Nontronite and Montmorillonite as Nutrient Sources for Life on Mars. R. L. Mickol[1], P. I. Craig[2] and T. A. Kral[1,3], [1]Arkansas Center for Space and Planetary Sciences, University of Arkansas, Fayetteville, AR 72701, [rmickol@uark.edu], [2]Lunar and Planetary Institute, Universities Space Research Association, Houston, TX 77058 [3]Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701.

Introduction: Spectral data from the martian surface indicate the presence of various clay minerals in some of the planet's oldest terrains. The presence of clay minerals suggests long-term water-rock interactions. The most commonly identified clay minerals on Mars to date are nontronite, an Fe-rich smectite clay, and montmorillonite, an Al-rich phyllosilicate [1]. Both clays can contain variable amounts of water both adsorbed on their surface and absorbed within their structural layers. Over Mars' history, these clay mineral-water assemblages may have served as nutrient sources for microbial life.

Methods: *Experiment 1*: Two methanogen species, *Methanobacterium formicicum* and *Methanosarcina barkeri*, were tested for their ability to grow in the presence of nontronite or montmorillonite, without the use of additional nutrients. Two grams of each clay were added to each of five test tubes, and transferred to a Coy Anaerobic Chamber to deoxygenate overnight. Ten milliliters of bicarbonate buffer were added to each tube and the tubes were sterilized via autoclave. Before being inoculated into the sterilized clay solutions, methanogens were subjected to an aerobic washing procedure to remove residual media following the methods of McAllister and Kral [2]. Next, 0.5 mL cells+buffer were added to each test tube prepared above. The test tubes were pressurized with 170 kPa H_2, incubated at 37 °C, and monitored over time for methane production. Negative control tubes consisted of buffer or buffer plus clay.

Experiment 2: In a second experiment, test tubes consisted of a clay mixture of 1 g nontronite plus 1 g montmorillonite.

Following growth periods, clays will be analyzed for the presence of possible biosignatures in the form of mineralogical changes using X-Ray Diffraction (XRD), Near InfraRed spectroscopy (NIR) and Scanning Electron Microscopy (SEM).

Results: *Experiment 1*: *M. barkeri* failed to produce significant methane in any of the 2 g nontronite or 2 g montmorillonite sets. *M. formicicum* produced methane using montmorillonite as a nutrient source, but was unsuccessful with nontronite (Fig. 1).

Experiment 2: *M. barkeri* and *M. formicicum* both produced increasing methane during 30 days of incubation at 37 °C in a nontronite/montmorillonite clay mixture (Fig. 2).

For both experiments, growth in the presence of clays+buffer was much more delayed than growth in normal media (Fig. 2).

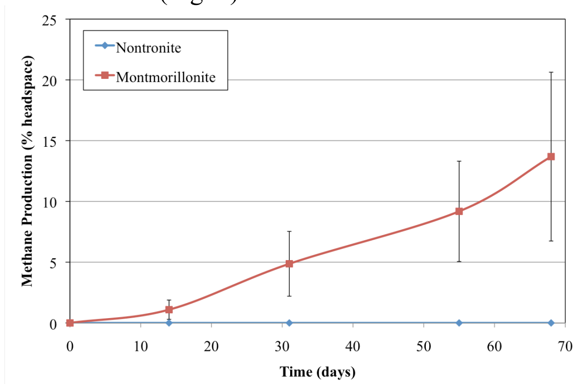

Figure 1. Methane production by *M. formicicum* in media containing solely bicarbonate buffer and clay (nontronite or montmorillonite).

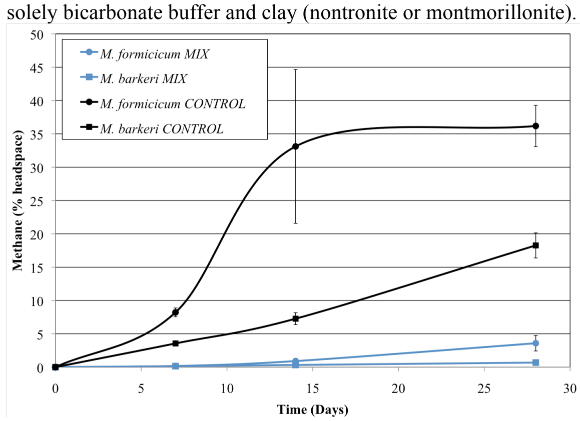

Figure 2. Methane production by *M. formicicum* and *M. barkeri* in media containing solely bicarbonate buffer, nontronite and montmorillonite (mix) or in normal anaerobic growth media (control).

Discussion/Conclusions: Nontronite and montmorillonite have been identified in the oldest terrains on Mars [1, 3]. We have shown that methanogens can utilize nutrients from montmorillonite without supplemental media. Clay minerals are of particular interest in astrobiology because of their water content and have been hypothesized to preserve organic matter and possibly biosignatures on Mars [4]. We will compare our laboratory data to observations of Mars in order to identify potential biosignatures on Mars.

References: [1] Carter, J., et al. (2013) *JGR* 118, 831-858. [2] McAllister, S.A., and Kral, T.A. (2006) *Astrobiology* 6, 819-823. [3] Poulet, F., et al. (2005) *Nature* 438, 623-627. [4] Ehlmann et al., (2008) *Nature Geo.* 1, 355-358.