MODELLING THE THERMAL HISTORY OF THE PARENT BODY OF ACAPULCO- AND LODRAN-LIKE ACHONDRITES.

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We performed model calculations for the internal constitution and the thermal evolution of the parent body of the Acapulco- and Lodran-like meteorite clan. A one-dimensional heat conduction equation for a sperically symmetric body is solved by a finite-differences method considering heating by radioactive isotopes, mainly ^{26}Al, a temperature- and porosity-dependent heat conductivity, sintering of the granular material, and melting, but no melt-migration.

These model calculations are compared to the available information on maximum metamorphic temperatures and thermochronological data. Because the number of thermochronological data that can be used for this purpose is small for the members of the Acapulco-Lodran-clan, we subdivide the available data into three different groups: a “typical acapulcoite”, a “typical lodranite”, and, as a separate group, the acapulcoites that bear relic chondrules and, thus, suffered less strong thermal metamorphism than chondrule-free acapulcoites. It is possible to find a thermal evolution model for the common parent body, based on the onion-shell hypothesis, that fits consistently to the empirical data set for the cooling histories of the three representative groups. This is done by searching for an optimised set of model parameters by applying a genetic algorithm.

We determine for the parent body a radius of 270 km and a formation time of 1.66 Ma after CAI formation. The parent body of the acapulcoite-lodranite clan, thus, seems to have been bigger than typical size estimates of the parent bodies of ordinary chondrites, and formed earlier, consistent with its higher degree of thermal metamorphism. The peak temperatures in the inner core region of the parent body seemed to be sufficiently high for partial melting, but substantial differentiation is not expected. The average initial/surface temperature is derived as nearly 300 K which suggests a formation of the acapulcoite-lodranite parent body closer to the proto-sun and in a hotter part of the accretion disk than the parent bodies of ordinary chondrites. It is argued that the body formed from a precursor material that resembles that what is found in the CR chondrites of low metamorphic grade or Kakangari. The derived burial depths of acapulcoites and lodranites range between 4 and 8 km and therefore support the assumptions that all these meteorites are excavated by a single impact event on a small region of the parent body or from a small fragment of it.