Life after shock: the mission from Mars to Earth

Conference or Workshop Item

LIFE AFTER SHOCK: THE MISSION FROM MARS TO EARTH.

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Introduction: In view of the geological and climatological development of planet Mars, the origin and evolution of life in the first 1.5 billion years of martian history appears possible. There is also convincing evidence that a significant amount of surface material was ejected from Mars by impact processes and a substantial portion of that transferred to Earth. The minerals of the Martian meteorites collected so far indicate an exposure to shock waves in the pressure range of 5 to 55 GPa [1]. As terrestrial rocks are frequently inhabited by microbial communities, rocks ejected from a planet by impact processes may carry with them endolithic microorganisms, if microbial life existed/exists on this planet.

Experiment: We produced planar shock waves by an explosive device, which accelerates a planar flyer plate. The plate impacted an Armco iron container, in which the sample, an assemblage of different kinds of microorganisms and rock, was placed parallel to the shock front. Independently of the peak shock pressure predetermined by the dimensions and material properties of the experimental set-up, the actual peak shock pressure of the recovered shocked material was controlled by measurement of the refractive indices of plagioclase, based on accurate calibration for shock pressure [e.g., 2].

Based on the experience with shock recovery experiments at an ambient temperature of 293 K [3], we performed a new set of experiments to extend the temperature conditions to 233 K and 193 K, respectively, in order to better simulate the Martian temperature environment (147 to 290 K). Considering the detailed knowledge about the composition and constitution of Martian surface rocks and the well-known relation between shock pressure and post-shock temperature for various types of rocks, we used dunite (corresponding to the Martian chassignite meteorites) on the one hand, and sedimentary rock (sandstone) saturated with water and salt on the other hand, as an extension of our earlier work with gabbro [3]. Dunite is the rock of choice because of a relatively low increase of shock and post-shock temperature after shock loading [1]. Sandstone served as an analogue of the Martian water-saturated regolith.

Conclusion: The aim of these experiments was to determine the temperature or pressure as the limiting factor for the survival rate of microorganisms during shock loading and to better understand the underlying molecular mechanisms of the survival of microorgansims in an impact and ejection scenario.

References: [1] Fritz, J. et al. 2005. *Meteoritics & Planetary Science* 40:1393-1411 [2] Stöffler D. et al., 1986. *Geochim. Cosmochim. Acta* 50: 889-903. [3] Meyer et al. 2006. *Geophys. Res. Abstr.* 8: 00554.