would no doubt have commemorated it with their own inscriptions, bearing the name of their units as responsible for the task. The fact that they didn't indicates that legionaries were present at best as individuals only during the repairs of the Odenwald Limes, temporarily assigned to other units. The situation in the case of the Antonine Wall was different, where the majority of building inscriptions commemorated the initial building activity of legionaries (RIB 2163, RIB 2171, RIB 2180, RIB 2188, RIB 2191, RIB 2192, RIB 2209, RIB 2210, RIB 2216 and RIB 3506). Even here, however, the apparent reconstructions were made by auxiliaries (RIB 2170, RIB 2145 and RIB 2155, see also p 25–30).

These construction and repair activities may explain the presence of individual legionaries on both of the frontiers – at the Odenwald Limes the majority of inscribed material

can be attributed to the commanders of numeri units (*Praepositi Numeri*), in the case of the Antonine Wall, where no numeri units are attested, the legionary centurions could have only commanded the small vexillations of auxiliary units divided among the small forts or the individual legionaries may have been charged with organising the repairs or other building activities with garrisons at hand, which also contributed with the inscription in their name (see p. 27–28 and RIB 2170, RIB 2145, RIB 2155). It is notable the presence of individual legionaries on the Antonine Wall is known from sites where a plethora of repairs and reconstructions took place (see Balmuildy RIB 2191, RIB 2192, Castlecary - RIB 2146, RIB 2147, RIB 2148, RIB 2149 and RIB 2151, Croy Hill - RIB 2160, RIB 2161, RIB 2162, RIB 2163, Rough Castle - RIB 2144). The tombstone of an apparent legionary and his sons at Croy Hill, who could have been representative of specialised craftsman entrusted with the supervision of building or repair activity, is especially noteworthy (COULSTON 1988, 1–29).

It seems to be much more logical to employ a locally available workforce to maintain and repair the frontier and the individual posts there, rather than sending entire legionary detachments from distant bases to do the repairs that were needed practically constantly everywhere on the Limes. The initial phase of construction of the frontier (connected with the surveying phase) required the massive employment of a specialised workforce, not only for the complete construction of the forts, fortlets and watchtowers, together with standardised Military Way, but in the case of the Antonine Wall also for the erection of a massive linear barrier. The evidence from both frontiers points to this organisation of affairs on the Limes, and although none of the examples presented can be taken as a general rule, the comparison at least clearly shows the distinction between a repair/reorganisation/reconstruction of the frontier on one side, which could have been handled with a local workforce under the leadership of specialised legionary foremen, and centrally organised construction of brand new frontier line, which required the deployment of specialised workforce en masse.

4.3 The abandonment of frontiers

Both the Antonine Wall and the Odenwald Limes were abandoned on purpose, without major military or political defeat and in an orderly fashion. The execution of abandonment differed in the two areas. On the Antonine Wall practically all the evidence suggests that the forts and fortlets were burned down, buildings levelled, and all the valuable material either destroyed or buried deep under the ground or in wells, on the Odenwald Limes, at least in the case of forts, it appears that there was taking place careful dismantlement rather than a simple destruction of the former bases. Troops retreating from Scotland were leaving their previous bases de facto to

the enemy, and therefore they applied a sort of ‘scorched earth policy’, while the numeri leaving the studied section of the Odenwald Limes were moving forward from apparently friendly and pacified territory.

Both garrisons probably left some residual outposts operating on former frontiers. Any comparison of these residual outposts is almost impossible because of the general dearth and ambiguous nature of the evidence at hand (see p. 88–91, 195–198). It can at least be presumed that the post-frontier outpost must have been profoundly different in character – while on the former Odenwald Limes one should expect that there remained small sentries at the important crossroads and the civilian settlements possibly continued to exist for a while (see p. 167–170, 175–176), on the Antonine Wall an isolated outpost with few soldiers would be ineffective without the proximity of larger backup forces, or outside of the area of tribes who were friendly to the Romans. The very limited evidence suggests that the relatively large coastal bases and a largest fort at Mumrills were the last places abandoned. The length of time for which these bases served as the outposts is, however, unclear (see p. 88–91). Very few comparable patterns can thus be identified in the way the Antonine Wall and Odenwald Limes were abandoned, although principally both of these actions were apparently orderly and planned in advance.

4.4 The inscriptions

Both studied frontiers are well known for the abundance of inscribed material that was found during their excavation and documentation. There may have been various reasons that so much effort was invested into the provision of frontier posts with elaborate engravings, often further sculpturally adorned by *Peltes* or the winged Victories. Despite the nature of the Odenwald Limes as a connecting line could probably motivate the sentries to adorn their posts with lavish and grandiose reliefs (THIEL 2009, 138–140), this cannot be expected on the Antonine Wall, because of the remoteness of the frontier and generally low level of Romanisation of northern fringes of province *Britannia*. There was no wide audience for the monumental reliefs erected there, especially for the distance slabs on the northern face of the Antonine Wall rampart, where only isolated Roman patrols and Caledonian barbarians could see them. Instead, emperor’s own propaganda may have played a key role in the conquest of nowadays Scotland in the 2nd century AD and subsequent construction of the Antonine Wall and lavish commemoration of this deed (see p. 11–13). That was addressed primarily to the army, which physically built the monument and then withdrew back to its permanent quarters in nowadays England (see p. 16–17).

So again, the Antonine Wall and Odenwald Limes have much less in common than suspected. In the author’s belief, an explanation for the rich adornment of the frontier posts

(specifically the distance slabs on the Antonine Wall) on both studied sections of the Limes should be still looked for somewhere else. In the Antonine period, to which all the inscribed material from both the Antonine Wall and Odenwald Limes belongs, richly adorned inscribed stones in a similar artistic style were at least occasionally used on the other sections of Roman frontiers, such as in *Pannonia*, *Moesia* or *Dacia* (IVLEVA 2012, 208–209), although they are not found there that often. The exceptionality of both the Antonine Wall and Odenwald Limes should be perceived in the amount of epigraphy, which survived, and was only found since the late middle ages in the respective regions (see p. 5–6, 16–17, 25–30, 153–155, 159–160). The survival in quantity is actually what makes the material from these frontiers unique and an explanation should be looked for in the history of research and the fate of the frontiers after their abandonment.

At the Antonine Wall many of the inscribed stones were deliberately hidden in disused wells or ritually buried under the ground (see p. 88–91). Ploughing or stone robbing thus couldn't endanger them until a relatively long time after, when settlements in central Scotland started to expand and deep tillage was introduced. At the Odenwald Limes, other reasons, further discussed below, could have played an important role, except for the deliberate abandonment of this frontier (probably accompanied by a specific form of deposition for at least some inscriptions in the ruins of the demolished stone watchtowers – see p. 154–192). The general remoteness of nowadays Geo-Naturpark Bergstrasse-Odenwald allowed a relatively thick forest to cover most of the former frontier up to today, and therefore helped to protect the inscriptions against chance discoveries during ploughing and their subsequent reuse as stone material for building purposes (although something like this happened in both studied areas from time to time, e.g. the lost inscription at Wp 10/25 – p. 179 or the similarly lost inscription from Bar Hill – RIB 2172 p. 28). The deliberate hiding of inscriptions and the absence of an extensive agricultural usage of the landscape can thus be perceived as favourable preconditions for the survival of many inscriptions. That is exactly what happened at the Antonine Wall and Odenwald Limes respectively. The fact that both frontiers had been deserted for a long time when the massive stone robbing of abandoned Roman frontier posts took place in late antiquity and in the early middle ages in many other areas of former Limes (e.g. in case of RIB 1051 or CIL III 5769, just to mention those in proximity of the studied area) no doubt also played a positive part.

4.5 Surveying of the frontiers

The principal problem of any assessment of the similarity or dissimilarity of the surveying process in the cases of the Antonine Wall and Odenwald Limes is the very nature of the evidence, which is always indirect. Although it is well known that the main tool for all the surveying in the Roman period was the *groma*, with which the experienced worker could survey the straight lines, squares and rectangles in the landscape via series of right-angled triangles (DILKE 1971, 70), much is still unknown about the surveying of the linear frontiers in general, including the effective surveying distance or workforce management during the surveying process. The evidence thus consists solely of what was surveyed, and we can only speculate about the way it was done.

The first step in assessment of the surveying process is the definition of the sites, which can be considered nodal – they defined the position and course of the frontier, and the sites between which the frontier was later built. At the Antonine Wall such sites were the easternmost and westernmost harbours in the extremities of the Forth-Clyde isthmus, which was chosen as a frontier line for obvious reasons – even nowadays it effectively cuts Scotland in half. Probably only a few other locations had such an effect on the layout of the frontier and the course of the linear barrier as the terminal harbours – even the strategic position of Camelon was chosen without regard to the course of the Antonine Wall (or perhaps the course of the Antonine Wall was chosen without an attempt to incorporate this nodal fort, see Table 4), but apparently the Camelon fort played a vital role during the surveying process – see p. 146–147). Both the course of the Antonine Wall itself (POULTER 2009, 116–120) and the course of the Military Way on the Odenwald Limes always turned to the positions of the nodal sites (see p. 145–149, 232–234).

At the Antonine Wall, the river crossing played the most important role further (see p. 145–146) and several strategic places were also chosen with regard to their blocking capacity of north-southern communication (see p. 127–133). From a surveying point of view, nodal sites thus included Carriden, Camelon, Castlecary, Bar Hill (the only site for its excellent line of sight rather than for blocking movement in the landscape), Balmuildy and Old Kilpatrick. All these forts were located either on important river crossings (Camelon, Castlecary, Balmuildy), superior observation and surveying spots (Bar Hill) or they fulfilled the already mentioned function of convenient harbour (Carriden and Old Kilpatrick). On the Odenwald Limes the pattern was much more uniform. The nodal sites – defined as all the same-sized forts – were located at places most easily accessible on the course of the frontier and at least somehow

accessible from the areas beyond it (see p. 223–230). Again, the starting point in the north was probably defined by good anchorage near the position of the later fort at Wörth. There were no river crossings on the studied section of the Odenwald Limes.

It already appears, that there were differences between the two examples of the Limes Romanus in the selection of the nodal sites – while the Antonine Wall forts tried to block or control movement from/to the territory south of the frontier (see p. 145–146), the Odenwald Limes nodal sites were best accessible from the course of the “frontier” itself, some were located on spots with good access to potential *Barbaricum* (see p. 223–230), and some were better accessible from exactly the opposite direction (see p. 226–227). The nodal sites were thus chosen with regard to the expected movement of people in the local landscape – at the Odenwald Limes the access points to the controlled frontier road – Military Way were checked, and at the Antonine Wall the primary concern was the access points to the paths south of the frontier line.

If the nodal site positions on the two frontiers differed, surprising homogeneity can be observed in the landscape setting of the intermediate sites, as either inaccessible outposts or just those occupying less accessible positions from various directions. Several smaller forts and fortlets on the Antonine Wall were positioned directly intervisible with nearby nodal sites. But if they would have been moved to more accessible spots, the intervisibility with neighbours would have been lost (see p. 105–110). Surprisingly even Bar Hill fort could be defined in this way, since it was carefully positioned off the Antonine Wall in order to have a good line of sight to the surrounding area but most importantly also the east, to positions of other sites (see p. 105–106). That was obviously a preference over physical attachment to the frontier rampart, typical for all the other installations on the Antonine Wall.

The very same characteristic can be applied on the majority of watchtower sites on the Odenwald Limes – the intervisibility between plethora of forts and watchtowers was enabled only on a threshold and if the watchtower sites would have been moved (sometimes to a spot with better line of sight in general or on more convenient spot for blocking the free movement throughout the landscape), the intervisibility would be lost (see p. 216–218), just like in many Antonine Wall sites. Interestingly, one in theory had such good line of sight from the individual watchtowers on the Odenwald Limes, that if the fort in question would have been moved, it’s new position could have been shifted several dozen meters in most of the directions and still it would be visible from the watchtower, but moving the watchtower site the same way would

usually block the intervisibility for good (Figs. 204–208). Clearly the watchtowers were positioned in order to be intervisible with the forts and not vice versa.

All the just mentioned should not overshadow the apparent fact that great deal of dissimilarity can be found between mentioned frontiers in terms of positioning of the intermediate/marginal sites. The absolute majority of Antonine Wall small forts and fortlets had good line of sight beyond the frontier, especially to the river valleys, where the access paths to the linear barrier lied (see p. 127). On the other hand, on the Odenwald Limes usually only one of the watchtower sites between the forts or between the fort and fortlet had at least some line of sight to the area beyond the frontier (see p. 232–233).

The landscape positioning of individual marginal frontier posts clearly differed. The best example of this phenomenon is the role of fortlets, which on the Antonine Wall stood on various positions that usually could not have been defined as major blocking or strategic points (possibly with exception of Watling Lodge, see p. 71, 137, 141; maybe also Inveravon, if fortlet was located there, see p. 62–63, 74, 80 and Table 4). On the Odenwald Limes the fortlets, regardless when added to the frontier (see p. 233), were positioned on the access routes from within to the frontier itself. They had absolutely marginal lines of sight and were intervisible only with their neighbours. Just from this definition it is apparent that these installations must have performed different duties on their respective frontiers and their positions were chosen with different intentions. Especially the cases of marginal sites points to a different focus, that was put on the positions of permanent installations on the frontiers – while on the Antonine Wall the main concern was the access to the area beyond the frontier/blocking the movement from the area beyond the frontier in the nodal sites, the marginal ones usually had common denominator in good line of sight to the area beyond the frontier and visibility to the already described nodal sites in their vicinity (see p. 101–102, 127, 141–142).

The Odenwald Limes differed. The main focus was put on the course of the frontier – the main sites blocked any access from outside of the frontier area at regular intervals, as they were located in places best accessible on the course of the linear frontier, while the intermediate watchtowers had the best line of sight again on the course of the linear frontier (see p. 232–237). The sole function of blocking the movement in the landscape had just three fortlets on the Odenwald Limes and nearby watchtower sites were carefully positioned to be still intervisible with them. If any common pattern can be seen, it is the attempt to have nodal sites on blocking points/crossroads in the landscape, and that the positions of all the others were dictated by visibility to the areas of interest. At the Antonine Wall that was beyond the linear barrier to the

north, at the Odenwald Limes the course of the Military Way was the obvious focus. Why some access points were controlled by the forts and some only by fortlets can only be explained by an individual evaluation of their importance (see p. 254–267).

The course of the Military Way on the Odenwald Limes was surveyed as almost identical with the course of best possible path connecting the nodal sites. Very little deviation from this scheme was found, and if it indeed existed, it was only small and apparently conducted in order to make Hesselbach intervisible with several watchtower sites (see p. 231–232). Such an assessment could not have been made on the Antonine Wall (see p. 97–98, 130), but at least it was recognised that several sites were clearly positioned on the crossroads of the course of the linear barrier and the most convenient access routes from the broader areas beyond the frontier to the south of it – that is, where the forts at Inveravon, Castlecary, Cadder, Balmuildy and Bearsden were located (see p. 134–140). While Castlecary and Balmuildy can be defined by their sizes and positions as nodal sites, Inveravon, Cadder and Bearsden forts positions were obviously chosen also with the respect to the alignment system and without respect to the intervisibility pattern. The sites could well have controlled the movement from the north to the south and somehow served the same purpose as the fortlets on the Odenwald Limes – they were representatives of marginal sites whose positions were chosen in order to block free movement in the landscape on the north-southern axis (see Table 4). Other marginal fort sites on the Antonine Wall, such as Westerwood, Castlehill and Duntocher, were obviously chosen for good lines of sight to the landscape for their garrisons.

The question of surveying the less important sites on both frontiers can be also approached via the existence of alignments. These, after all, seem to have been most related to the surveying phase of the future frontiers (see p. 146–147, 233–235). Although they were identified on both frontiers, they differed greatly in what was actually aligned, and some should be considered non-realistic or conjectural, on both the Antonine Wall and the Odenwald Limes (see Tables 3 and 14 and p. 123–126). The logical alignments on the Antonine Wall may be those projecting from at least one surveying nodal site (Carriden, Camelon, Castlecary, Balmuildy and Old Kilpatrick), and those projecting/ending on Bar Hill, where the early surveyors camp was located (see Table 6). In some of these cases the aligned gates were located at the exact distance from the source/end point of the alignment. The surveyors were no doubt able to achieve this up to distances of several kilometres (DILKE 1971, 59–61). Dividing the course of the future Antonine Wall into sectors of known length between individual forts and fortlets could have helped them with the task, since the division of forts and fortlets by regular distances made it far easier to calculate the length of the built rampart, later divided between

the individual gangs of legionaries (see p. 146–147). Furthermore, the positioning of individual sites aligned to other sites ensured the relative straightness of the linear barrier in grand scale despite it ran in both cases in slightly zig-zag manner. All the other alignments (between marginal forts or fortlets) should at least for now be considered merely as suggestions. They could have been coincidental, or they could have been part of a more complex system that cannot be reconstructed via evidence available at hand. The specified realistic alignments of the Antonine Wall indicate (highlighted starting site in bold in Table 6) that several major points – gate positions – were used for surveying the frontier, and defined the positions of sites that again can be called intermediary – those filling the gaps between garrisons whose positions were already dictated by the landscape. The logic of such positioning is clear – surveying from several nodal points hastened the process of frontier construction, and the Antonine Wall could have been subsequently planned via short stretches, usually in the direction of the best field of view between individual sites (POULTER 2009, 116–117), when the general course was known. Even marginal sites such as the fortlets and expansions were demarcatable in the landscape on their exact spots at more or less the same time, their positions delineated by the easiest and most common Roman surveying method, offered by *groma* – a direct line (see p. 248).

The situation on the Odenwald Limes was fundamentally different in terms of the alignments. Here the concern of the surveyors was apparently not on defining all sites prior to the construction of the linear barrier, since no linear barrier was built there until the reign of Hadrian. Instead, the positions of marginal sites were chosen on the very same line that already defined the positions of fort gates and from the exactly the same surveying spots used for the construction of the nodal sites – forts, already predefined by their landscape setting mentioned above. The ultimate precondition for such a surveying method was a direct line of sight, and that could be one of the explanations for the common intervisibility of individual watchtowers with nearby forts, regardless of the complex terrain relief of the Odenwald mountain range. Again, the alignments observed on the Odenwald Limes, which were either between individual watchtowers or simply fort gates and watchtowers, should be considered as less credible and more conjectural, simply because they do not seem to bring any advantage to the survey of the frontier or its later operation (the more credible have starting site highlighted in bold in Table 14). The alignment between individual gates plus the centre of the fort and the individual site was, in the case of the Antonine Wall, identified only between Cadder fort and Glasgow Bridge fortlet (see p. 126), and theoretically something similar could have been expected in the case of the Bearsden fort, although these alignments were much less clear, because of the lack of direct intervisibility between aligning sites (see Table 6). At Odenwald Limes, however, the aligning

of the watchtowers again allowed the surveyors relatively quickly to choose where the new outposts and the course of the Military Way should be built, all during the same process, during which they had already demarcated the positions of the fort gates. The allocation of work could thus have been assessed and the process of constructing the frontier could start without further delays.

The principal prerequisite for surveying the Odenwald Limes was the landscape clearance – obviously a corridor must have been cut through the forest so that the positions of the watchtowers could be defined via the alignments. The same width of corridor was eventually necessary for both the alignments of the watchtowers to the gate positions of the forts, and for possible signal communication (see p. 232). As already discussed, the corridor in the absolute majority of cases was ca 150 m to the left and right from the course of the Military Way / nearby later palisade. Just in few places the intervisibility was achievable only with even wider corridor (see p. 217). The tree-cleared corridor could obviously have been either cut physically by legionaries constructing the frontier, or the original forest could have been burnt down in a controlled manner, and at least some evidence from Hesselbach indicates that option (see p. 162).

All the evidence presented suggests that the surveying of both frontiers was performed visually – visibility to certain stretches of the landscape was important on both frontiers, and the alignments could have been made with ease only between intervisible sites, either directly or at least from the position of what was aligned. More complicated alignments should be considered as less probable, despite not entirely impossible – definitively they must have been more laborious to achieve (see p. 125. 147). The hierarchy of the sites appears as a recognisable pattern, some sites were chosen with regard to the landscape (the nodal ones, from which the other installations were surveyed) and the others with regard to them. The nodal sites can be defined as those meant to block movement throughout the landscape. The secondarily chosen sites were sometimes less accessible, but they were chosen because of a good line of sight to either the landscape or to the neighbouring sites, or they were simply intermediary sites, located on some less prominent access points to, or beyond, the frontier. If the surveyors chose the last option, then they usually preferred either to select a site on a place visible from the positions of one or two other nodal sites or to locate it on a local topographical crossing point over the frontier line, such as where the fortlets on the Odenwald Limes were located or indeed as the fortlet at Summerston on the Antonine Wall was located (see p. 141–142, 225–228). The importance of frontier crossings/access to the frontier line was clearly defined by the size of garrison supplied to mentioned posts, which is discussed in further chapter.

5. Modus operandi of the Antonine Wall and the Odenwald Limes

5.1 Introduction

The abundant evidence for the Antonine Wall and Odenwald Limes, acquired via both archaeology and spatial analyses, was compared and evaluated in the previous chapter. Hints and suggestion were offered regarding the creation, surveying and abandonment of both frontiers. One topic that occasionally arose during the discussion of surveying but has not yet been properly discussed. What was the goal of surveying the frontiers in the way they were surveyed? What were the Romans trying to achieve? In other words, how were the Roman frontiers supposed to operate – what was the modus operandi of the Antonine Wall and Odenwald Limes?

5.2 Modus operandi of the Odenwald Limes

The Odenwald Limes will be discussed first, primarily because Professor Dietwulf Baatz suggested its modus operandi relatively recently, in 2007 (BAATZ 2007, 8–25). This was in accordance with the modern interpretation of the Roman frontiers – the Limes was a rationalisation of frontier control in order to suppress raids into the province from *Barbaricum*. The controlled Military Way served as a communication hub for reinforcements and the transport of supplies – the small barbarian warbands may have tried to attack the convoys or sneak into hinterland to pillage there. The string of observation platforms – watchtowers in the forest-cleared corridor – served as a prevention. The watchtowers were supposed to raise an alarm when their garrisons spotted anyone unauthorised trespassing into the tree-cleared corridor of the Limes. In moments of crisis the watchtowers could hold the ground for a while – that is why they had entrances on the first floor. The relief should soon arrive via the Military Way from the nearest fort and push any small raiding party (so called *latrunculi*) back. The raiders were later blocked further by the palisade, which certainly could not stop them, but at least hindered their chances of crossing the frontier without being seen and also prevented them from carrying out the attack from horseback (BAATZ 2007, 8–17).

Professor Baatz estimated the intervisibility between sites via the topographic study of a map with a resolution of 1:50 000 (BAATZ 2007, 16), which cannot be compared with detailed results of the intervisibility study performed in an artificial environment (see p. 238–241). He could summarise the obvious, however; sites were intervisible enough to make a signal chain, and so he suggested that each watchtower site belonged into the jurisdiction of certain fort. Despite not taking the succession of forts at Seckmauern and Wörth into consideration, he

suggested that Wp 10/1 – Wp 10/5 belonged together to the fort at Wörth, Wp 10/6 – Wp 10/8 to the fort at Lützelbach, Wp 10/9 – Wp 10/11 to the fortlet at Windlücke, Wp 10/12 – Wp 10/16 to the fort at Hainhaus, Wp 10/17 – Wp 10/24 to the fort at Eulbach, Wp 10/25 – Wp 10/28 to the fort at Würzburg, Wp 10/29 – Wp 10/32 to the fort at Hesselbach, Wp 10/33 – Wp 10/34 to the fortlet at Zwing, Wp 10/35 – Wp 10/37 to the fortlet at Seitzenbuche and Wp 10/38 – Wp 10/40 to the fort at Schlossau (BAATZ 2007, 16).

The core of the idea was solid – such hierarchy is expected, and vertical organisation is the most efficient way to run a signalling and threat response system on any frontier. The principal problem of Baatz' assumption is the disparity in the length of individual sectors – this varied between 1,33 km (Wp 10/33 – Wp 10/34) and 7 km (Wp 10/17 – Wp 10/24). For better understanding of the problem, it is possible to estimate how many men could have served on the Odenwald Limes. Forts could have housed ca 160 men (see p. 167), individual watchtowers could accommodate at best five men (BAATZ 1976, 42–45). The Zwing and Seitzenbuche fortlets could not have offered shelter to more than 32 men, and the internal area of the Windlücke fortlet was enough for just one or two contubernial blocks, and so no more than 16 men there (see p. 176–179 and Table 10). The overall garrison for the studied section of the Odenwald Limes was thus 1395 men on more than 36 km of frontier line, which means that there was in theory 1 Roman soldier available per 25,8 m of the frontier line. The garrisons of the forts were of course crucial, as they were expected to aid the attacked watchtowers, and so the utmost precondition for the effectiveness of the frontier system was the equal distribution of the soldiers across the frontier, which is where Professor Baatz' system obviously failed – the fortlet at Windlücke, together with three neighbouring watchtowers included 31 men who were supposed to control a 3.6 km long stretch of the frontier (that is one man per 116 m of the frontier line) while the nearby fort at Lützelbach was only supposed to back up three watchtowers on a 2,9 km long stretch of the frontier, which could have been comfortably done with 175 men, since one soldier was at hand per 16.6 m of the frontier line (Fig. 248).

The first problem of Professor Baatz' interpretation of the *modus operandi* of the Odenwald Limes is thus clear – the fortlets could not stand alone tactically, the garrisons there could at best only defend the fortlet against the raiders. The fortlets were obviously built as blocking features in the landscape (see p. 225–228), they had no headquarters and therefore no independent command, and were certainly under the jurisdiction of nearby forts. They could hardly muster an effective fighting force from their garrison. The problem of garrison allocation and its illogical distribution in the presented model is also apparent between Eulbach and Würzburg forts – as they were supplied with the same garrison, the first was supposed to take

care of the 7 km long stretch of the frontier with only 200 men (one soldier per 35 m of a frontier line) while the second was only supposed to look after for four watchtowers on 4,7 km of the frontier (one soldier per 26 m of the frontier).

I would like to propose a different model of organisation. The fort at Wörth did not exist in the initial phase of the Odenwald Limes, and instead one was located at Seckmauern (see p. 168–171). From this fort not only the suspected watchtowers in the vicinity of the Main were visible (with exception of Wp 10/1 – see p. 213), but Wp 10/5 (which position was aligned to the fort gates – see Table 14 and Figs. 153, 217) and Wp 10/6 were also in the line of sight of this fort. The first sector was thus 4,55 km long (3 Roman miles), and there were 160 men from Seckmauern fort and 25 more on the watch duty (Wp 10/2 – Wp 10/6, nothing certain is known about Wp 10/1 but its position was certainly not visible from Seckmauern), thus one soldier was supplied per 24,7 m of this stretch of the Limes (Fig. 249).

Since the fortlet at Windlücke could hardly have stood alone tactically, the next sector comprised Wp 10/7 – Wp 10/10, Lützelbach fort and Windlücke fortlet. The lateral intervisibility between sites and their general proximity allowed the spread of alarm signals comfortably enough to raise the alarm, and although both fort and fortlet had bad lines of sight, individual watchtowers had more in their lines of sight than their immediate neighbours. The whole stretch of the frontier was 4,2 km long (2,84 Roman miles), 196 men were located there, and thus the density of Roman military presence was one soldier per 21,4 m of the frontier.

The next logical stretch of the Odenwald Limes can be postulated as the area between Wp 10/11 and Wp 10/17, with the fort at Hainhaus nearly in the middle. This 5,39 km (3,6 Roman miles) long sector was occupied by 195 men, which gave a density of one soldier per 27,6 m. All the watchtowers were directly intervisible with the Hainhaus fort (Fig. 249).

Although the fort at Eulbach had all the watchtowers between Wp 10/12 and Wp 10/25 in the line of sight, it would be illogical to subordinate this whole 12 km long stretch to just one fort. Instead, only the installations between Wp 10/18 and Wp 10/23 should be considered as belonging to the Eulbach fort. This stretch was thus only 5,6 km long (3,8 Roman miles) and was occupied by ca 190 Men, distributable as one per 29,5 m of the frontier line (Fig. 249). All the watchtower sites were comfortably intervisible with the fort (Fig. 156).

Würzburg controlled practically the same stretch of the frontier as Eulbach (5,7 km – 3,85 Roman miles) with only five watchtowers (Wp 10/24 – Wp 10/28). Approximately 185 men could have operated there, which makes a density of one soldier per 30,8 m of the frontier

in relatively difficult terrain (Fig. 249), which was still best accessible from the mentioned fort. All the watchtower sites were comfortably intervisible with the fort (Fig. 157).

Hesselbach fort was carefully positioned to be intervisible with all the watchtower sites between Wp 10/29 and Wp 10/34, and they should all be counted as under the jurisdiction of this fort (Fig. 158). The only site which was not visible from this fort was the fortlet at Zwing, but this was blocking the most convenient route from the north to the Military Way (see p. 227) and was intervisible with both neighbouring watchtowers (Fig. 161). This stretch of the frontier was 6,3 km long (4,25 Roman miles) and approximately 222 Roman soldiers could serve there, theoretically dispersible as one per 28,4 m of the Limes (Fig. 249).

The last identifiable sector of the Odenwald Limes was connected with a fort at Schlossau, to which all the watchtowers between Wp 10/35 and Wp 10/40 could have belonged, as well as the fortlet at Seitzenbuche. The same number of soldiers should thus be expected as on the previous sector (if the Wp 10/40 is included just for the regularity of the scheme), distributed over a 5,3 km (3,6 Roman miles) long stretch of the frontier (one soldier per 23,9 m of the frontier). The intervisibility was more complicated in this case, since only the positions of Wp 10/38 – Wp 10/40 were visible from Schlossau (Fig. 159). The only site that could have served as a relay to the west was the Wp 10/38d, which had a clear line of sight up to the position of Wp 10/32 in the western direction, and from which one could see all the watchtowers in the vicinity of the Schlossau fort, as well as the fort itself (Figs. 199, 249).

This suggested system offers a much more equal distribution of the garrison over the more or less equal stretches of the frontier, with the same sites and a conservative estimate of the size of their garrisons. The only problematic part remains the beginning in the north, where the organisation must have changed after the abandonment of Seckmauern in favour of Wörth. Some sort of harbour or landing in vicinity of the later fort should have been provided from the beginning. At best Wörth could have been intervisible only with the first one or two watchtowers on the ascend to the position of Seckmauern fort, not with those further inland (Fig. 152), so for an alarm warning system to operate in the sector between Wörth and Lützelbach forts, a relay that was intervisible with both east and west was needed. To such purpose could not serve the position of any known watchtower between two mentioned forts since none was intervisible with both Wörth and Lützelbach forts (see Table 13 and Figs. 163–171 and p. 235). So, either the Romans were satisfied with a gap in the signalling system after the abandonment of the Seckmauern or another outpost in the form of at least a fortlet/watchtower was located somewhere around the fort at Seckmauern. The only place it

could have existed in order to be intervisible with set of installations between Wp 10/2 – Wp 10/6 was the location of centre of the Seckmauern fort (taking into consideration the 9 m height of the observation platform above the ground – see p. 235 and Figs. 153, 165). I would like to suggest that Seckmauern may not have been abandoned utterly. A small fortlet, similar to Windlücke, could have been located there in the centre of the fort and then destroyed by the subsequent construction of the villa. The distribution of the garrison would change only cosmetically, since the fort at Seckmauern was replaced by similar sized fort at Wörth and the only change than would be the shift of command/headquarters of the sector towards Main river.

The presented version of *modus operandi* of the Odenwald Limes is still just a suggestion – it may be that the Romans organised the frontier differently. The suggestion is based on the logic of an equal distribution of the garrison and command over it across a guarded stretch of the landscape, which is by far the most efficient way to prevent raiding parties sneaking in past the Roman surveillance. Fortlets were necessary for the existence of such system, to block access, and therefore the result of this study is the statement that they probably had timber and earthen (or some other) predecessors. Regular timber watchtowers could have been also provided on the fortlet sites originally – they could have served the same purpose as the later fortlets and been destroyed by later constructions of the stone outposts. From this point of view certain sites were simply promoted from simple watchtower site to more firmly controlled spot with a fortlet in later period of existence of the Odenwald Limes.

The vast majority of the watchtowers were directly intervisible with their “parent” forts (where the residences of officers commanding the just proposed sectors were located as the presence of *praetorium* and *principia* at least in Hesselbach indicates) and could have raised optical alarms and thus warned the garrisons directly, or started an acoustic alarm via horns. Certainly, the watchtowers were close enough for the second scenario as well. The hierarchical relationship between sites in form watchtowers + fortlets → individual fort should be expected because the forts were usually best accessible on the course of the frontier (in order to reinforce other sections, see p. 254–267), they had good intervisibility with individual watchtower sites (which both gave them dominance over the respective sectors of the frontier) and their garrisons could thus briskly react on any alarms raised alongside the course of the frontier defined by the Military Way. Since the positioning of the individual forts was relatively similar alongside the course of the frontier (see p. 223–228 and Table 10) and distances between them were roughly equal (see Table 9), one should expect, since none had apparently any prominence over the others, that roughly the same amount of men was responsible for equal stretches of the frontier in order to disperse the available garrison most evenly and thus make the prevention against the

raiding most effective. Despite I do prefer the equality of distribution of men in correlation to allocated length of the frontier, it is certainly possible that Romans used less rigid formula in terms of allocation of outposts like watchtowers and fortlets to individual forts. The whole point of presented scenario was in stressing that the currently known or expected sites offered the possibility to divide the whole length of the studied area of the Odenwald Limes into roughly equal sectors, which allowed roughly equal distribution of garrison as suggested above.

It can thus be concluded that the Odenwald Limes exhibited all the characteristics of a carefully designed frontier against raiders, with a sophisticated alarm system – or at least all the conditions for the existence of such a system were met there. It was obviously surveyed this way, on the easiest and most direct path between the anchorage at Wörth near the Main River and the Schlossau fort. The way itself may have been the reason this frontier ever existed, and the positioning of the majority of watchtowers was chosen with regard to this Military Way. Since the later alternations didn't change the distribution of the garrison on the Odenwald Limes dramatically, it is apparent that it served its original purpose until the abandonment.

5.3 Modus operandi of the Antonine Wall

Like the Odenwald Limes, the Antonine Wall was at first glance the “terrain following frontier” as defined by Dr David J. Woolliscroft (WOOLLISCROFT 2001, 152–153). The modus operandi of the Antonine Wall was discussed far more than the function and layout of the Odenwald Limes, although usually only on a theoretical level. The antiquarians saw it as a defensive curtain, merely a physical embodiment of what the *Historia Augusta* stated about the Hadrian's Wall, which was supposed to “*separate the barbarians from the Romans*” (SHA, *Historia Augusta*, Hadrian 11.2). Professor MacDonald suggested a more complex function for this frontier, and his conclusions were in accordance with the beliefs of his time – the Antonine Wall was an administrative body rather than defensive monument, built in order to control movement throughout the landscape and to prevent raiding (MACDONALD 1934, 388–393). Professors William Hanson and Gordon S. Maxwell later implied that the purpose of military deployment on the linear barrier across the Forth-Clyde isthmus was not only the control of movement and countering the low intensity threats – raiding. According their point of view the size of the garrison and its much denser distribution (in comparison to the Hadrian's Wall) was enough to also counter “medium intensity threats”, thanks to the proximity of relatively strong outpost forts in the east (HANSON – MAXWELL 1986, 171). They further implied that the Antonine Wall was in fact an “offensive frontier”, which was supposed to actively counter the raids before they could reach the frontier, because the raiders were under surveillance from

permanent positions on the linear barrier. They also estimated the garrison of the Antonine Wall as ca 7000 men, although that maximum figure was not at hand from the very beginning, in their opinion, and was later further reduced (HANSON – MAXWELL 1986, 152–173). J. P. Gillam principally saw the Antonine Wall as an evolved and adapted copy of Hadrian's Wall (GILLAM 1975, 51–56), and his view was in many ways enhanced by Professor D. J. Breeze (BREEZE – DOBSON 2000, 94–110), who further appreciated the landscape setting of the Antonine Wall and the careful positioning of many of the forts on the frontier (BREEZE 2008, 144–160).

It was MSc John Poulter who eventually suggested the first complex *modus operandi* of the Antonine Wall, although the majority of his work was dedicated to the surveying phase of frontiers in Britain. He noted that the whole Antonine Wall was actually planned according to the landscape in which it was set, not trying to take defensive advantage of it, but to block the most convenient paths via permanent installations, while still keeping the intervisibility between individual sites and having a proportionately good line of sight for the sentries from the mentioned permanent installations to the north (POULTER 2009, 123–129). His point of view and conclusions were further verified via assessments of individual fort positions (GRAAFSTAL–BREEZE – JONES – SYMONDS 2015, 63–67) as well as via studies of intervisibility in the artificial environment (DYČKA 2018, 315–323). Poulter eventually suggested a further explanation as to how the Antonine Wall could have operated as a frontier, proposing a two-level signalling system, according which it was supposed to be originally surveyed. The positioning of several forts, fortlets and all expansions and minor enclosures was in his theory determined via alignment to several lines, all in order to use signalling to raise the alarm as either “trouble” or “serious trouble” (POULTER 2018, 129–134). Scepticism towards this complex system was expressed earlier in this thesis (see p. 123, 148–149). To it can be further added doubts about effectiveness of signalling over long distances (DONALDSON 1985, 19–24) as well as the existence of actual need for centralised signalling system on frontier, which was certainly lacking in the case of the Odenwald Limes. Instead I would like to propose the signalling organisation connected more with the hypothetical site hierarchy, similar to the already presented system on the Odenwald Limes.

The new *modus operandi* of the Antonine Wall is largely based on the evidence presented in previous chapters, and mainly the chapter dedicated to the spatial analyses. The Antonine Wall was still designed differently to the Odenwald Limes, and not just through the deployment of different types of troops and the provision of a linear barrier right from the beginning. Much more interaction and trespass were expected by the Romans when building it – the access routes through the mural barrier were blocked by forts or fortlets (see p. 145–146)

– while the *lilia* and massive ditch with a berm offered further protection (see p. 18–19). All this fits neatly with the theory that the purpose of this monument was to prevent raiding.

The size of the garrisons at individual fortlets and forts, discussed further below, implies that the majority of smaller forts and fortlets could counter small raiding bands on their own (see Table 4). When more serious trouble arose (medium intensity threats), they would need reinforcements from other forts, principally from those able to accommodate a full auxiliary unit or more. These included the forts at Carriden, Mumrills, Castlecary, Balmuildy, Old Kilpatrick and possibly Bar Hill. These sites can be seen as nodal ones (for frontier control, not to be confused with the surveying phase) and I would like to propose that units stationed in these installations had a responsibility for “their” sections of the frontier, and that officers in these installations were the superiors of the soldiers in remaining forts and fortlets. The question then is how to define the stretches of the frontier? The following assumption is based largely on the indications gained through the interpretation of the Antonine Wall via spatial analyses and via comparison with the Odenwald Limes. Before its actual presentation, the question of the garrison must be addressed in detail.

There is no evidence for size of the garrison at Carriden fort. The assumption of 480 men is based solely on the size of the fort (see p. 29), which is equal to that of Balmuildy, and could thus accommodate a complete auxiliary unit: 480 infantrymen, 384 men from a part-mounted unit or 240 cavalrymen (DAVISON 1989, 99–101, 186). Since the only evidence from the site suggests infantry (RIB 2138), the complete cohort is expected as a garrison, which seems proportionate to the significance of the terminal fort and harbour (Pl. 18). The fort/fortlet at Inveravon did not yield any evidence about its garrison, but since it was relatively small, it is treated as equal to the Duntocher fort for the assessment of the garrison on the Antonine Wall, and therefore a centurial outpost (see below). The fort at Falkirk originally occupied either 1,4 ha (like Castlecary) or 0,9 ha (like Westerwood), so the garrison of this barely investigated fort can be only guessed to have originally housed 480/200 men, and a more conservative estimate is used in the assessment of the garrison on the Antonine Wall (Pl. 12). The fort at Mumrills (Pl. 7) was certainly large enough to accommodate fourteen barrack blocks of the size of the one documented there (see p. 53–54 and Pl. 7), and since only part-mounted and mounted units were attested there (see p. 27), there was enough space for ca 560/900 men (if taking into consideration that 64 men of part-mounted unit could fit into one barrack block/one *Turma* of 40 men could fit into the barrack block found at Mumrills - DAVISON 1989, 99–101, 186). Since the fort at Camelton was of roughly the same size as that at Mumrills (see 27–29) and attested were there ten large contubernial blocks, and space still for four more in *retentura*, the size of

the original or planned garrison is expected to be the same as at Mumrills, although there is no indication what kind of unit actually occupied this fort. The size of the fort, its strategic positioning and the dimensions of individual barrack blocks (Pl. 11) means that one should not be surprised by combined garrison, consisting of various auxiliary infantry and at least some cavalry.

The fort at Rough Castle was definitely not spacious enough to accommodate a complete auxiliary unit but its size almost corresponds with the proportions of the forts examined on the Odenwald Limes and a garrison larger than 160 men should not be expected either there or at the Croy Hill fort (Pl. 5–6). The slightly larger Westerwood fort didn't reveal any evidence about the barrack blocks, but no more than one extra half-barrack block could fit there, and therefore a garrison of 200 men can be seen as a maximum for this fort (Pl. 13). The Castlecary fort, although large enough to accommodate almost an entire auxiliary unit, yielded only evidence for two double auxiliary units, one part-mounted, the other of infantry (see p. 27). Due to the space available (Pl. 8), and because no internal buildings are known from this site, the garrison is only expected to have been originally 480 men if these were infantry, and if a part-mounted unit was present, then only 384 men (DAVISON 1989, 99–101). Because of their similarity in size (see p. 29), the same estimate was also used for Kirkintilloch fort, but it would not be surprising if the garrison of both forts consisted of detachments of several units (Pl. 15).

A complete auxiliary unit could be expected at Bar Hill, although the exact evidence for barrack blocks comes only from the smaller part of the fort, where three complete barrack blocks were discovered (see p. 54). In this, as well as in many previous cases, the author presumes that Romans would not laboriously encompass an empty area of the fort with the rampart and the ditch. The interior was planned to be occupied, and if evidence for occupation is lacking, the buildings in question were probably not substantial stone-built granaries, but structures with more shallow foundations, like barrack blocks. Five more barrack blocks of the same size as discovered in this fort could certainly fit in the interior of Bar Hill and thus the complete auxiliary unit of ca 480 infantry could have been housed there (Pl. 1).

The fort at Cadder could accommodate 520 auxiliary infantry soldiers with its nine positively confirmed barrack blocks, but a more realistic figure for the small fort would be 480 infantry men or even one century less (Pl. 2), thanks to the relatively small size of the barrack blocks and history of the fort (see p. 54–55). The unexcavated fort at Auchendavy was a similar size (Pl. 14), where one could in theory expect the same size garrison, although the exact

evidence is lacking. Eight contubernial blocks were attested at Balmuildy (see p. 55), which means that the fort could have accommodated either 560 infantrymen, 448 men of a part-mounted unit or 280 riders (DAVISON 1989, 99–101, 186). An infantry (BREEZE 2008, 94) or part-mounted unit (HANSON – MAXWELL 1986, 154) is expected here, but due to the size of the fort and the number of contubernial blocks (Pl. 4), the part-mounted seems to be more probable here and would be equal to the significance of the position of the forts.

Any estimate of the original garrison of Bearsden fort is hampered by the irregular layout and strange internal organisation of the fort. The excavator could only confirm room for 64 cavalry men (BREEZE 2016, 335–344; see p. 55–56), although the fort could have sheltered at least double the number of men, nothing discernible was found in the interior. Again, the larger garrison is taken as more logical, because it would make no sense to locate to 64 cavalrymen at a remote outpost without any support from infantry in the fort, which occupied 1.7 ha, with an annexe (Pl. 3). The evidence for a garrison at Castlehill is largely missing except for one altar of a part-mounted unit found nearby the fort. Nothing is known about the internal arrangements of Castlehill fort, but due to the limited amount of space there (Pl. 16), only a detachment of around half a part-mounted unit should be expected here (ca 192 men – DAVISON 1989, 99–101, see p. 28 and Table 4). Duntocher Fort, the smallest of all the forts on the Antonine Wall, was comparable in size with fortlets on the ORL, most notably with Trienz (see p. 177–178), also occupying 0,2 ha. Since no internal buildings, except for the central one, are known from this fort, the garrison can be only speculatively estimated as one century at best, 80 infantrymen (Pl. 17). Six large barrack blocks were discovered in the excavated half of the fort at Old Kilpatrick, which were each large enough to accommodate one infantry century (see p. 56–57). The original garrison was thus at least 480 foot soldiers, but again, it is unlikely that the whole *retentura* would be left vacant, especially since there was room for five more barrack blocks of the same size as in *praetentura*, and fort was already equipped with all the buildings necessary and space was also left for the *praetorium* in the central part. The overall garrison could thus have been 880 men if the garrison consisted only of infantry (which was attested there via inscription – see p. 29), or alternatively 700 part-mounted troopers, or 440 cavalrymen with their horses could shelter there (DAVISON 1989, 99–101, 186). The part-mounted unit or a combination of several detachments of units should be expected at this fort thanks to its strategic positioning, size (Pl. 9), and the size of barrack blocks (see p. 56–57).

The garrison of the fortlet at Kinneil could have been at best 32 men, based on the internal space and possible reconstruction of the internal buildings (see p. 70–71). Since Seabegs Wood and Croy Hill occupied the same area, the same garrison size is expected for

them (Pl. 19). The smaller fortlets at Watling Lodge, Wilderness Planation, Summerston, Duntocher and Cleddans (Pl. 19) could not accommodate the same number of soldiers as Kinneil, and based on the continental parallels, the maximum size of the garrison of such installations would have been 16 men (BAATZ 2007, 11, Abb. 4). Three fortlets that were never excavated but at least somehow confirmed, at Laurieston, Glasgow Bridge and Cawder House, are treated merely in order to assess the complete garrison of the Antonine Wall as smaller fortlets, with posts for 16 men at best (see Table 4). Excavations at the watchtower at Garnhall gave no indication of the size of its garrison, but one should not expect it to be different to that of other installations of this type on ORL, and therefore five men should be expected there. Expansions and minor enclosures could not shelter any garrison and therefore are not included in this study.

The garrison of the Antonine Wall, with a nearby fort at Camelon in the early period, when fortlets stood at Croy Hill and Duntocher instead of forts, can thus be estimated as between 5969 men and 7301 men (without seaside forts and fortlets, see Table 4). In the later period, when the fortlets were replaced with small forts, it could have been 6177 men – 7509 men and further on later again less, due to the abandonment of accommodating structures on several sites on the Antonine Wall (see p. 84–89). The most pessimistic figures will be used for the distribution of the garrison as in the case of the Odenwald Limes.

The modus operandi presented is based on the expectation that a similar system as in the case of the Odenwald Limes operated on the Antonine Wall, only with a more structuralised hierarchy. Nodal sites and their commanders were superior to the smaller forts and marginal outposts, which, when spotting an intruder directly or thanks to a patrol, may have needed to contact the nodal sites for reinforcements. Mutual visibility was a primary precondition for such a system, which allowed raising an alarm via fire or smoke, or the physical proximity of the sites, which allowed the spread of an alarm acoustically, or a connection via road for mounted messenger. Although some sites were slightly too far away for the use of acoustic signals (unlike the sites on the densely occupied Odenwald Limes) the Military Way was provided, and sites were intervisible enough either directly or via strategic relays (see p. 117–123). In order to make the system effective, the outposts should not be far from the nodal forts, otherwise the relief could not reach them in time. The last precondition for the system is again identical with the pattern followed in the case of Odenwald Limes – the equal distribution of the garrison for individual sectors on the frontier.

The first stretch of the Antonine Wall is also the most problematic – only two installations can be assigned there, Carriden as a nodal fort and the fortlet at Kinneil. Obviously, something is missing here, since not even the course of the Antonine Wall in this area is known with certainty (see p. 74) and these sites were not intervisible (see Table 5). In order to achieve the same distribution of garrison on this stretch as on the others, three or four more fortlets, or one small fort between Kinneil fortlet and Carriden fort, are needed, ideally at Kinglass Park (see p. 111). Without them, this 6,9 km (4,66 Roman miles) stretch of the Antonine Wall (starting at Carriden fort and ending on the edge of the line of sight of Kinneil fortlet ca 1 km east of the Inveravon fort) had only 512 soldiers at disposal, which gives a density of one soldier per 13,5 m of the frontier (Fig. 250).

As a second stretch of the frontier can be presented the bulk of installations in the vicinity of Mumrills fort, namely Inveravon with Falkirk forts, and Laurieston with Watling Lodge fortlets (Fig. 250). This stretch would thus be 11,3 km long (7,6 Roman miles), terminating at the edge of the line of sight of both Mumrills fort and Watling Lodge fortlet, roughly in the middle of the Tentfield East and Tentfield West expansions. The role of the fort at Camelon, which was in visual contact with all the military installations on this sector, just like the fort at Mumrills, and could fit well to the system of frontier control here, despite being physically separated from the barrier remains enigmatic. With this fort included, the density of the military presence was one soldier per 7,9 m of the frontier, and without Camelon the same ratio was 13 m/one soldier.

The third sector of the Antonine Wall consisted of the forts at Rough Castle and Westerwood, the fortlet at Seabegs Wood and the watchtower at Garnhall. The stone-built fort at Castlecary can be defined here as a natural nodal installation (see p. 145–146), which was directly intervisible with all the installations except Westerwood (Fig. 10). The watchtower at Garnhall served as a relay for this, which position was determined by Castlecary and Westerwood forts (see p. 124). A point on the course of the Antonine Wall ca 0,8 km west of the Westerwood fort, where the line of sight of the mentioned fort ends and the course of the Antonine Wall can be already observed from Croy Hill fort and fortlet can be estimated as the end of this sector. This stretch of the frontier was thus 10,6 km along the course of the linear barrier (7,1 Roman miles) and the density of the available garrison was thus one soldier per 13,6 m of the Antonine Wall.

The next 9,3 km of the Antonine Wall can be seen as an inter-stretch or marginal area. The fort at Bar Hill was located on a prominent spot roughly in the middle, but its garrison was

just a standard auxiliary infantry unit at best. The main reason to identify this site as a nodal site is the good accessibility from this fort to both Auchendavy (only downslope) and Croy Hill (downslope and then slightly up again – see Fig. 90), and the superior visibility of the landscape and all neighbouring Roman military sites in general (see Fig. 2). As the western end of this stretch can be perceived the point, where the line of sight from Kirkintilloch and Auchendavy ends, 0,8 km west of the Auchendavy (Fig. 250). In the early period, when only a fortlet stood on Croy hill, the density of soldiers was exactly one per 10 m of the course of the frontier. Later, when the fortlet was replaced with a fort, it was one soldier per 8,7 m of the frontier.

Balmuilty can be seen as a natural lynchpin of the western sector of the Antonine Wall. This site was no doubt nodal, although it has practically no visual connection with the remaining sites in the area, except of the group of relays at Wilderness Plantation (see Figs. 12, 30, 48–50). The fortlets at Glasgow Bridge, Cawder House, Wilderness Plantation and Summerston in theory fell under its jurisdiction, with forts at Kirkintilloch and Cadder. The intervisibility was more complex here than in the east, but Wilderness Plantation was directly intervisible with Kirkintilloch and, through Cawder House, also with Cadder, while Glasgow Bridge could have served as an outpost of Kirkintilloch fort, with which it was intervisible (see Table 5). All the forts blocked or controlled the access routes from/to the Kelvin valley and could have best reinforced each another through this valley rather than directly on the course of the Antonine Wall. Since they all had an excellent line of sight to this area as well, it was probably their area of interest (see Fig. 81). This stretch was 11,3 km long (7,6 Roman miles), and the concentration of soldiers here was one man per 8,7 m of frontier line (Fig. 250). The position of the putative fortlet on Giral Hill (see p. 76, 121), which was the last place visible from Summerston fortlet and in theory the easternmost place visible from exceptionally high tower gate of Bearsden fort, was defined as an end of this sector (see p. 107–108).

The last stretch of the frontier is reconstructed as the longest one and in theory could have been divided into two (with Castlehill being prominent in the east and Old Kilpatrick in the west), but only the Old Kilpatrick fort was chosen as a nodal site, especially since the other forts belonging to this sector were significantly inferior in both garrison size and their positioning, in comparison with Old Kilpatrick (Pl. 9, 16, 17). The forts at Bearsden and Duntocher, together with fortlets at Cleddans and Duntocher belonged to this sector. In the early phase, when only a fortlet stood at Duntocher, the density of the garrison of this sector was one man per 11,4 m of the frontier but after expansion of Duntocher fortlet into something which should be called a “bigger fortlet with an annexe”, the value decreased to 10,8 m of frontier line per soldier. The intervisibility was problematic on this stretch, but the Castlehill fort could have

served as an ideal relay which would have been intervisible with all the installations on this sector based on the assumption that Bearsden fort had gate towers of proportional size (see p. 117–123 and Fig. 29), and assuming that one relay (Mount Pleasant fortlet) exclusively for Old Kilpatrick fort was located near this nodal site (see p. 78, 121). Still the intervisibility was possible mainly laterally thanks to complexness of the terrain at foothills of Kilpatrick Hills (see p. 106–108, 111–114, 120–123).

The presented hierarchical model may have somehow been connected with Bishopton fort, but poor knowledge about this site in general means that no conclusions or even hints can be offered there. The peripheral sites of Outerwards and Lurg Moor do not seem to be related to the system. Only one was intervisible with Antonine Wall sites over a distance, preventing any meaningful signal communication (Fig. 17), and furthermore if need of reinforcements or any support would come be at these fortlets, Bishopton should be the recipient of signalling. Lurg Moor was not intervisible with this fort. These two fortlets, possibly three if the suspected one at Laverockhouse Hill really existed (see p. 131–133) could hardly have stood alone so far from any other Roman military sites and provided any useful intelligence or frontier control there. At least one small fort of Antonine date should be expected in Ayrshire or Renfrewshire.

The system proposed for the Antonine Wall demonstrated a surprisingly even distribution of the garrison in even cluster across the frontier. A few sites are obviously missing for a complete picture, but in the majority of situations intervisibility was good enough for a signalling system to operate as advance warning for both the garrisons of permanent installations and the patrols in the Kelvin and Carron valleys.

The most densely occupied was naturally the easternmost sector thanks to the combination of garrisons of Mumrills and Camelon forts. The reduction of garrison should be expected in later periods in the west, especially in the case of Cadder and Old Kilpatrick forts (see p. 85–87), but even if that would happen in terms of one or two hundred men, the distribution of soldiers on respective sectors would decrease only to one soldier per 9,5/10,31 m of the frontier in the case of Balmuildy sector and one soldier per 11,8/13,1 m of the frontier in the case of Old Kilpatrick sector, which is still comparable or equal to e.g. Castlecary sector. These figures would be still better cosmetically if one would presume the existence of at least small fortlets (and thus took in consideration their potential garrisons) at Mount Pleasant and Kinglass Park.

6. Conclusion

The results of the last chapter are a fitting conclusion to this thesis. Both the Antonine Wall and Odenwald Limes were similar in most principal attributes, although there were many physical variations, different periods of construction, different usages of materials and different types of garrison.

Both were surveyed via optical means. Several types of sites can be clearly identified in terms of their spatial disposition (not physical remains or the area they occupied etc.) on both frontiers – the nodal sites, blocking the access corridors from outside the frontier; the observation installations, which could have served either as observation platforms or for relaying signals (but were principally defined by a good line of sight in some direction); and intermediate sites, which may have been positioned following loosely a distance formula or for the comfort of the surveyors, who chose their positions as convenient because they were on a line to another installation which they were surveying from their position.

Signal communication was possible on both frontiers, regardless of whether it was just a relic of optical surveying. The conditions for its use were met. On both frontiers the distribution of the troops was roughly equal in individual sectors along the course of the frontier, and thus both were excellent in preventing raids. Suggested *modus operandi* was an example how this distribution could have been organised in hierarchical manner. Both frontiers were abandoned solely for tactical reasons, although the Antonine Wall was probably built only thanks to the political events in Rome, while the Odenwald Limes was created in order to achieve better frontier management on a provincial level when part of the local garrison was temporarily transferred elsewhere.

A plethora of evidence was found on both frontiers suggesting that the planners had anticipated how the whole frontier was going to operate during the surveying phase. Only thus could intervisibility have been maintained between individual sites with applied OFFSETB, while the nodal sites retained their blocking function in the landscape in such complicated sectors as the stretch of the Antonine Wall around Balmuildy or the section of the Odenwald Limes in the vicinity of the fort at Hesselbach.

The landscape was a determinant for the course of both frontiers, but in a different way for each. The Odenwald Limes was built on the most convenient line connecting the existing clusters of the Roman military presence in *Germania Superior* (THIEL 2009 140–141), while the Antonine Wall crossed the Forth-Clyde isthmus on a zig-zag course (POULTER 2009, 115–

117) in a more complicated way than necessary if the goal was solely to build a barrier dividing the on Roman and non-Roman part. Instead the Antonine Wall connected the positions of individual nodal sites, and it was only at Bar Hill that the builders took the liberty of ignoring the position of the fort and building the mural barrier ca 43 m north of the *porta praetoria* of this fort.

Despite many conclusions can be presented below, not all the questions concerning the layout and organisation of the Antonine Wall and Odenwald Limes were answered in this thesis. Evidence was presented that the stone fortlets must have been preceded by some sort of installations on the Odenwald Limes, just like probably was the stone watchtower at Wp 10/5. Wp 10/31 made sense in the broader area where it was located 60 years ago, but its exact position is probably different than originally suggested (see p. 189 and Fig. 143). The fort at Seckmauern must have had a successor, but the position of Wp 10/38 remains unknown exactly, and the results of spatial analyses and their interpretation cannot be taken as more than hints.

At the Antonine Wall it was clearly shown that multitude of new fortlets inland should not be expected to be found in the future (see p. 143–144), but the current state of knowledge is hardly complete and this thesis has demonstrated that there are still fundamental gaps in our knowledge of the monument regarding the vicinity of terminal sites, and much more has to be resolved in the peripheral areas (see p. 121, 165), where the author could only suggest the position of a fortlet at Laverockhouse Hill via complex analysis (see p. 130–134). Minor enclosures could have served as extensions to the signal post at Wilderness Plantation, but expansions remain enigmatic (POULTER 2018, 128–129). Their role as signalling platforms is dubious at best, and, with the exception of Tentfield West, they had no superior line of sight to the landscape or to the other Roman military installations on the Antonine Wall in comparison to nearby forts and fortlets.

The system of hierarchical command suggested for both frontiers also seems to have been planned from the very beginning of the frontier. Apart of the evidence presented, this is also based on the practices of the Roman Army – everybody was subordinate to somebody else, except of the emperor, of course. There was not always a clear distinction in rank, since seniority also mattered (LE BOHEC 2015, 149–150), but subordination was present on all the levels of life in the army and it is only logical to also find traces of it on the Limes. A complex hierarchical system works well especially in terms of controlling the previously demarcated areas, such as the Limes. Intruders on both frontiers could be seen when approaching – on the Antonine Wall the sentries had good line of sight to the broader valleys of the rivers directly to

the north of their posts (see p. 127), where patrols and scouts no doubt also operated. The forestation of the Odenwald Limes region did not allow the enemy to be seen at such a distance (and therefore the builders did not even try to position the majority of watchtowers on places with a good line of sight to the *Barbaricum*), but the greater density of installations was a clear response to that. The tree-cut corridor was at least wide enough to permit signal communication and it seems that it was mostly wide 150 m east and west of the course of the later palisade, although twice that distance was required in certain areas. Once intruders left the safety of the forest in the vicinity of the tree-cleared corridor and moved towards the Military Way, they were immediately in the line of sight of several watchtowers. The sentries in smaller forts and fortlets (and theoretically on expansions and minor enclosures, if some soldiers were present there) on the Antonine Wall could raise local alarms, informing the nearest, usually intervisible, forts about the trespassers. Their area of interest on the Antonine Wall was the stretch of land directly north – the area where the majority of the installations had the best line of sight. On the Odenwald Limes, again because of the forestation, the zone of possible interaction was in the immediate vicinity of later palisade. Although there is no specific evidence, provision of palisades alongside the major roads on Limes could have been rather logical reactions to the experience of interactions with trespassers, rather than enlightened decision of Emperor Hadrian (see p. 160). The hierarchy on the Antonine Wall can be reconstructed via the fortlet → small fort → regular fort relationship, where they were usually intervisible. Sentries on watchtowers on the Odenwald Limes had the same comfort of visibility to their parent bases (respective forts) and could also raise the alarm if help was needed.

Both frontiers were defended to a certain extent. The linear barrier with a ditch at the Antonine Wall, further reinforced via *lilia*, extra ditches and walls around its forts and fortlets, could slow raiders or even medium sized warbands without siege engines. The watchtowers on the Odenwald Limes were clearly prepared for ambushes due to the absence of entrances at the ground level. In both cases the threats they were facing were apparently surprise attacks, cunning, rather than heavy assaults.

Finally, it is appropriate to ask a fundamental question: how did the Roman frontiers operate? This has been discussed for decades (KRISTOF 1959, 269–282; WHITTAKER 1994, 60–98; AUSTIN – RANKOV 1995, 170–185; BREEZE 2011, 184–189; LUTTWAK 2016, 67–125), and the author would not like to offer a comprehensively new point of view, since much is apparently already known. The organisation of the frontiers described above strongly indicates that raiding or low-level-intensity threats were present in both studied areas. Both frontiers were purposefully planned to face them. The equal distribution of the garrisons strongly indicates

that, together with the fact that the Odenwald Limes didn't change its nature during its 60 years existence (no site was abandoned except for Seckmauern fort, which was replaced by the nearby fort at Wörth) and the Antonine Wall was also only altered cosmetically during its 20 years of service (there was no Antonine I and II, the garrison was probably reduced in a later period, but that should not be taken as reorganisation with the aim of improvement).

The system must thus have been effective, and it is vital to note that neither of the studied frontiers were abandoned because of their failure in prevention of raiding or because they were stormed by the invaders. They were maintained in the way they were built until the end, and it is hard not to believe that there was a blueprint for both of them – the surveyors and builders not only followed the terrain for the best positioning of installations, but tried to achieve something to their benefit via the positioning of individual features of the frontier. Apparently greater concentrations of forces were not preferred. Instead the soldiers were relatively evenly dispersed alongside one line, on which they could easily regroup. All this is well known from the other frontiers of Imperial Rome, but the precision of this system is still striking when one takes into consideration the stretches of the frontier proposed above, and compares the distribution of the garrisons between the two separate frontiers in suggested operational schemes.

The operation itself was hierarchical, as the spatial relationships in chapter 5. *Modus operandi of the Antonine Wall and the Odenwald Limes* indicate. The most senior officer for the Antonine Wall probably resided at Mumrills, although the author would consider Camelton more suitable for this duty, most notably for its size, the presence of stone-built large barrack blocks and the spectacular buildings in the annexe (see p. 66). A large and much altered *praetorium* was found in Mumrills (see p. 39–40, 46), however, which speaks for the presence of the *Praefectus of Ala I Tungrorum*, the commander of the unit that was attested in this fort via the altar (RIB 2140). Such officer would probably be senior to most, if not all, officers present in the forts on the Antonine Wall. It is likely that Camelton was in practice much more closely related to Dere Street and the fort was only involved in surveying the Antonine Wall because of its convenient position (see p. 124–127, 265).

The overall hierarchy on the Odenwald Limes cannot in fact be reconstructed in such a regionalised way as the frontier was presented, because the closest sites at which senior officers could have resided were the Obernburg and Oberscheidental forts, where standard auxiliary troops were located. The frontier was thus not presented completely from a hierarchical point of view, but so wasn't in fact the Antonine Wall as well, since even the *Praefectus* from

Mumrills was still subordinate to the *Legatus Legionis* of the Sixth Legion from York. With the exception of Schlossau, however, the Odenwald Limes forts in the studied sector were under the command of legionary centurions from a legion north of the Odenwald Limes (see p. 159–160), so it seems more likely that they were the direct subordinates of the *Praefectus* of *Cohors IV Aquitanorum*, stationed in Obernburg (AE 1903, 381). The chain of command was thus in neither case presented in complete picture, only a sketch of hierarchy was presented on topographically limited territory.

Has this comparison of the Antonine Wall and the Odenwald Limes shed any light on the complex Roman strategy for the frontiers, or for frontier organisation (as suggested by Professor E. Luttwak, LUTTWAK 2016, 219–223)? I remain relatively sceptical based on current evidence. The surveying and positioning of the frontier features, and the postulated hierarchical system of frontier management, suggests a relatively pragmatic organisation, adopted to local conditions. Although the builders and surveyors knew what they were building and why they were building forts/fortlets/watchtowers etc. in specific locations, asking about their goals may be the wrong question. We could perhaps better respond via asking what orders they were given? The answer to this seems clear – prevent/contain the raids on the frontier. The frontier builders had enough time and knew the terrain where the army would be operating and could thus prepare. They sought acquisition of an advantage over the elusive enemy, who obviously did not want to fight on Roman terms (otherwise they would have built medieval castle-like structures or called the legions to pitched battles), via the construction of a frontier infrastructure. The “barbarians” just wanted to bypass the garrison of the Limes. This is strongly indicated by the distribution of the clusters of garrison alongside the linear barriers or just roads and by the systematic improvements and strengthening of the frontier defences – linear obstacles – in the course of the 2nd century AD instead of relocating the garrisons to better positions. This cannot be called a strategy, however, because a strategy is by definition an action, and the construction of the Limes was only a reaction. The only strategic thinking about the Limes involved the (micro)management of the distribution of the garrison on the frontier and apparent obsession with security of the communication lines (both visual for signalling and physical for movement throughout the landscape, possibly because of supply lines).

Both the Odenwald Limes and the Antonine Wall were clearly developed forms of frontier, and those who build them had experience from the operation of other frontiers. The positioning of sites and distribution of the soldiers were strongly influenced by local conditions, and the goals seem to have been to block the convenient paths to the Limes/on the Limes, control access via local paths and to have good communication lines between the separate

frontier posts, both visual ones for signalling and physically ones for reinforcements. In order to achieve that, sentry posts were located on spots with a good view of the frontier area. Definition of that is what mostly differed in the studied sectors – a tree-cleared corridor on the Odenwald Limes, and the boggy valleys of the Kelvin and Carron rivers on the Antonine Wall.

I. List of abbreviations

AE – L'Année épigraphique

AdV - Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland

BLfD – Bayerisches Landesamt für Denkmalpflege

BRGK – Bericht der Römisch-Germanischen Kommission

CIL – Corpus Inscriptionum Latinarum

CSIR – Corpus Signorum Imperii Romani

DES – Discovery and Excavation in Scotland

GAJ – Glasgow Archaeological Journal

HVBG – Hessische Verwaltung für Bodenmanagement und Geoinformation

JAXA – Japan Aerospace Exploration Agency

JRS – Journal of Roman Studies

LAD – Landesamt für Denkmalpflege Baden-Württemberg

LDBV – Landesamt für Digitalisierung, Breitband und Vermessung Bayern

LfDH – Landesamt für Denkmalpflege Hessen

LGL – Landesamt für Geoinformation und Landentwicklung Baden–Württemberg

ORL – Obergermanisch-Raetischer Limes

PSAS – Proceeding of the Society of Antiquaries of Scotland

RCAHMS - Royal Commission on the Ancient and Historical Monuments of Scotland

RGK – Römisch–Germanische Kommission

RIB – Roman Inscriptions of Britain

RIC – Roman Imperial Coinage

RLK – Reichs-Limeskommission

Wp – Wachposten

II. Glossary

All based on *LE BOHEC, Y. ed. 2015: The Encyclopedia of the Roman Army: Bd. 1: A–Eas; Bd.2: Eas–Pol; Bd. 3: Pol–Z. Chichester.*

Ala: Unit of 480 (Quingenaria) or 720 (Milliaria) auxiliary horsemen, divided into 16 or 24 Turmae of 30/32 men each. Under command of the equestrian *Praefectus Alae*.

Armamentaria: stores of (not only) weapons in *principia*. Sometimes this term is used generally for storage buildings in Roman forts.

Aedes: “Room of Standards” or sometimes “Sacellum”, placed in the *principia*, usually at the back of the *basilica*. Except for the banner of the unit and statues of worship also the unit’s treasury (*aerarium*) was located there, sometimes under the floor in a strongbox.

Balnea: Baths. Provided regularly in a military context in north-western frontiers. Typology varies (REVELL 2007, 230–237), but buildings consisted of: *praefurnium* (furnace room), *frigidarium* (cold room), *apodyterium* (changing room), *caldarium* (steamy hot room, with hypocaust), *tepidarium* (dry hot room, with hypocaust), *sudatorium* (another hot room, with hypocaust) and *laconicum* (another hot, sweating, room, with hypocaust and frequently also pipes in the walls for the further circulation of hot air). Not all these rooms were necessarily present in all military bathhouses. In some more luxurious *praetoria* a private bathhouse was integrated in the commandant’s house.

Basilica: Cross hall or hallway behind the courtyard of the *principia*, opposite the entrance to the headquarters building. Several rooms were located opposite the entrance to the courtyard, including the *aedes* in the middle.

Cohors: Unit of 480 (*quingenaria*) or 800 (*milliaria*) auxiliary infantrymen, divided into 6/10 centuries of approximately 80 men. Under the command of the equestrian *Praefectus Cohortis*.

Cohors Equitata: Unit of 600 (*Quingenaria*) or 1040 (*Milliaria*) auxiliary infantrymen and horsemen, divided into 6/10 centuries and 4/8 Turmae. Under the command of the equestrian *Tribunus*.

Contubernium: Smallest subunit in the Roman Imperial Army, consisting of 8 men living in one tent or barrack (contubernial) block. Led by Decanus. Barrack blocks were narrow buildings, usually consisting of 10 such blocks with a larger centurion (infantry) or decurion

(cavalry) house on one of the ends of the row. One barrack block was generally supposed to accommodate one Centuria (80 men) or one Turma (32 riders) together with their officers and servants. Individual contubernial blocks were divided (although not always architecturally) into a sleeping room in the back (*papilio*) and room for the equipment at the front (*arma*).

Fabricae: Workshops in the Roman forts.

Fossa fastigata: Classical v-shaped ditch.

Fossa punica: Ditch with asymmetrical profile. Sharper slope on the outer side of the ditch.

Groma: Roman surveying tool used for the simple geodesy like measuring the straight lines, rectangles or triangles.

Horreum: A granary. On the northern frontiers they were typically constructed of stone, but there are timber examples as well. Usually of rectangular shape, with buttressed external walls and sleeper or dwarf walls in the interior to support the elevated timber floors.

Hypocaust: Underfloor heating used especially in the bathhouses, but also in more luxurious buildings such as the *praetoria*.

Legatus Augusti pro praetore: Official title for the governor of a Roman province, with one or more legions under their command.

Legatus Legionis: commander of the legion.

Lilia: Roman trap-holes or foxholes with wooden stake(s) at the bottom, performing a function of the barbed wire at certain spots in the vicinity of fort/fortlet/frontier defences.

Mansio: Staging post for various travelling officials and higher officers, collecting taxes etc. Usually in the form of an urban house with a courtyard, own bathhouse and stables.

Numerus: Roman auxiliary unit of initially irregular nature. Numeri were units originally raised from a certain region, not receiving numbers such as standard Auxilia but differing from each another by geographical epitomes or nicknames. They were stationed on frontiers in relatively small forts, sometimes called Numerikastellen or Numeruskastellen.

Praetorium: Commanding officer's house inside the fort, often (but not exclusively) standing next to a Principia. Resembled Mediterranean style houses in layout, with peristyle.

Praetentura: Part of a marching camp between the *praetorium* and *porta praetoria*. In the case of permanent forts on the Limes, it was between the *principia* and the *porta praetoria*, projecting towards the frontier line.

Principia: Headquarters building in the middle of most of the Roman forts. Its shape and size varied across the Roman frontiers and time periods. It was usually formed of a courtyard, sometimes with adjacent rooms, *basilica* and several rooms placed opposite the entrance of the courtyard, including the *aedes* in the middle, and either one or two more rooms on each side of it (three or five rooms in a row, in total).

Porta decumana: The rear gate of the Roman fort.

Porta praetoria: The main gate of the Roman fort, usually facing the Limes.

Porta principalis dextra: The right gate of the Roman fort.

Porta principalis sinistra: The left gate of the Roman fort.

Retentura: Part of a marching camp between the *praetorium* and *porta decumana*. In permanent forts on the Limes, it was usually the area between the *principia* and *porta decumana*, projecting onto the hinterland.

Titulum: External linear defence of a camp, consisting of a palisade or an earthen bank with a palisade, located in front of the camp gate and blocking direct access to it.

Vexillatio: A detachment of Roman soldiers from various units, used as a task force for long expeditions or special assignments.

Via decumana: The rear road, leading from the back of the *principia* to the *porta decumana* in a standard Roman fort.

Via Praetoria: The main road, leading from the *porta praetoria* to the *principia* of a Roman fort. In front of the *principia* it crosses with the *via principalis*, copying the crossing of the *Cardo* and *Decumanus* in Roman towns.

Via principalis: One of the two main roads inside every Roman fort, going between the *porta principalis sinistra* and *porta principalis dextra*.

Via Quintana: The so-called Fifth road, dividing *retentura* into two halves (not present in smaller forts).

Via Sagularis: Peripheral road around the inner side of defences of Roman fort.

Vicus: Irregular roadside settlement, adjacent to the Roman auxiliary fort. It usually consists of the strip-houses facing the road with or without the porticus in front. In some cases, larger substantial buildings were there, such as the Mansio, bathhouse or small temple. Inhabitants – Vicani.

Villa Rustica: Romanised rural settlement.

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