THERMAL AND STRUCTURAL EVOLUTION OF ASTEROID (4) VESTA. B. J. R. Davidsson[1], [1]Dept. of Physics and Astronomy, Uppsala University, Box 516, 75120 Uppsala, Sweden (bjorn.davidsson@physics.uu.se)

Introduction: Placing the formation and evolution of a large differentiated planetesimal like asteroid (4) Vesta into a broader context of Solar System chronology has important implications for our understanding of planetary formation. Vesta is here assumed to form instantaneously at t=1.0 Myr after CAI by low-velocity contraction of a boulder swarm created by streaming instabilities. A novel computer code tracks the last phase of formation, from a radius R=564 km swarm with 90% porosity, via cold-pressing, to hydrostatic equilibrium at R=314 km, porosity above 42% and bulk density d=2.00 g/cc. The code then calculates temperature versus depth and time for an initially homogeneous mixture of metal and rock which contains radioactive Al-26 and Fe-60. Heat conductivities and specific heat capacities are functions of temperature and porosity. The porosity profile is updated continuously as a result of hot-pressing. When the first sign of metal melting occurs at t=1.68 Myr, the core porosity is 35%, R=310 km and d= 2.20 g/cc. The gradual melting of metal and its flow towards the center is modeled. Initially only void spaces are filled out, but as the liquid fraction reaches a threshold, silicate grains migrate upward, thus finalizing the differentiation. Around this time, efficient hot-pressing of weakened warm rock leads to substantial shrinking. By t=1.9 Myr, R=270 km, d=3.14 g/cc, and a compact solid rock mantle separates a ~110 km liquid metal core from a ~10km porous metal/rock crust. At t=2.1 Myr rock melting is initiated, and is completed 0.8 Myr later. The densities of metal and rock are considered temperature dependent, resulting in swelling or shrinking of the body, as well as density gradients within core and mantle. Efforts are ongoing to allow the resulting buoyancy to drive convection, with the corresponding energy transport accounted for. This will allow for studies of the duration of the magnetic dynamo, and more realistic changes of temperature, radius, and density as the body heats further and eventually cools and solidifies, thereby approaching the current R=263km and d=3.46 g/cc.