Lunar atmosphere is supplied by degassing of the planet, meteoric vaporization, neutralization of solar wind ions and possibly from spallation products of cosmic ray bombardment. The dominant loss process is apparently photoionization and subsequent acceleration of the resulting ions from the moon by the fields of the solar wind (1). A lack of evidence of chemical reaction of atmospheric gases with surface materials suggests that the bulk of the gases are essentially inert, or that the reaction products are volatile.

Those gases with continual, widespread supply which are not adsorbed on the cold nighttime part of the lunar surface behave as if in a classical exosphere. The concentration tends to vary as an inverse power of surface temperature (2), resulting in a concentration maximum on the night side and a substantial daytime depletion. Hydrogen, He, Ne, and perhaps oxygen, nitrogen, and carbon monoxide should be expected to behave in this manner. In the available data from the first lunation of the Apollo 17 lunar surface mass spectrometer, only the mass 4 atom measurement of He can be identified as a native, noncondensible constituent. Its diurnal behavior closely follows the diurnal variation predicted by classical exospheric lateral flow theory. With continuing outgassing of the instrument and the site, it is likely that the separation of native and artifact contributions to other noncondensible species should be possible eventually. There is some evidence to suggest that neon may be partially adsorbed by the nighttime surface, but this should be questioned in view of the contaminant levels and the difficulties encountered in cryogenic pumping of neon in laboratory apparatus.

Another gas that was previously thought to be noncondensible is argon. However the abundance of $^{40}$Ar in the lunar atmosphere appears to increase with the approach of sunrise, beginning when the terminator is about 50 km to the east of the Apollo 17 ALSEP. This indicates a release of adsorbed argon from the lunar surface shortly after sunrise. These atoms may travel roughly 2 scale heights horizontally. Those which happen to travel westward across the sunrise terminator are responsible for the presunrise increase and a pocket of gas near the terminator (2). While it is likely that other gases exhibit this effect, the contaminant levels present in the first lunation of data preclude their identification.

Identification of native helium and $^{40}$Ar are important confirmations of two sources of lunar atmosphere: helium must come mainly from the solar wind, while $^{40}$Ar results from decay of $^{40}$K within the moon. Data from the Apollo 16 lunar orbital mass spectrometer (3) and from the ALSEP suprathermal ion detectors (4) indicate the presence of neon, which must also be derived from the solar wind.

Evidence for volcanism is slight at this point. There seems to be a significant amount of uncondensed carbon monoxide or nitrogen (28 amu) on the nighttime side, which may be artifact. However there is one transient
event in the Apollo 15 lunar orbital mass spectrometer data which indicates present volcanic activity. It occurred to the northeast of Mare Oriental, at about $3^\circ$S, $107^\circ$W. The major gas was essentially $N_2$, although there was at least one other gas which contributed to mass 32 amu. This may have been $O_2$, or sulfur fragmented from a molecular gas. Owing to the rapid motion of the spacecraft through the disturbance, the resolution of other gases was not made. While this event could have been artifact, a careful examination of sources of gas on the spacecraft has not revealed a mechanism capable of producing the observed mass spectrum. The amount of lunar gas needed to produce the disturbance can be estimated to have been as little as a few kg (5). However the likelihood of a spacecraft flying through such an event is so small as to cause the nature of the event to be questioned.

REFERENCES