p147

FLUID-MIXING AND ORGANIC SYNTHESIS ON EARLY MARS

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Regression of recently obtained experimental volume and heat capacity data for aqueous organic compounds at 280 bars and up to 250°C (Criss & Wood, 1996; Hnedkovsky et al., 1996; Inglese & Wood, 1996) with a theoretical equation of state (Shock et al., 1992) permits estimates of thermodynamic properties for thousands of aqueous organic compounds. Incorporation of these data into geochemical models allows quantitative prediction of the consequences of geologic processes involving organic synthesis and transformation. The general applicability of these models allows us to asses the potential of organic synthesis in a variety of geologic and planetary environments (Shock, 1995; 1996; Schulte & Shock, 1996). It has been demonstrated that hydrothermal systems on early Mars could have sequestered a significant amount of atmospheric carbon in the martian crust as carbonate minerals (Griffith & Shock, 1995). Similarly, early martian hydrothermal systems could have allowed the synthesis of organic compounds which may have led to the emergence of life on Mars. Previous models have ignored the potential of organic synthesis in these systems by assuming that all of the carbon is converted to carbonate. More realistically, some of the carbon would be converted into organic compounds. Preliminary calculations indicate that given a reservoir of water and a carbon-bearing hydrothermal fluid in disequilibrium with that reservoir on Mars, there is the potential for organic synthesis during mixing of the two fluids. The potential for synthesis is highly dependent on the H_2 content of the hydrothermal fluid, which is set by reactions between H_2O and iron-bearing mineral assemblages. For example, mixing of a hot fluid in equilibrium with the fayalite-quartz-magnetite mineral assemblage with cold, carbonated H_2O can lead to organic synthesis when temperatures reach between 50°C and 200°C. In this temperature range, the pH of the mixture increases from ~4 to 5.5, while the logarithm of the oxygen fugacity increases from -70 to -45. At metastable equilibrium in this temperature range, inorganic carbon accounts for about 10% of the total carbon budget. Organic acids are always the predominant compounds but ketones, alcohols and alkenes are also present.

Previous studies of hydrothermal systems have demonstrated by observation or experiment that reactions involving creation and transformation of organic compounds can occur (Hennet et al., 1992; Simoneit, 1993; Marshall, 1994; Seewald, 1994). Incorporation of data for thousands of new organic compounds will lead to more accurate quantitative descriptions of the speciation of carbon in these models, allowing us to better assess the potential for organic synthesis and the feasibility of the emergence and existence of life in these environments. Better constraints on the composition and evolution of the martian crust and volatile reservoirs will also help constrain the model variables and allow an improved description of the processes which may have led to the emergence of life on Mars.

Criss, C. M. and Wood, R. H.: 1996, *J. Chem. Thermo.*, in press.

Griffith, L. L. and Shock, E. L.: 1995, *Nature* **377**, 406.

Hennet, R. J.-C. et al.: 1992 *Naturwissenschaften* **79**, 361.

Hnedkovsky, L. et al.: 1996, *J. Chem. Thermo.*, in press.

Inglese, A. and Wood, R. H.: 1996, *J. Chem. Thermo.*, submitted.

Marshall, W. L.: 1994, *Geochim. Cosmochim. Acta* **58**, 2099.

Schulte, M. and Shock, E.: 1996, in preparation.

Seewald, J.: 1994, *Nature* **370**, 285.

Shock, E. L.: 1995, Geol. Soc. Amer. Annual Meeting, Abstracts with Programs, p. A-312.

Shock, E. L.: 1996, CIBA Foundation Symposium No. 202, "Evolution of Hydrothermal Ecosystems on Earth (and Mars?)," London, 30 Jan.-1 Feb., 1996.

Shock, E. L. et al.: 1992, *J. Chem. Soc. Faraday Trans.* **88**, 803.

Simoneit, B. R. T.: 1993, in *Organic Geochemistry* (Engel, M. H. and Macko, S. A. eds.), Plenum Press, New York, p. 397.