Introduction: Determining the energetics governing the formation, transport, diffusion, trapping, and possible sequestration of water in lunar regolith is necessary to fully understand lunar surface chemistry. Many experiments must use Earth-based regolith simulants because samples of lunar regolith are scarce. These simulants are designed to match the actual lunar soil in chemical and mineralogical composition and physical properties, including particle size and geometry and mechanical properties. A major difference between these samples and the Earth-based surrogates is the fact that actual lunar samples have been space weathered and contain implanted protons from the solar wind. A direct comparison of the formation and diffusion of molecular water and hydrogen in lunar sample Apollo 14163 and lunar soil simulants LMS-1 and LHS-1, Mare and Highlands simulants, respectively, developed by the Exolith Lab, has been done using Temperature Programmed Desorption (TPD) experiments in lunar relevant conditions in [1]. The results from this paper help with experimental design for technologies to extract lunar water and understanding the lunar water cycle and solar wind implanted gases.

TPD Results: H₂O and H₂ desorption was measured using TPD experiments for LMS-1, LHS-1, and Apollo 14163 samples under ultra-high vacuum (UHV) conditions. The resulting curves were fit using a model which considers desorption at the vacuum grain interface, transport in the void space between grain-grain boundaries, molecule formation via recombination reactions and sub-surface diffusion [1]. This model was developed by Jones et al., and a detailed explanation can be found in [2].

Water. The TPD model fits are shown in Figure 1 for Apollo 14163, LMS-1, and LHS-1. Each sample follows a similar overall trend. The total amount of water released during the experiments was calculated to be the least for the Apollo 14163 sample at 103 ppm, followed by 176 ppm from LMS-1 and 195 ppm from LHS-1 [1].

Hydrogen. TPD results for H₂ indicated that only the Apollo sample directly released measurable quantities of molecular hydrogen. Since essentially no molecular hydrogen was observed from the simulants, LMS-1 and LHS-1 do not display the desorption chemistry associated with the implanted hydrogen from the solar wind [1].

Activation Energies: The most probable H₂O formation and desorption effective activation energy was calculated from the model described in [2] to be ~150 kJ mol⁻¹ for all samples. The probability distribution widths, shown in Error! Reference source not found., were ~100 - 400, ~100 - 350, and ~100 - 300 kJ mol⁻¹ for LMS-1, LHS-1, and Apollo 14163, respectively [1].

Conclusions: These terrestrial surrogates are useful for understanding the surface and interface interactions of lunar regolith grains. TPD results demonstrate that the desorption and formation of H₂O from the simulants is similar to that of the regolith. However, the absence of H₂ beyond background levels in the simulants is assumed to be due to a lack of space weathering and solar wind implantation in the Earth-based simulants [1].