RACEMIZATION OF METEORITIC AMINO ACIDS.

B. A. Cohen[1] and C. F. Chyba, The University of Arizona, Tucson AZ 85719 [1]bcohen@lpl.arizona.edu.

Amino acids are the building blocks of proteins, among the most biologically critical molecules. It was first noted in the 1800's that the vast majority of amino acids used by living organisms are the left-handed enantiomers (laevorotatory, or L) rather than the right-handed enantiomers (dextrorotatory, or D). However, the question of why life chose the L- over the D-enantiomers remains an outstanding question. Delivery of chirally enhanced extraterrestrial organic material might have been one way to enhance the concentration of L-amino acids on the earth and to encourage the choice of L-enantiomers in life processes. Amino acids were first found in the carbonaceous chondrite Murchison [1], but were reported to have a D/L ratio of ~1. Recently L-enantiomeric excesses have been reported in the Murchison amino acids [2,3]. If a non-racemic mixture of amino acids were incorporated into an asteroidal parent body, the chiral signature might be transmitted to Earth through meteorite delivery. This work investigates how much racemization takes place throughout an extraterrestrial amino acid's lifetime.

Racemization rate data was obtained for nine different amino acids: alanine, aspartic acid, glutamic acid, isoleucine, leucine, phenylalanine, proline, serine, and valine. D/L ratios were determined after a number of thermal history scenarios based on meteorite evidence and asteroid thermal models [4,5]. The process can also be worked backward, beginning at time t=now with some D/L ratio and determining the initial ratio.

Cronin and Pizzarello [2] find L-enantiomeric excesses in Murchison amino acids that are not easily racemized (α-methyl amino acids), but a racemic mixture of the α-hydrogen amino acids investigated. Engel and Macko [3] find L-enantiomeric excesses in the more easily racemized α-amino acids alanine (D/L= 0.5) and glutamic acid (D/L= 0.3), though these results are controversial. Back-modeling reported excesses shows that these observed ratios could be produced by a wide range of initial D/L ratios. Whether the mechanisms for imposing chirality on amino acids could produce such starting ratios is unclear.

For the bulk of their history before we find them, meteoritic amino acids experience cold and dry conditions that prevent racemization, but racemization can quickly take place in an aqueous environment. The degree of racemization is quite sensitive to a number of parameters that are difficult to constrain, including duration and temperature of the liquid phase. The final D/L ratio does not give unambiguous information about the path which produced it. These results support the idea that delivery of an initial chirality to the earth in the form of extraterrestrial organic material is possible, since there are some scenarios in which 100% racemization of an initial D/L≠1 amino acid mixture need not occur.

References: [1]Kvenvolden, K. *et al.* (1970) Nature 228, 923-926. [2]Cronin, J.R. and S. Pizzarello (1997) Science 275, 951-952. [3]Engel, M.H., and S.A. Macko (1997) Nature 389, 265-268. [4]Grimm, R.E. and H.Y. McSween (1989) Icarus 82, 244-280. [5]Coker, R.F. and B.A. Cohen (1998) see abstract in this volume.

METSOC abstract #5188