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A reservoir for solar-wind-produced water in lunar soils.

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Introduction: Discoveries of new sources of WATER on the Moon are becoming more numerous as our research progresses. All these recent discoveries of different forms of H (OH, HOH, and H2O ice) on the Moon, both endogenic and exogenic, have reshaped our view of "water" ON and IN the Moon Despite these discoveries, a potential large reservoir, LUNAR SOIL, has been largely overlooked until recently [1-2]. This was the first report and confirmation of OH in micro-meteorite-formed, impact glass in lunar soils; so-called "agglutinates", with abundances of up to 500 ppmw H2O, presents a medium for the accumulation of H from all the various sources. And the Lunar Soil Characterization Consortium (LSCC) [3-5] has demonstrated that the impact-melt glass portion of the fine-grain sizes of the lunar soil contains upwards of 70-80 % of such water-bearing glass. This could make for lunar soil feedstock with upwards of ~0.1 wt% H2O, in addition to any water produced solar-wind hydrogen reduction of ilmenite, etc. Therefore, thermal rendering of the fine-portions of the soil for solar-wind volatiles (e.g., H, He-3, C, N) will encounter additional quantities of water, exceeding those of the absorbed solar-wind.

Sources of Agglutinitic Water: Hydrogen-isotope compositions [1-2] are suggestive that the observed OH represents the end-product from both solar-wind and micro-meteoritic inputs to the Moon, the major agents of space weathering. Verification of abundant solar-wind-generated OH supports formation and retention of OH by solar-wind bombardment, implantation, H-reduction of the FeO component of impact melts, and indigenous OH. In addition, all these water sources have major implications for possible contributions to polar ice [6-7]. The survival of solar-wind OH in micro-meteorite-impact-formed agglutinates implies that similar mechanisms may contribute to surface OH observed on the surface of other airless bodies, such as asteroids, Mercury, Phobos, and even 4-Vesta [8-10].

Proton Bombardment of Lunar Soil: To study the proposed solar-wind formation of OH in lunar soil [11-12], Ichimura et al. [8] irradiated dried (500 0C under dynamic vacuum; **Fig. 1**) lunar highland and mare soils with ~1 keV protons, forming OH-, but the irradiated soils had been exposed to terrestrial for 3-5 minutes before the IR measurements, leaving ambiguous results. Ichimura et al. [9-10] then irradiated the dried lunar soils with both ~1 keV protons and deuterons (**Fig. 2**), producing both OH and OD, resp., as measured by IR spectroscopy. This is considered an unambiguous proof of the formation of OH (and HOH) in lunar soils by solar-wind proton radiation. These particles would also find ready partners from the myriads of "dangling bonds" of oxygen, formed by soil crushing and general comminution. They also observed a decrease in relaxation times on the order of days to weeks. This may be related to the ephemeral nature of the OH observed by Sushine et al. [13] with their EPOXY data of the Moon. Such formational processes for OH and HOH are applicable to other airless bodies (e.g., asteroids, Vesta, Phobus), with intensities as a function of solar-wind flux.

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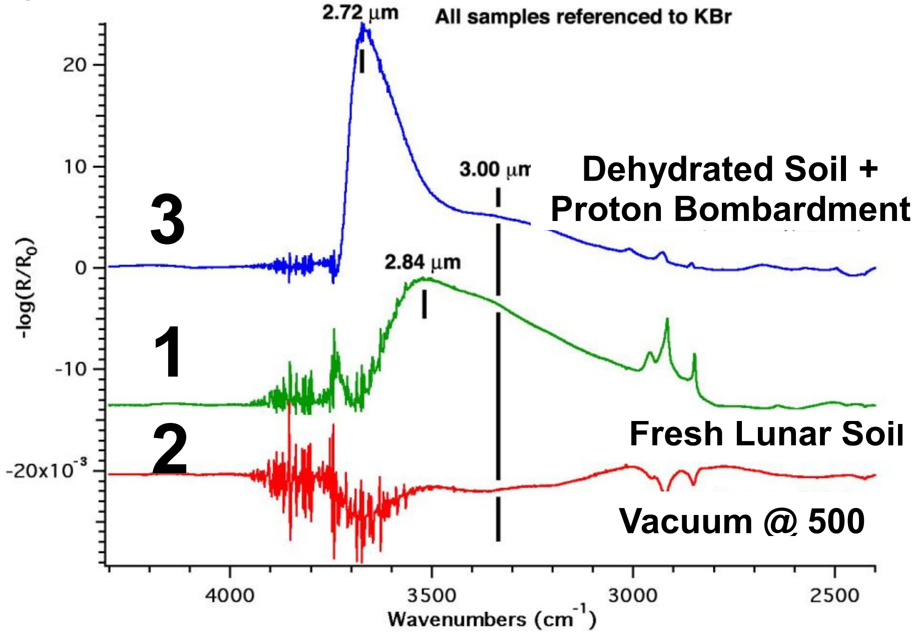
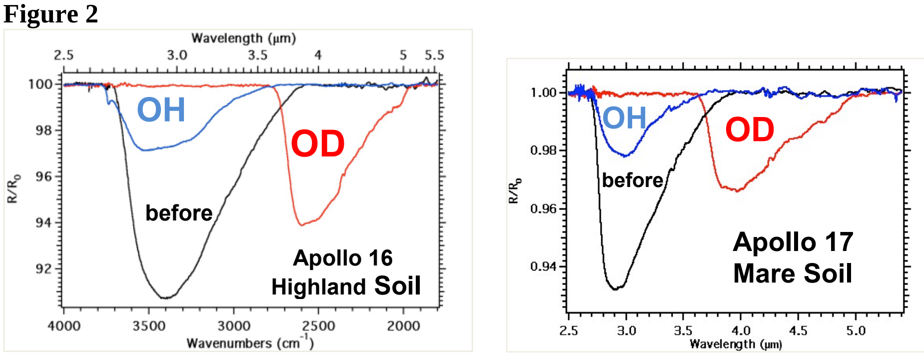
Figure 1.



(Ichimura, Zent, Quinn, & Taylor (LPSC, 2011)

Figure 2



Proton Implantation Creates OH Deuteron Implantation Creates OD

(Ishimura, Zent, Quinn, & Taylor, *EPSL* (2012 in press)