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On Using a Pyroclastic Deposit as A Manned Lunar Base Site

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The potential of lunar regions mantled by pyroclastic deposits for resource utilization has recently been summarized by Hawke et al. (1990). We agree that such areas have high resource potential and suggest that they have high scientific potential as well. On the Apollo 17 mission, orange glass beads and their crystallized black equivalents were found in high concentration at Shorty Crater. These beads were interpreted by various authors as impact melt ejecta from large impacts which had penetrated to more mafic material at depth, vapor condensates, splash droplets from impacts into lava lakes, or pyroclastic rocks. A pyroclastic origin is now commonly accepted . It is also commonly accepted that the dark mantle geologic units are made from similar pyroclastic materials.

The explosive eruptions that formed the lunar dark mantling deposits have been likened to some types of terrestrial volcanic activity. The largest, or regional, lunar pyroclastic deposits most likely formed in a manner similar to terrestrial strombolian fire-fountaining, while the smaller, localized, deposits most likely formed by vulcanian-type explosions. The strombolian eruptions consist of a series of discrete time transient explosions separated by periods of less than 0.1s to hours. The fire-fountains form when jets of disrupting magma are released. The jets are driven by excessive volatile gas pressure escaping from the rising and expanding bubbles within the magma. The vulcanian-type eruptions, on the other hand, occur when gas and pressure build up beneath a cap rock in the magma conduit. Explosive decompression occurs as the cap rock is broken away and the magma and gas expand upward and outward. Material from these eruptions is deposited 100's - 1000's km away from the source with the coarser fragments falling closer to the vent and the finer particles at the fringes. A detailed study of the deposits of such eruptions at or near a base would reveal much about the early volcanic history of the moon and the volatile component of lunar magmas.

Hawke *et al.* (1990) suggest that ilmenite found in Apollo 17 -type pyroclastic glass may provide feedstock for the hydrogen-reduction-of-ilmenite process for producing lunar oxygen. They also suggest that the ilmenite may help retain solar wind hydrogen and helium which can be extracted for use at a lunar outpost or even transported back to earth for fusion fuel in the case of helium-3. Therefore, they suggest that ilmenite-rich material may be the best candidate. Here we propose a somewhat different approach. We propose that the pyroclastic glass can be reduced directly to produce oxygen and one or more metals. Sulfur would be another important byproduct of this processing. This process would eliminate the need for having specific minerals such as ilmenite or for doing any mineral concentration. The bulk pyroclastic would provide the feedstock. Some recent experiments performed at Johnson Space Center suggest that an iron-rich composition would be the most suitable for this direct feedstock reduction and that the titanium content may not be important.

In addition to providing feedstock for oxygen extraction, the lunar pyroclastic deposits would be extremely useful in constructing and supporting the lunar base. Unlike typical maria and highland areas, the unconsolidated nature, chemical makeup and block-free surfaces of the pyroclastic deposits would provide a source of uniform, relatively unconsolidated, block-free material which could be easily mined and used for a variety of lunar base needs including radiation protection, construction material, and feedstock for various extraction and processing operations as suggested by Hawke et al. (1990).

Hawke, B.R., C.R. Coombs, B. Clark (1990) Ilmenite-rich pyroclastic deposits: An ideal lunar resource. Proc. 20th Lunar and Planet. Sci. Conf., 249-258.