SOME SURFACE PROPERTIES OF APOLLO 17 SOILS.[1] H. F. Holmes, E. L. Fuller, Jr., and R. B. Gammage, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830.

The surface chemistry of Apollo 17 lunar fines samples 74220,35 (the orange soil) and 74241,42 (the gray control soil) has been studied by measuring the adsorption of nitrogen, argon, and oxygen (all at 77°K) and also of water vapor (at 20°C). There are general similarities and some marked contrasts between these fines and those from the Apollo 12, 14, and 16 missions.[2,3] Similarities include: 1. Initially (prior to water adsorption) these two samples had a low specific surface area (Table 1). 2. There was no evidence for a pore system of the type that affects gas adsorption isotherms (i.e., gives rise to capillary condensation hysteresis loops and are less than a few hundred angstroms in size) as the initial nitrogen isotherms were completely reversible over the entire pressure range (Figure 1). 3. Both samples were attacked by water vapor at high relative pressures. 4. The attack by water vapor increased the specific surface area and created a pore system which gives rise to a capillary condensation hysteresis loop in the isotherms (Figure 1).

Specific surface areas obtained from the nitrogen adsorption data (by the BET method[4]) are given in Table 1. The value for sample 74220 after outgassing at 300°C (pre-H_2O) is in good agreement with that reported by Cadenhead (0.46 m^2/g).[5]

In spite of the general similarity of all the results obtained to date there are significant specific differences, not only between 74220 and 74241, but also between these two and the previously studied fines.[2,3] Both of the Apollo 17 samples were hydrophobic in their initial interaction with water vapor (water surface areas were about half of the nitrogen value). This can be contrasted with the hydrophilicity of the previous samples.[2,3] However, both of the Apollo 17 samples were strongly hydrophilic after the attack by water vapor at high relative pressures. The alteration of sample 74220 was completed with one cycle in water vapor to high relative pressures. This is a sharp contrast to Apollo 12, 14, and 16 samples where the alteration process continued through several cycles.[2,3] This difference may be related to the very high glass content of sample 74220.[6] Another difference in sample characteristics may be seen in the blocking action of irreversibly adsorbed water. That the dependence of specific surface area and the size of the hysteresis loop on outgassing temperature is due to the presence of irreversibly adsorbed water is shown by the fact that one can reverse the effect of outgassing at an elevated temperature by the simple expedient of irreversibly adsorbing water on the sample. In the case of sample 74220 the effect of irreversibly adsorbed water on the specific surface area and hysteresis is much less than that observed with previously studied samples.[2,3] In this respect sample 74241 is intermediate between 74220 and the previous samples. In the case of sample 74241 (and the previous samples) there is an increase in both the specific surface area and the size of the hysteresis loop when the outgassing temperature is increased from 200 to 300°C. Obviously this is not the case with sample 74220.

The general nature of the attack of lunar fines by adsorbed water at high relative pressures can be explained on the basis of forming a system of pores having wide bodies and narrow openings, with the narrow openings as the site where irreversibly adsorbed water blocks access of nitrogen to the pore system. The mechanism for the formation of this pore system has not been firmly established.

Neither of the two Apollo 17 samples would chemisorb carbon dioxide, independent of the presence or absence of chemisorbed water. In the case of these two samples there is no danger of surface contamination due to chemisorption of carbon dioxide from terrestrial atmospheres.

[1] Research sponsored by NASA under Union Carbide contract with the U. S. Atomic Energy Commission.

[2] H. F. Holmes, E. L. Fuller, Jr., and R. B. Gammage, Earth Planet. Sci. Lett. **19**, 90 (1973).

[3] H. F. Holmes, E. L. Fuller, Jr., and R. B. Gammage, Proc. Fourth Lunar Sci. Conf., in press (1973).

[4] S. Brunauer, P. H. Emmett, and E. Teller, J. Amer. Chem. Soc. **60**, 309 (1938).

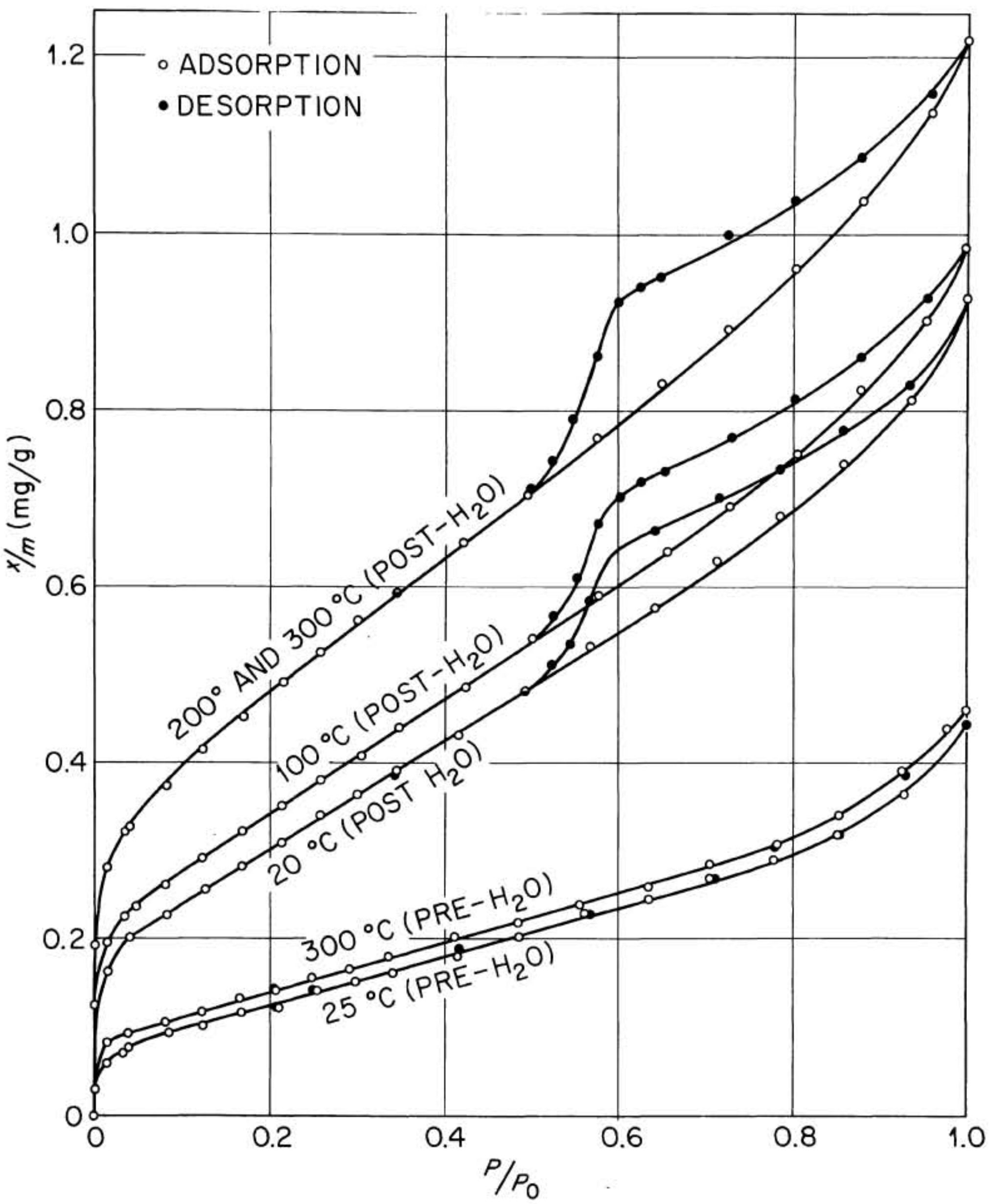
[5] D. A. Cadenhead, Trans. Amer. Geophys. Union **54**, 582 (1973).

[6] Apollo 17 Preliminary Examination Team, Science **182**, 659 (1973).

TABLE 1

Surface Area in m^2/g

Outgassing Temp. (°C)	Sample 74220,35	Sample 74241,42
25 (pre-H_2O)	0.35	0.36
300 "	0.42	0.37
25 (post-H_2O)	0.90	0.57
100 "	1.02	0.64
200 "	1.40	0.88
300 "	1.38	1.01



Adsorption of N_2 on 74220,35 at 77 °K
Sample Outgassed at Indicated Temperature.