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Title: LUNAR SURFACE OUTGASSING AND ALPHA PARTICLE MEASUREMENTS

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LUNAR SURFACE OUTGASSING AND ALPHA PARTICLE MEASUREMENTS. S. L. Lawson[1], W. C. Feldman[1], D. J. Lawrence[1], K. R. Moore[1], R. C. Elphic[1], S. Maurice[2], R. D. Belian[1], and A. B. Binder[3]. [1]Los Alamos National Laboratory, Los Alamos, NM; [2]Observatoire Midi-Pyrénées, Toulouse, France; [3]Lunar Research Institute, Tucson, AZ. (stefs@lanl.gov)

Introduction: The Lunar Prospector Alpha Particle Spectrometer (LP APS) searched for lunar surface gas release events and mapped their distribution by detecting alpha particles produced by the decay of gaseous radon-222 (5.5 MeV, 3.8 day half-life), solid polonium-218 (6.0 MeV, 3 minute half-life), and solid polonium-210 (5.3 MeV, 138 day half-life, but held up in production by the 21 year half-life of lead-210). These three nuclides are radioactive daughters from the decay of uranium-238. Radon reaches the lunar surface either at areas of high soil porosity or where fissures release the trapped gases in which radon is entrained. Once released, the radon spreads out by "bouncing" across the surface on ballistic trajectories in a random-walk process. The half-life of radon-222 allows the gas to spread out by several 100 km before it decays (depositing approximately half of the polonium-218 recoil nuclides on the lunar surface) and allows the APS to detect gas release events up to several days after they occur. The long residence time of the lead-210 precursor to polonium-210 allows the mapping of gas vents which have been active over the last approximately 60 years. Because radon and polonium are daughter products of the decay of uranium, the background level of alpha particle activity is a function of the lunar crustal uranium distribution.

Using radioactive radon and polonium as tracers, the Apollo 15 and 16 Command Module orbital alpha particle experiments obtained evidence for the release of gases at several sites beneath the orbit tracks, especially over the Aristarchus Plateau and Mare Fecunditatis [1]. Aristarchus crater had previously been identified by ground-based observers as the site of transient optical events [2]. The Apollo 17 surface mass spectrometer showed that argon-40 is released from the lunar interior every few months, apparently in concert with some of the shallow moonquakes that are believed to be of tectonic origin [3]. The latter tectonic events could be associated with very young scarps identified in the lunar highlands [4] and are believed to indicate continued global contraction. Such quakes could open fissures leading to the release of gases that are trapped below the surface. A primary goal of the APS was to map gas-release events, thus allowing both an appraisal of the current level of tectonic activity on the Moon and providing a probe of subsurface uranium concentrations.

Analysis: The APS consisted of five pairs of silicon ion-implanted detectors which were collimated to a 45° half-angle aperture. The detectors were positioned on the five outward-pointing faces of a cube which was mounted at the tip of one of the spacecraft booms. The five analog signals sent to the electronics box were digitized using a common 8 bit ADC, spanning the nominal energy range between 4.5 MeV and 6.6 MeV (corresponding to 0.02 MeV per channel). The detector resolution was approximately 0.1 MeV. During data acquisition, LP spun at 12 RPM with its spin axis approximately perpendicular to the ecliptic. Thus, three of the APS faces swept through nadir when the spacecraft was near the equator, while the other two faces were either nadir- or zenith-pointing when the spacecraft was near the poles.

The primary lunar alpha-particle signal is from reflected interplanetary alpha particles. Therefore, we have examined only APS data acquired during periods of low interplanetary alpha particle flux. To minimize statistical uncertainties, spectra were summed over all LP mapping cycles when the instrument was turned on (approximately 229 days over 16 months).

Conclusions: The LP APS data were studied to map sites of radon release on the lunar surface. We found only a faint indication of alpha particles resulting from the decay of polonium-218. However, our radon-222 alpha particle map indicates that radon gas is presently emanating from the vicinity of craters Aristarchus and Kepler. The LP gamma-ray spectrometer, which effectively has significantly higher spatial resolution than the APS, identified thorium enrichments at these two craters [5]. Thorium and uranium are both incompatible elements whose lunar surface abundances are highly correlated; thus, it is likely that the radon-222 alpha particles measured using the LP APS originate from Kepler and Aristarchus. Our detection of radon over Aristarchus is consistent with one of the results of the Apollo 15 APS. The polonium-210 distribution mapped by the APS indicates a variability in time and space of lunar gas release events.

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