**Introduction**

The possibility for the formation of ice deposits or other volatiles on the Moon has been suggested previously, not only by degassing form the early Moon, but also by deposition from water-rich meteorite impacts near lunar poles (1). Temperatures have been estimated to not exceed 40K in shadowed Moon craters allowing the preservation of frozen water molecules over geologic time scales. Presence of ice has been verified based on data from various space missions (e.g., Figure 1) and radar measurements with the Arecibo radio telescope.

**Importance of Lunar Ice**

Lunar water ice has the advantage that it can be used by future explorers to be converted into hydrogen and oxygen for rocket fuel. There have been several mining purposes being discussed such as ice-mining from the permanently shadowed areas. This can be accomplished either by a transport rover, drag line bucket, or a combination of the two with the material being loaded into a sealed vessel and heated by a solar furnace, while the released gasses are recovered and condensed into water (Figure 2). A better option would be to separate the water from any organic endowment and any other particles that the ice might harbor, which could be done using surfactant modified zeolite (Figure 3) or nanofilters (2). That way the water could also be used for human consumption, plus the organic endowment may harbor a treasure trove of organic material. Not only would we be able to recover organic material from comets crashed on the Moon long ago, but these lunar ice-filled craters are the only location where we might find evidence of very early life on Earth. By discovering a rock fragment that was dislodged from Earth during a meteorite impact and landed on the Moon, we might unravel the origin of life riddle, possibly even detecting macromolecules before the first life form originated on Earth.

**Water on the Moon**

Figure 1. Map of hydrogen concentrations inferred to be water ice at the lunar north and south poles based on results from NASA’s Lunar CRater Observation and Sensing Satellite and Lunar Reconnaissance Orbiter (purple highest concentrations, green lowest concentrations) (3).

**Minining Water and Separating it from the Organics**

Figure 2. Set-up to mine water on the Moon. Material is loaded into a sealed vessel and heated by a solar furnace while the released gasses are recovered and condensed into water and stored in a storage tank for later use. The source of the sunlight (solar furnace) could be from areas of uninterrupted solar power such as the rims of Shackleton or the top of Maipelt Mountain (4).

Figure 3. Device to separate clean water from organic residue. The Surfactant Modified Zeolite (SMZ) filter was previously tested and proved extremely efficient removing organic compounds due to its (1) cage-like porous structure, (2) hydrophobic properties, (3) and charge characteristics (5). SMZ has a distinct advantage over activated carbon in this regeneration of the sorbent and recovery of the organic compounds is much easier. While activated carbon has to be heated to desorb retained volatile organics, SMZ is readily regenerated by blowing air through the filter. No added heat source or an ice bath condenser are needed.

**An Early Lunar Hydrosphere?**

Water seems to be more abundant in lunar rocks than previously thought (6) and some of the rocks also contain phyllosilicates (7), evidence of an early exposure to liquid water. This observation may be linked to vapor transport during degassing of a magmatic source region, or from a hybrid endogenic-exogenic process when gases were released during an impacting asteroid or comet (8). A more speculative suggestion would be the existence of an early Moon or Earth-Moon system hydrosphere, or perhaps a significant accumulation of water after an impact. Evidence for larger-scale hydrological processes would be hard to find since any resulting surface topography would be long erased by 4 billion years of pounding with solar wind and cosmic radiation. Nevertheless, the idea should be tested as it would be beneficial to know what happened to the water on the Moon early on, how much water the Moon retained, and for how long.

**References**