

CAN METHANOGENS GROW IN A PERCHLORATE ENVIRONMENT ON MARS?

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Introduction: We have been studying methanogens as a model for life on Mars for a number of years now. Methanogens are microorganism in the domain Archaea that use carbon dioxide as a carbon source, molecular hydrogen as an energy source, produce methane as a by-product of metabolism, and have been shown to grow on a Mars soil simulant, JSC Mars-1 (1). The relatively recent discovery of methane in the Martian atmosphere has added relevance to these types of studies (2). In 2008, The Mars Phoenix Lander discovered perchlorate at its landing site in concentrations of approximately 1.0wt% (3). Because of perchlorate's powerful oxidizing property, many believed that the chances for extant life on the planet had decreased.

Methods: The research reported here was designed to determine if methanogens could grow in the presence of three different perchlorate salts. The methanogens tested were *Methanothermobacter wolfeii*, *Methanosarcina barkeri*, *Methanobacterium formicicum* and *Methanococcus maripaludis*. Standard growth media were prepared containing 0, 0.1, 0.5 and 1.0wt% magnesium perchlorate, sodium perchlorate, or potassium perchlorate. Organisms were inoculated into their respective media followed by incubation at each organism's optimal growth temperature. Methane production, commonly used to measure methanogen growth, was measured by gas chromatography of headspace samples.

Results and Discussion: Methane concentrations varied with species and perchlorate salt tested. However, all four methanogens produced substantial levels of methane, even in the presence of 1.0wt% perchlorate salt. In all cases, there were no differences in methane concentrations at 0 and 0.1wt% perchlorate salt. In most cases, 1.0wt% perchlorate salt resulted in lesser amounts of methane, at least initially. There are at least two possible explanations for this. The higher perchlorate concentrations may be inhibiting methane production by the methanogens, but with time some of the methanogens are adapting. A second explanation would be that methanogenesis is not being inhibited, but the methane being produced is being oxidized by the perchlorate. In preliminary experiments where methane was added to tubes containing perchlorate salt solutions, there was no decrease in methane concentration with time. This would seem to rule out the second explanation. Whatever the explanation, the results reported here indicate that the perchlorates discovered by the Phoenix Lander would not rule out the possible presence of methanogens on Mars.

References: [1] Kral, T.A. et al. 2004. *Origins of Life and Evolution of the Biosphere*, 34, 615-626. [2] Mumma, M.J. et al. 2009 *Science*, 323, 1041-1045. [3] Hecht, M.H. et al. 2009 *Science* (submitted).