MARS-ANALOG EVAPORITE EXPERIMENT: EVAPORATION RESULTS. J. M. Moore[1], M. A. Bullock[2], and T. G. Sharp[3], [1]NASA Ames Research Center, MS 245-3, Moffett Field, CA, 94035, jeff.moore@nasa.gov, [2]Southwest Research Institute, 1050 Walnut St., Suite 300, Boulder, CO 80302, [3]Dept. Geological Sciences, Arizona State University, Tempe, AZ 85287.

Introduction: This research is part of a multi-year experimental investigation to understand the nature and evolution brines and evaporates on Mars [1][2]. The spectacular discoveries of the MER rovers and the infrared spectrometers aboard *Mars Express* and *Mars Reconnaissance Orbiter*, both illustrate the relevance, as well as guide the future direction, of this work.

Here we report the results from our evaporites apparatus in which two types of brine were subjected to evaporation under Mars-like conditions.

Evaporites Experiments: The overarching objective of our evaporite experiments is to produce evaporites from synthetic Mars brines under simulated Mars conditions in order to understand how evaporitic sulfates and other salts may have formed on Mars. In order to achieve this, we are performing four sets of experiments. Each experimental set itself consists of four experiments (see: Experimental Procedure, below). Synthetic brines are subjected to fast and slow evaporation at just above 0°C and at 25°C, and at 10 and 500 mbar, respectively. In addition, brines are frozen rapidly (~2 weeks) and slowly (~4 months), followed by sublimation of the ice. Obviously evaporation or freezing-sublimation could have happened much more slowly on Mars, but we are looking for mineralogical differences at laboratory-reasonable time scales. Experiment sets with H_2SO_4 added (protocols C and D, below) will follow the first two experiment sets, since we anticipate that lessons learned in synthesizing evaporites under present and past Mars-like conditions will inform our interpretation of the results of these later experiments. In each of the four experimental sets we will focus on distinct chemistries. Evaporites will be produced from: **A**. Brines synthesized under present-day Mars conditions [1]; **B.** Brines synthesized under Mars conditions with added acidic volcanic gases [2]; C. Brines similar to (A) with 0.01 to 1 x 10^{-5} molar H_2SO_4 added; D. Brines similar to (B) with 0.01 to 1 x 10^{-5} molar H_2SO_4 added.

Evaporites Experiment Apparatus: Formation of the evaporites are carried out in thin, conical 50 cc teflon sample holders that sit inside and line cylindrical receivers. Precipitation occurs at the bottom of each sample holder on a gold-plated TEM sample grid with a holey-carbon thin film, which is removed at the conclusion of a run and placed directly into an X-ray diffraction sample chamber. Each receiver contains a conical cavity for supporting the teflon sample holders, a helical path about the outside diameter, and two O-rings to contain coolant. The helical path provides efficient circulation of the coolant near each sample for temperature stability. The sample holders and receivers are mounted into a stainless steel cooling block that is itself fitted with coolant lines to further ensure an isothermal environment. The entire assembly (9 flasks within a block) resides within a vacuum desiccator chamber. The desiccator has been fitted with two gas valves; one for flushing its interior with a synthesized Mars gas, and the other for pumping the desiccator down to pressures as low as 1 mbar when required. The gas input and output valves are teflon solenoids, which can be actuated both manually and by the computer-controller. A pressure sensor feeds information back to the computer to ensure appropriate pressure in the chamber. Cambridge Sensotec Rapidox 200 O_2 sensors (capable of detection of O_2 down to 10^{-17} ppm) have been fit into the vacuum lines. These are constantly monitored by the computer-controller in order to detect any oxygen contamination. An electrical feed-through allows signals from thermistors attached to the sample flasks to be passed to the computer controller. A laptop computer using Labview and a PCMCIIA data acquisition card serves as the controller, measuring temperature and pressure in the chamber, logging data and controlling the vacuum pressure in the chamber (Fig. 1).

Experimental Procedure: The four-run experiment set we report on here involves the evaporation at 3°C and 10 mbar of two brines, one representing the brine we made under paleo- or acidic Mars conditions [2], and the other a brine formed under simulated modern Martian atmospheric conditions [1]. For each given brine composition, evaporation under two different conditions: one under paleo- or acidic Martian gas and the other modern Martian atmospheric gas.

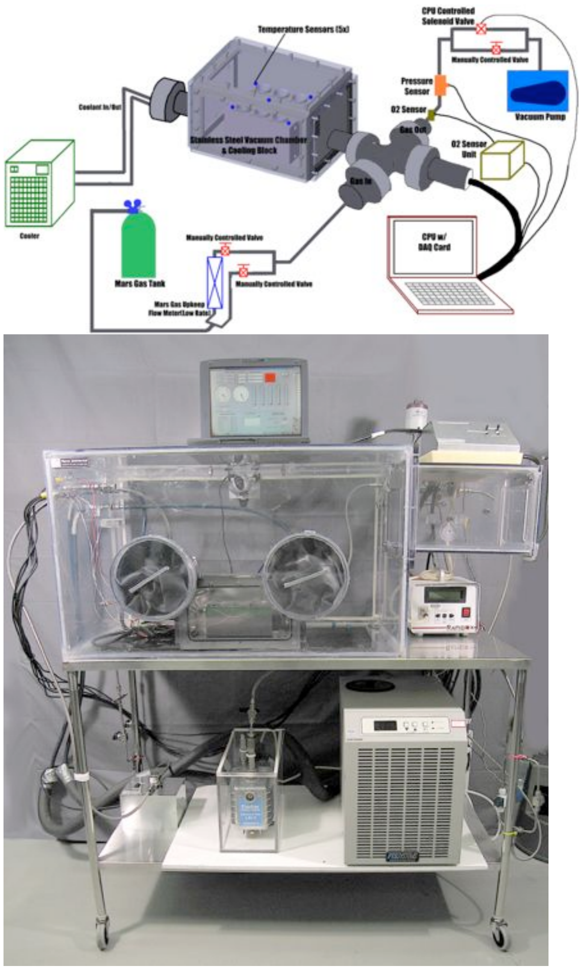

Figure 1. Mars-analog evaporites experimental apparatus

We performed an analysis of our synthetic brines and compared their composition with the brines produced in our brine experiments. For example, we found that the synthetically-produced "ancient *or* acidic" Mars brine was quite similar to that created in our year-long experiment, except that it was higher in sulfates by about an order of magnitude (Fig. 2).

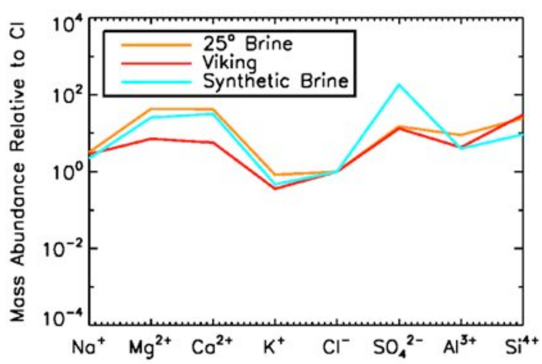

Figure 2. Composition of one of the synthetic brines used to create evaporites (light blue line) compared with the composition of brine produced in the experiments reported in [2] (orange line) and the average composition of Viking soils (red line).

Brines were placed into 9 sample holders (in the amounts of 20 ml), and desiccated. The desiccation of liquid samples was followed by visual (video monitoring) inspection. Brines were typically desiccated in ~14 days. The thoroughly dry precipitate samples were removed in an oxygen and moisture free glove box, sealed, and sent for analysis.

Analysis: We are analyzing our evaporite products using X-Ray diffraction (XRD), Scanning Electron Microscopy (for imaging), and Near Infrared Spectroscopy. Here we give an example of a precipitate that was analyzed using XRD (Fig. 3). Our conclusions regarding this sample are that the predominant phase is gypsum, which occurs with a mixture of hydrous sulfates such as hexahydrite ($MgSO_4.6H_2O$), and possibly mirabilite ($Na_2SO_4.10H_2O$), and starkeyite ($MgSO_4.4H_2O$). Calcite is probably present in very small amounts and magnesian calcite is also possible. Sylvite and halite probably occurred in the Mars-analog evaporites in very small amounts.

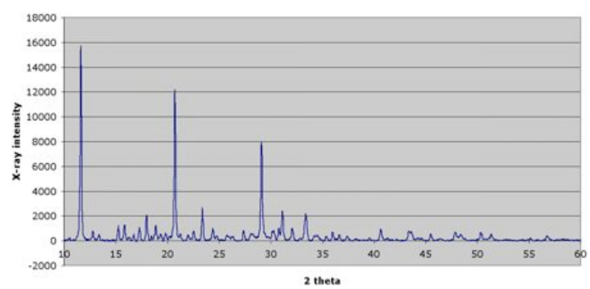

Figure 3. X-ray intensity as a function of angle from radiation diffracted by Mars analog evaporite salts.

Conclusions: At the time of this writing, the run results (precipitates) are undergoing several additional analyses. We will report on these results and our initial conclusions regarding their implications for evaporites seen on Mars and the history of Martian evaporites.

These experiments represent one of the first ever attempt to produce Mars-like evaporites in the laboratory. With the exciting discovery and initial characterization of actual evaporite deposits on Mars, such as at Meridiani Planum, it is imperative to understand the conditions (aqueous and atmospheric) that must have existed to form these deposits. Our future experiments will be responsive to both orbitally obtained and surface rover data, so that speculations about how layered deposits formed on Mars can be well-grounded in laboratory data.

References: [1] Bullock M.A. et al. (2004) *Icarus, 170,* 404-423. [2] Bullock M.A. and Moore J.M. (2004) *GRL, 31,* L14701.