AMINOSTRATIGRAPHY OF ORGANISMS IN ANTARCTIC AND SIBERIAN PERMAFROST CORES. K. L. F. Brinton[1], A. I. Tsapin[1], G. D. McDonald[1], and D. Gilichinsky[2], [1]Jet Propulsion Laboratory, MS 183-301, 4800 Oak Grove Drive, Pasadena, CA 91109, USA, kbrinton@its.caltech.edu, [2]Institute of Basic Biological Problems, Russian Academy of Sciences, 142292, Pushchino, Moscow Region, RUSSIA.

Introduction: Amino acid racemization dating (or *aminostratigraphy*) in Antarctic and Siberian permafrost core samples can be used to evaluate the age of organisms in frozen environments. The potential for subsurface permafrost on Mars makes terrestrial permafrost an important source of information regarding the preservation of both living organisms and their remains.

Aminostratigraphy: Aminostratigraphy can be used to determine the age of samples by measuring the degree of racemization that has taken place since the death of an organism or group of organisms [1,2]. Terrestrial life possesses mainly the L form of protein amino acids, and in living organisms this low D/L ratio is maintained through repair and replenishment mechanisms. After death, amino acids undergo a racemization reaction until they approach a 1:1 mixture of D and L enantiomers. The reaction proceeds via the loss of the α-proton to form a carbanion intermediate, which is then reprotonated to yield either the L or D form. The rate of this process is governed by the environmental temperature, pH, activity of water, whether the amino acid is free or protein bound, and the electronegativity of the amino acid side chain. Under a given set of conditions, the racemization reaction can be written as:

$$\text{L-amino acid} \underset{k\text{obs}}{\overset{k\text{obs}}{\rightleftharpoons}} \text{D-amino acid}$$

where $k$obs is the observed first order rate constant for enantiomeric interconversion. The equation describing the relationship between D/L ratio and time is:

$$\ln\left(\frac{1+\text{D/L}}{1-\text{D/L}}\right) - \ln\left(\frac{1+\text{D/L}}{1-\text{D/L}}\right)_{t=0} = 2(k\text{obs})(t)$$

The amino acid analysis technique used in this study [3] involves *o*-phthaldialdehyde/N-acetyl L-cysteine derivatization. This produces fluorescent diastereomers, which are separated and detected by high performance liquid chromatography with fluorescence detection.

Antarctic and Siberian Permafrost Samples: We have obtained Antarctic permafrost core samples ranging in depth from the surface to 8 m. We have also obtained Siberian permafrost cores which range in depth from the surface to 4.9 m. As an example of dating by aminostratigraphy, a Siberian permafrost sample from 4.9 m depth has an aspartic acid D/L ratio of 0.24. Using $k$obs=1x10^{-7} yr^{-1} for aspartic acid racemization at -20ºC [4], this D/L ratio gives a racemization age of approximately 2.4 Ma, which is consistent with the age determined for this sample by stratigraphic methods [5].

Evaluation of Permafrost Temperature Histories: The temperature history of permafrost from both these regions is not completely understood, particularly in the case of Siberian permafrost. While this may make aminostratigraphy more difficult, a plot of $k$obs vs. time (as confirmed by a complementary technique such as ^{14}C dating) could clarify the temperature history of the cores. Such data would add to our understanding of the life cycle of permafrost both on Earth and potentially on Mars as well.

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