

**MODELING OF LIQUID WATER ON CM PARENT BODIES AND IMPLICATIONS FOR AMINO ACID RACEMIZATION.** B. A. Cohen<sup>1</sup> and R. F. Coker<sup>2</sup> <sup>1</sup>Department of Planetary Sciences and <sup>2</sup>Department of Physics, The University of Arizona, Tucson AZ 85721 (bcohen@lpl.arizona.edu)

**Introduction:** We have constructed an asteroid thermal model with the intent of tracking the radial and temporal dependence of temperature and composition throughout a 100-km diameter CM-type parent body, with emphasis on constraining the temperature and duration of a liquid water phase [1]. The characteristics of the liquid water phase are critical in determining the evolution of amino acids on meteorite parent bodies [2].

The model is a one-dimensional solution to the heat-flow equation with a suite of long- and short-lived radionuclides as the heat source. The materials are forsterite, enstatite, inert rock, and H<sub>2</sub>O in the solid, liquid, and vapor phases. We use the most recent temperature-dependent expressions for thermal conductivity, heat capacity, density, vapor pressure, and viscosity for these materials at temperatures spanning 50-1200K. We include serpentinization, dehydration, vapor diffusion, gas fracturing, and convection.

**Model Results:** With <sup>26</sup>Al as the dominant energy source, and using the canonical value of <sup>26</sup>Al/<sup>27</sup>Al=5\*10<sup>-5</sup> [3], a parent body accreting more than ~3.5 Ma after Al synthesis in a cold nebula will not produce liquid water in situ. The inclusion of <sup>60</sup>Fe extends the time for the final accretion in a cold nebula to about 4 Ma after nuclide formation. For a body accreting in a warm nebula (near the melting point of ice), peak temperatures are well over the serpentine dehydration temperature unless final accretion is forestalled further. The dominant factor affecting the maximum temperature of the liquid water, for a given heat input and initial temperature, is initial ice fraction. A high (40%) initial ice fraction buffers temperature rises and produces the large amount of serpentine (60%) observed in CM chondrites [4]. In every case where liquid water is produced, a thermal runaway ensues due to the exothermic serpentinization reaction, producing peak temperatures in excess of 400K. The liquid water not consumed by serpentinization is vaporized and diffused outwards at a rate dependent on the bulk permeability. Liquid water can persist for as little as 10<sup>4</sup> years in cases with very high permeabilities, or for millions of years in cases with low permeabilities.

Some locations in the asteroid contain liquid water that never gets hotter than the temperature range predicted by CM meteorite observations (273-298K) [5,6]. The location of this CM-matching zone moves outward with higher central temperature, and the width of the zone increases with permeability. The widest

band in any of our cold-nebula models was 1 km wide located 28 km from the center of the asteroid. Certain conditions produce a band only 4 km from the surface, but it is a mere 0.2 km wide.

**Amino Acids:** The extent of racemization of amino acids residing on a meteorite parent body, and thus the abundance of homochiral molecules available to deliver to the early earth, is dependent on the liquid water conditions on the parent body [2]. If biological amino acids were subjected to the conditions predicted by our model, they would completely racemize and erase any initial chiral signature. On the other hand, conditions inferred from CM chondrite observations can act to preserve an initial chiral signature in these amino acids. Thus far, our model does not produce scenarios that are fully consistent with CM meteorite observations. Alternatively, some of the constraints on CM parent bodies thermal histories based on meteorite observations could be reconsidered in the context of model results.

**References:** [1] Coker, R.F. and Cohen, B.A. (1998) *Met. Planet. Sci.* 33, A33-34. [2] Cohen, B.A. and Chyba, C.F. (1998) *Met. Planet. Sci.* 33, A33. [3] Podosek, F.A. and T.D. Swindle (1988) in *Meteorites and the Early Solar System*. Tucson, University of Arizona Press, 1093-1113. [4] Scott, E.R.D., et al. (1988) in *Meteorites and the Early Solar System*. Tucson, University of Arizona Press, 718-745. [5] Zolensky, M.E. (1984) *Meteoritics* 19, 346-347. [6] Rowe, M.W. et al. (1994) *GCA* 58, 5341-5347.