CONVECTIVE COOLING OF CARBONACEOUS CHONDRITE PARENT BODIES DURING AQUEOUS ALTERATION. K. P. Harrison and R. E. Grimm, Southwest Research Institute, 1050 Walnut St, Ste 300, Boulder, Colorado, U.S.A.

Introduction: Thermal modeling has been a useful tool in constraining the internal structure of meteorite parent bodies [1]. An important part of this tool is hydrothermal circulation, which was likely required to produce the aqueous alteration observed in different carbonaceous chondrite types, including CI, CM, and CV. Flow of water through parent body pore spaces was originally inferred from water/rock ratios (W/R) greater than plausible porosities [2, 3]. The first model of such flow started with the melting of an initially icy parent body due to Al-isotope heating, followed by parameterized hydrothermal convection [3]. In this model, aqueous alteration, which is likely to have occurred as a strongly exothermic serpentinization reaction, was assumed to occur rapidly, and temperatures readily exceeded likely limits for CI and CM bodies [2, 3]. A potential solution [4], which also considers O-isotope constraints, assumes a combination of low porosities and high flow rates. Importantly, this model also assumed that aqueous alteration occurred at rates that could be offset by ice melting. While it is not clear that such finely controlled serpentinization can occur, slower rates may nonetheless be possible. Indeed, some work [5] suggests that serpentinization is only geologically rapid at temperatures over 100 °C. Slowing of the reaction occurs because the reaction front recedes from the pore boundary behind an altered rind, and the low permeability of this rind may ultimately control alteration rate [5]. Slow rates of serpentinization are important because they allow the parent body to develop vigorous hydrothermal convection (and therefore enhanced cooling rates) while alteration is ongoing. The body therefore only holds some fraction of the total alteration heat at any given instant.

Modeling: To explore the effects of slower serpentinization rates, we have run a series of parameterized convection models based on [3] to yield a range of minimum permeabilities required to keep the parent body within CI or CM temperature limits given different durations of constant alteration heat release. For CIs, permeabilities range from 10^{-13} to 10^{-8} m^2 for alteration durations of 10^6 yr down to 100 yr. The lower temperature limit for CMs yields minimum permeabilities 3 to 5 orders of magnitude greater than CI values. Such high permeabilities are likely unrealistic, but the 1-D parameterizations used in their calculation do not capture convective heat loss with sufficient accuracy, and more detailed modeling is required. We present recent advances in 2-D models (using a modified version of the U.S.G.S. code HYDROTHERM) that complement our and others' efforts [e.g., 6] by including a fully integrated treatment of ice melting and slow alteration heat release.

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