N92-12926

MODIFICATION OF AMINO ACIDS AT SHOCK PRESSURES OF 3 TO 30 GPA: INITIAL RESULTS.

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Since the discovery of amino acids in the Murchison meteorite, much speculation has focused on their origin and subsequent alteration, including the possible role of secondary processes, both terrestrial and extraterrestrial. As collisional processes and associated shock waves seem to have affected the silicate portions of many primitive meteorites, a mixture of powdered Allende (125-150 m grain size) and nine synthetic amino acids (six protein and three non-protein) were subjected to controlled shock pressures from 3 to 30 GPa to determine the effect of shocks on amino acid survivability. This report presents preliminary characterizations of the recovered shock products.

The shock experiments employed a powder propellant ballistic range, and the samples containing amino acids were encased in metal jackets; the latter and the flat-plate projectile were manufactured from materials of known equation-of-state, such that the peak pressures could be calculated from only a measured impact velocity (Gibbons, et al, 1975; and Schaal, et al, 1979). Temperature measurements cannot be made during such experiments, however, the metal container was recovered within one minute and equipped with a thermo-couple while simultaneously being placed on a pre-cooled aluminum block. The highest temperature recorded was 58°C at 30 GPa, and all samples cooled to ambient room temperature within 10 minutes. The unshocked control sample underwent all target preparation and recovery procedures, including milling and lathe operations, save the actual impact. The retrieved test samples were prepared for analysis to determine the extent of destruction of amino acids and the extent of their racemization. The general procedure followed was extraction of amino acids from the mineral matrix with dilute acid; separation of amino acids from other ions by ion exchange chromatography; and derivatization and analysis of amino acids gas chromatographically as described by Kvenvolden, et al (1972).

Results were as follows: (a) amino acids decreased as a function of increased pressure (e.g., aspartic acid was three orders of magnitude less at 30 GPa vs. the control sample and the 3 GPa sample). (b) Racemization increased as a function of increased pressure (e.g., aspartic acid increased from D/L = 0.011 for the control sample to D/L = 0.68 (equilibrium = 1.0) at 30 GPa). Evidence of secondary amino acid formation was insignificant. In terms of recovery, the acidic amino acids , aspartic acid and glutamic acid, survived better than the other amino acids. This result parallels findings in organic geochemistry in which the acidic acids survive longer in the sediment column. Perhaps the interaction of the carboxyl groups with the mineral matrix insures greater stability. Aromatic acids, such as phenylalanine, do not survive as well.

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