The outermost layer of the Earth, the lithosphere, is broken into several pieces called lithospheric plates. These plates move relative to each other at a rate of several centimeters per year. In regions where two tectonic plates meet, one plate may be forced beneath the other, a process known as subduction. One of the most important tools enabling us to study this phenomenon is numerical modeling of thermal convection. Dozens of different programs are used within the international geodynamic community to solve the system of equations describing the flow. Among them, a software package called ASPECT has been gaining prominence recently. ASPECT utilizes the finite element method to solve the governing equations and is particularly distinguished by its implemented adaptive mesh refinement. This feature is highly practical when studying subduction of lithospheric plates, as it allows for precise resolution of the narrow deformation zone at the plate boundaries. In the course of our work, we compared this program with the alternative software package SEPRAN, which has been used at the Department of Geophysics since the late 1990s. A subduction model with a mobile overriding plate was created in ASPECT, and its results were compared with an equivalent model implemented in SEPRAN. The fundamental behavior of the subducting plates is consistent; however, the comparison of both programs confirms the dependence of local effects on the resolution of the computational grid, especially in the area of plate contact.