Nontronite and Montmorillonite as Nutrient Sources for Life on Mars. P. I. Craig[1], R. L. Mickol[2], P. D. Archer[3], T. A. Kral[2,4], [1]Lunar and Planetary Institute, 3600 Bay Area Blvd, Houston TX 77058 (craig@lpi.usra.edu), [2]Arkansas Center for Space and Planetary Sciences, University of Arkansas, Fayetteville AR 72701, [3]Jacobs at NASA Johnson Space Center, Houston TX 77058, [4]Dept. of Biological Sciences, University of Arkansas, Fayetteville AR 72701.

Introduction: To date, the most common clay minerals identified in Noachian terrains on Mars are nontronite (Fe-smectite) and montmorillonite (Al-smectite) [1], both of which contain variable amounts of water and whose presence suggest long-term water-rock interactions. Over Mars' history, these clay mineral-water assemblages could have served as nutrient sources for microbial life.

Methods: Two methanogen species, *Methanobacterium formicicum* and *Methanosarcina barkeri*, were tested for their ability to grow in the presence of nontronite and montmorillonite, without additional nutrients. After 2 g of each sterilized and deoxygenated mineral were placed into each of 5 test tubes, 10 mL of bicarbonate buffer were added to each tube. Methanogens were aerobically washed [2] and inoculated into the clay solutions. Next, 0.5 mL cells+buffer were added to each tube. The tubes were pressurized with 170 kPa H_2, incubated at 37°C, and monitored over time for methane production. After 70 days, the minerals were removed from the tubes and analyzed for mineralogical changes using X-ray diffraction (XRD), chemical changes using scanning electron microscopy with energy dispersive spectroscopy (SEM/EDS), and volatile and organic content with evolved gas analysis (EGA).

Results: *M. formicicum* produced the most methane on montmorillonite (Fig. 1). Although no mineralogical changes were observed via XRD [3], SEM/EDS analysis showed textural changes and elemental depletions (Fig. 2). Reacted samples showed differences from control samples, particularly for the release of CO_2 at ~150°C (Fig. 3). Additional work is needed to determine if this is the result of the decomposition of the microbial biomass itself or due to biologically-mediated changes to the clay minerals.

Discussion/Conclusions: We have shown that methanogens can utilize nutrients from montmorillonite without supplemental media. Not only can methanogens utilize montmorillonite for their nutrients, we have identified potential biosignatures in the form of textural and chemical changes in the minerals. Although mineralogical changes were not identified, given more time or increasing the ratio of methanogens to minerals could increase in the amount of altered clay minerals to above the detection limits of XRD. We will compare our laboratory data to observations of Mars in order to identify potential biosignatures on Mars.

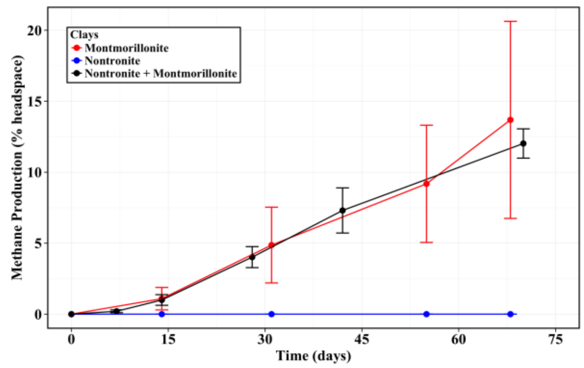

Figure 1. Methane production by *M. formicicum* in media containing solely bicarbonate buffer and clay mineral.

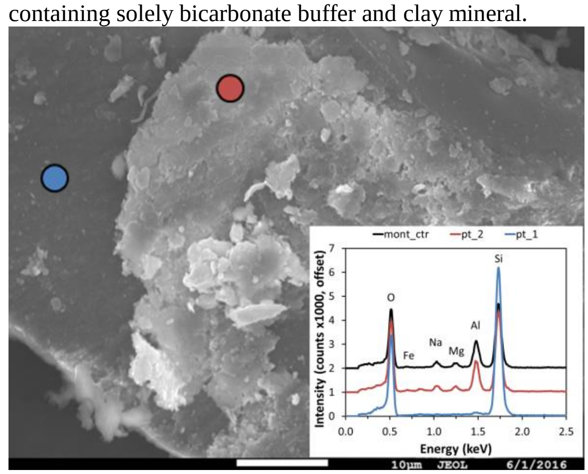

Figure 2. SEM/EDS analysis showing new texture and elemental depletion of montmorillonite with *M. formicicum*.

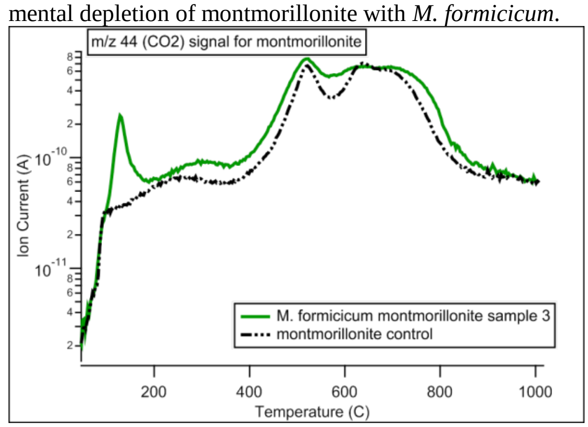

Figure 3: EGA curves for the control montmorillonite and montmorillonite with *M. formicicum.*

References: [1] Carter, J., et al., (2015) *Icarus* 248, 373-382. [2] McAllister, S.A., and Kral, T.A., (2006) *Astrobio* 6, 819-823. [3] Mickol et al., (2016) *Biosig. Workshop*, #2035.