PRELIMINARY RESULTS FROM THE LUNAR PROSPECTOR ALPHA PARTICLE SPECTROMETER.

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Introduction: The Lunar Prospector Alpha Particle Spectrometer (LP APS) builds on Apollo heritage and maps the distribution of outgassing sites on the Moon. The APS searches for lunar surface gas release events and maps their distribution by detecting alpha particles produced by the decay of gaseous radon-222 (5.5 MeV, 3.8 day half-life) and solid polonium-210 (5.3 MeV, 138 day half-life, but remains on the surface with a 21 year half-life as lead-210), which are radioactive daughters from the decay of uranium-238. Radon is in such small quantities that it is not released directly from the lunar interior, rather it is entrained in a stream of gases and serves as a tracer for such gases. Once released, the radon spreads out by “bouncing” across the surface on ballistic trajectories in a random-walk process. The 3.8 day half-life of radon-222 allows the gas to spread out by several 100 km before it decays and allows the APS to detect gas release events up to a few days after they occur. The long residence time (10s of years) of the lead-210 precursor to the polonium-210 allows the mapping of gas vents which have been active over the last approximately 50 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. The detection of radon-222 outgassing events at the margins of Fecunditatis basin was surprising because the observed surface distribution of uranium and thorium do not extend sufficiently eastward to cover Fecunditatis. If the Apollo detections prove sound, then those alpha particle emissions indicate substantial subsurface concentrations of uranium-238 within Fecunditatis. 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.

The LP APS: The APS consisted of five sets of two silicon ion-implanted detectors, each collimated to a 45° half-angle aperture, and mounted with aperture axes perpendicular to each of the five outward-pointing faces of a rectangular parallelopiped chassis mounted at the tip of one of the spacecraft booms. Each of the five analog signals sent to the electronics box were digitized using a common 8bit ADC, spanning the nominal energy range between approximately 4.5 MeV and 6.6 MeV (corresponding to 20 keV per channel).

Analysis: Because of the complex LP spacecraft geometry, we have initially examined only APS lunar equatorial data. When the spacecraft is at the lunar equator, three of the APS faces have surface normals that sweep through nadir as the spacecraft spins. Thus, in our preliminary study, we used data from only those three faces and only included data when an APS face normal was within 30° of nadir. There was a light leak in the APS which caused us to eliminate certain spectra, as well as eliminate spectra which were clearly saturated due to periods of high interplanetary alpha particle fluxes. Here we present APS data summed over all of the LP high-altitude mapping cycles.

Figure 1a shows summed spectra for the lunar nearside with latitudes ranging from –15° to 15° and longitudes ranging from –95° to 95°. Figure 1b shows summed spectra for the lunar farside with latitudes ranging from –15° to 15° and longitudes ranging from 100° to –100°. Figure 1c is the difference between these two spectra. Figure 1d shows the difference in counts per second between the nearside and the farside in only the 5.2–5.4 MeV energy range (polonium-210). Here, the nearside data have been separated into 10° longitude bins.

Conclusions: Data measured using the LP APS were surveyed to search for surface deposits of polonium-210 and energy spectra of alpha particles from the Moon that range between 4.5 and 6.5 MeV were constructed. Interplanetary conditions were very quiet during much of the prime mission of LP, thereby providing a low-background environment in which to search for the expected low signal intensities of the

5.3 MeV alpha line from polonium-210. Preliminary results show that a marginal, yet statistically-significant signal was indeed detected on the front side of the Moon as shown in Figure 1c. It was observed to cover much of the lunar near side between ±15° latitude and between –40° and 80° longitude, as shown in Figure 1d. If true, these observations indicate that deposits of uranium cover most of the nearside of the Moon, extending eastward of the observed boundary of the surface deposits of thorium as detected using gamma-ray spectroscopy [5]. The eastern boundary of these uranium deposits therefore must underly much of the near-equatorial eastern mare.

References: [1] Gorenstein P. (1993) in *Remote Geochemical Analysis*, C.M. Pieters and P.A.J. Englert, eds., 235. [2] Middlehurst B. (1967) *Rev. Geophys.*, **5**, 173. [3] Hodges R. and J. Hofman (1975) *Proc. Lunar Sci. Conf. 6th*, 3039. [4] Schultz P. (1976) *Moon Morphology*, Univ. of Texas, Austin. [5] Lawrence D.J. *et al*. (2000) *JGR*, **105**, 20307.

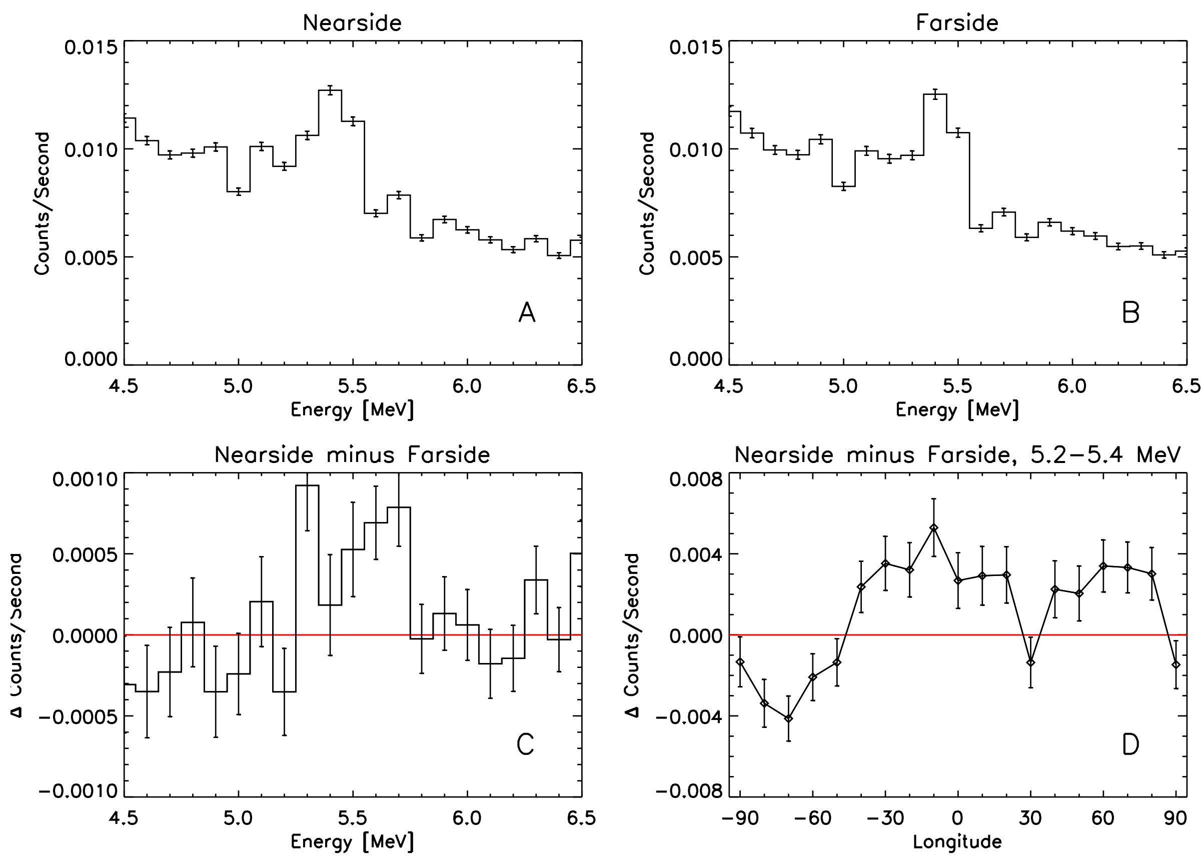

Figure 1. LP APS spectra for the equatorial (a) nearside and (b) farside of the lunar surface. (c) Nearside spectrum minus farside spectrum. (d) Binned nearside minus farside in only the 5.2–5.4 MeV energy range (polonium-210).