THERMAL ANALYSES OF APOLLO LUNAR SOILS PROVIDE EVIDENCE FOR WATER IN PERMANENTLY SHADOWED AREAS. B.L.Cooper[1] M.C. Smith[2] and E.K.. Gibson[3], [1] Jacobs ESCG (bonnie.l.cooper@nasa.gov), [2] East Tennessee State University (smithmc2@gmail.com), [3] NASA Johnson Space Center.

Introduction: Thermally-evolved-gas analyses were performed on the Apollo lunar soils shortly after their return to Earth [1-8]. The analyses revealed the presence of water evolving at temperatures above 200°C. Of particular interest are samples that were collected from permanently-shadowed locations (e.g., under a boulder) with a second sample collected in nearby sunlight, and pairs in which one was taken from the top of a trench, and the second was taken at the base of the trench, where the temperature would have been -10 to -20°C prior to the disturbance [9]. These samples include 63340/63500, 69941/69961, and 76240/76280.

At the time that this research was first reported, the idea of hydrated minerals on the lunar surface was somewhat novel. Nevertheless, goethite was observed in lunar breccias from Apollo 14 [10], and it was shown that goethite, hematite and magnetite could originate in an equilibrium assemblage of lunar rocks [11].

Current Effort: We have begun a re-analysis of the thermally-evolved-gas data which was preserved in paper format, converting the data into a spreadsheet in which the onset temperature of each peak is recorded. The lunar data are then compared to terrestrial samples that were measured in the same instrument and at the same pressure ($2x10^{-6}$ torr). Comparing the data with thermal gas release curves taken at ambient pressure would introduce an error, because the onset temperature decreases as pressure is lowered [12]. Gas released at temperatures below 150°C at $2x10^{-6}$ torr were shown by [3-5] to result from adsorbed terrestrial water, but volatiles above that temperature are likely to be an inherent component of the sample.

First Results: In the figure, we compare the water curve for permanently shadowed soil 63340 with that of a sample from a nearby sunlit area, 63500. The curves are overlaid to show the larger amount of water that was released from the sample that was in permanent shadow.

Conclusion: Evidence exists in the Apollo sample collection for the retention of water and other volatiles from permanently shadowed areas near the lunar equator, where temperatures are much higher (-20C) than in the permanently shadowed regions near the poles. Both cometary water and water from hydrated samples are seen, which supports the idea that these volatiles will be found in greater abundance at lower temperatures near the poles.

References:

[1] Moore, C.B., et al., (1970) *Science, 167*, 495. [2] Gibson, E.K. and Hubbard, N.J. (1972) *Proc. Third Lunar Sci. Conf.*, 2003-2014. [3] Gibson, E.K., Jr. and Moore, G.W. (1972) *The Apollo 15 Lunar Samples*. 307-310. [4] Gibson, E.K., Jr. and Moore, G.W. (1972) *Proc. Third Lunar Sci. Conf.*, 2029-2040. [5] Gibson, E.K. and Moore, G.W., (1973) *Science, 179*, 858-861. [6] Chang, S., et al. (1974) *Proc. 5th Lunar Sci. Conf.*, 1785-1800. [7] Gibson, E.K., Jr., (1975) *Moon, 13*, 321-326. [8] Gibson, E.K., Jr. and Andrawes, F.K. (1978) *Planetary Water and Polar Processes, Proc. 2nd Colloquium*. 2. [9] Keihm, S. and Langseth Jr, M. (1973) *Lunar & Planet. Sci. Conf. 4th*, 455-456. [10] Agrell, S., et al. (1972) *Lunar Sci. III*. 7. [11] Williams, R.J. and Gibson, E.K., (1972) *Earth and Planetary Science Letters, 17*, 84. [12] Kotra, R.K., et al., (1982) *Icarus, 51*, 593-605.