**SUMMARY**
PREMISE is an internally-funded study by Southwest Research Institute (SwRI) to simulate the flux of gases and volatiles that would occur at the lunar surface due to a cometary impact or lunar outgassing event. A small chamber containing a sample cell was added to an existing vacuum system to permit the pumping down and bakeout of JSC-1A Lunar Soil Simulant. Once a good vacuum was achieved (1x10^-10 Torr), the sample was then exposed to various gases to observe their retention, if any, as a function of the exposure period and pressures used. Gases included pure argon, a Mars mix and a mixture containing H₂, Ne, N₂, and Ar. Preliminary results suggested that retention of gas was occurring at room temperature. This experiment was investigated further and results are included below.

**BACKGROUND**
Two issues motivated this effort: First, recent evidence of water trapped in the polar regions of both the Moon [1] and Mercury[2] has triggered a renaissance in the study of regolith environments. Laboratory simulation of these environments not only demands ultrahigh vacuum (UHV) conditions, but also the introduction of fine powders of either actual lunar regolith soil samples or regolith “simulants” into that same vacuum environment. Regolith materials are a rare laboratory commodity and in short supply. Regolith simulants are much more plentiful, but are fabricated from terrestrial basaltic glasses that place serious physical limits (particle size & distribution, morphology, composition, oxidation state) on their usefulness as analogues for regolith samples[3]. The second motivating factor was the post-detection of Ar in the lunar surface by a mass spectrometer[4] deployed during the Apollo 17 mission (Dec ’72) that has not yet been verified by remote sensing[5].

**TECHNICAL APPROACH**
PREMISE consists of a stainless steel UHV system, a sample chamber and a gas inlet system. Both the vacuum system and gas inlet have separate turbomolecular pumping systems. In addition, the vacuum system also includes ion pumps for additional pumping once high vacuum conditions have been achieved by the turbopumps. The sample chamber consists of a Kimball Physics Magdeburg Hemisphere™ (Fig. 1) miniature vacuum chamber having one a 4.5” ConFlat™ CF flange connection at the base, with two 2.75” CF flange connections and four 1.35” CF flange connections on the housing. Chamber connections lead to the vacuum system, gas inlet manifold, UV quartz window, thermocouple (TC) feedthrough, rotary feedthrough, residual gas analyzer (RGA) and sample cell. The sample cell assembly consists of two copper gaskets (one solid, one standard) brazed together and gold plated (Fig. 2). This forms a cylindrical volume approximately 2 mm deep with a surface area of approximately 10 cm². The RGA is an Exeter X7000A quadrupole mass spectrometer (QMS) with mass scanning from 1 to 200 daltons. The full range of scanned masses is typically limited to 50 daltons to reduce data file size, as the heaviest mass used thus far has been that of CO₂ (44 daltons). However, bakeouts, laser ablation or disturbances to the regolith are covered by full-range scans (100 daltons) when necessary to capture any unanticipated features at higher molecular weights. A schematic of the complete system is shown in Figure 3.

**PROCEDURE**
GAS DOSING: After baking of the system to drive off atmospheric gases and volatiles, gas was introduced to the sample volume through a Varian sapphire leak valve at a selected pressure and for a selected period of time. At a base pressure of 1x10^-10 Torr, the desiccated JSC-1A regolith simulant was exposed to carbon dioxide (CO₂) in the simulated Mars atmosphere. Gas was introduced until the background pressure reached approximately 3x10^-10 Torr. After holding at a constant pressure for a total of 10 minutes, the leak valve was rapidly closed.

**RESULTS**
The desiccated JSC-1A regolith simulant was exposed at room temperature to carbon dioxide (CO₂) in the simulated Mars atmosphere. Ar was detected at a mass peak at 40 daltons (Ar0) and for daughter ion peaks at 22 daltons (Ar⁺), 16 daltons (Ar²⁺) and 14 daltons (Ar³⁺). These ions also show the time required for captured CO₂ molecules to reach equilibrium with evolving CO₂ molecules is inversely proportional to both temperature and pressure. The argon mass peaks at 40 daltons (Ar0) and 22 daltons (Ar²⁺) were also monitored during exposure of the simulant to the Mars gas mix. No retention of Ar at the sample surface was observed. Figure 4 presents mass scans for the mass 40 channel (top) and mass 44 channel (bottom) representing Ar and CO₂, respectively. The Ar signal in the argon mass peak does not show any retention at room temperature and these results are relevant to current interest in the sources and persistence of Ar detected by mass spectrometry[4] during the Apollo 17 mission. Though Ar has two doublets (92.6 & 93.2 nm and 104.8 & 106.7 nm) appearing in the UV portion of the spectrum, this gas has not been detected in the atmosphere at the limb of the Moon by the Lyman-Alpha Mapping Project (LAMP) about the Lunar Reconnaissance Orbiter (LRO).

The argon gas dosing was repeated to determine if Ar could be detected at a lower pressure, and the results showed that Ar was not detected at pressures below 1x10^-9 Torr. This effort suggests further adsorbant/adsorbate studies in regolith materials is warranted due to current missions investigating the Moon[6].

**REFERENCES**