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# Experimental simulation for a launch of viable microorganisms from Mars

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We investigate the likelihood of the theory of "Lithopanspermia", the hypothesis that viable microorganisms can be transported between terrestrial planets inside meteorites. On early Mars an evolution of life appears possible with respect to the geological and climatological development of the planet [e.g., 1]. Martian rocks can be impact ejected by moderate shock pressures in the range of 5-55 GPa [e.g., 2] as these rocks were accelerated due to the steep pressure gradient in a spallation zone [3] and transferred to Earth. Such an interplanetary transfer of rocks is documented by 35 Martian meteorites [e.g., 4, 5]. Furthermore, terrestrial rocks are frequently inhabited by microbial communities. Assuming that endolithic microorganisms populate Martian rocks such organism could be liberated from Mars by impact ejection.

With regard to the impact and ejection phase we tested the case for the transfer of microorganisms from Mars to Earth, using a high explosive set-up with thin layers of bacterial endospores of *Bacillus subtilis*, of the lichen *Xanthoria elegans* and of the cyanobacterium *Chroococcidiopsis sp.* embedded between two plates of gabbro. This rock was used in the shock recovery experiments as a good analogue for basaltic shergottites, the most common Martian meteorite. According to the shock pressure range observed in Martian meteorites we systematically subjected the microorganisms to various shock pressures in the range of 10-50 GPa. The survival rate of the microorganisms decrease exponentially with increasing shock pressure with a survival rate of 0.39% for *Chroococcidiopsis sp.* at a shock pressure of 10 GPa, a survival rate of

0.02% for *B. subtilis* spores at a shock pressure of 42 GPa and survival rate of 0.002% for the lichen *X. elegans* at a shock pressure of 50 GPa. In the experiments the temperature after shock compression increases from 10 ˚C to 250 ˚C and 350 ˚C at 10, 42 and 50 GPa, respectively.

According to [2] on average more highly shocked Martian meteorites reach Earth faster than lower shocked ones.. If the transfer time through space is the limiting factor for a transport of life between planets the highly shocked Martian meteorites would be the favourable transport medium for microorganisms. *Bacillus subt*. and the *Xanthoria elegans* are actually capable of surviving shock pressures in the range of 10-45 GPa. However, ultramafic rocks such as pyroxenites (nakhlites) are the most favourable host rocks for the interplanetary transfer of life, as shock pressure and especially the resulting post shock temperature represent limiting factors in the ejection process. These rocks not only display the lowest degree of shock metamorphism (5-20 GPa) but also suffer the least from post-shock heating.

[1] Wilson, A. 1999 *ESA pub. dev.* 79-94. [2] Fritz, J. et al. 2005. *Meteoritics & Planetary Science* 9/10. 1393-1411. [3] Melosh, H. J. 1984 *Icarus* 59. 234-260. [4] Bogard, D. and Johnson, P. 1983. *Science* 221. 651-654. [5] Nyquist et al. 2001 *Space Sci. Rev.* 96. 105-164.