METHANOGEN GROWTH IN PERCHLORATE-SUPPLEMENTED MEDIA AND IMPLICATIONS FOR LIFE IN PHOENIX-TYPE SOILS

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Introduction: Perchlorate (ClO_4^-), a highly oxidizing compound, was identified on the martian surface by the Phoenix Lander at concentration levels up to 1.0% [1,2]. There is some debate as to whether an environment with perchlorate salts is too harsh for any organism to survive. Methanogens are able to survive in a numerous unwelcoming environments. Due to their ability to survive in extreme conditions, these anaerobic chemoutotrophs may have been the first autotroph to evolve on Earth, making them a good candidate for life on Mars [3]. In this project we studied the survivability and growth of methanogens in perchlorate solutions relevant to Mars [2].

Methods: Four methanogen species (*Methanothermobacter wolfeii*, *Methanosarcina barkeri*, *Methanobacterium formicicum*, and *Methanococcus maripaludis*) were used to test for possible methanogen growth in three perchlorate salt media (sodium, potassium and magnesium). The methanogen species were chosen due to their previous success of surviving in Mars-like conditions [3]. A specific medium was prepared for each species; CO_2 was added as an energy source and H_2 for an energy source. Perchlorate salt solution at different concentrations was added to the sterilized beakers. Tubes were inoculated with the appropriate organism and methane growth was measured by gas chromatography.

Results and Discussion: Although methane concentrations varied with species and salt tested, all four species of methanogens produced detectable amounts of methane at all concentrations of each tested salt (Fig. 1). In all cases, there was little to no difference in methane concentrations at 0 and 0.1% perchlorate. In most cases, 1.0% perchlorate resulted in, initially, lesser amounts of methane. There are at least two possible explanations for this. The higher perchlorate concentrations may be inhibiting methane production by the methanogens. A second explanation would be that methanogenesis is not being inhibited, but the methane being produced is being oxidized by the perchlorate, resulting in less methane being measured in the headspace of the culture tubes. In some cases methane concentrations in the higher-concentration perchlorate tubes eventually reach the level of the control, supporting the second explanation.

Implications for Mars: Although methane in the Martian CO_2 atmosphere is globally very dilute, about

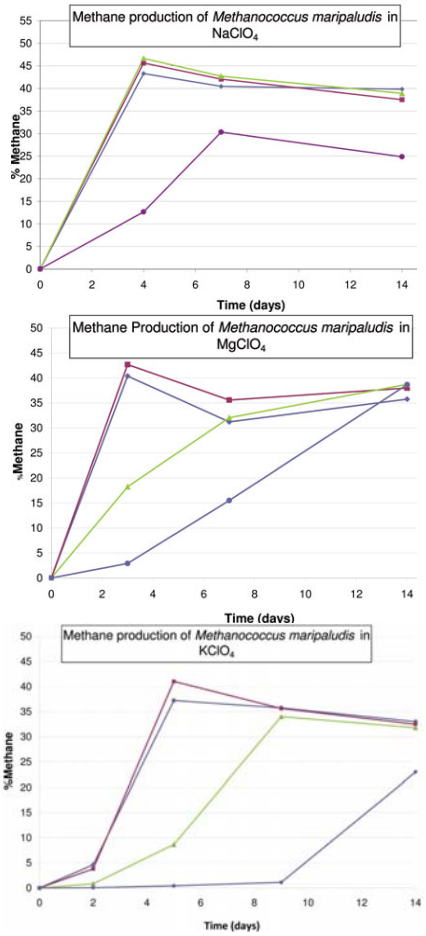

Figure 1. Methane concentrations in *Methanococcus maripaludis* cultures exposed to three perchlorate salts. Diamonds represent the control, squares the 0.1% perchlorate, triangles the 0.5% perchlorate and the circles 1.0% perchlorate.

10 ppb, there are localized areas where the concentrations are as high as 35 ppb [4] and must be constantly replenished due to photochemical losses [5]. These localized areas and concentrations cannot be explained by impacts or volcanism [5] and may be areas where methanogens are producing methane. Results here indicate that the perchlorates discovered by the Phoenix lander would not necessarily rule out the presence of these methanogens on Mars.

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