Exotic Particle Tracks and Lunar History

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ABSTRACT

With high voltage electron microscopy and optical microscopy of etched samples, we study the moon's history of irradiation by the solar wind, by heavy nuclei emitted during solar flares, and by heavy galactic cosmic rays. Within a well-preserved rock the track density, which decreases at first rapidly from $\sim 10^{11}$ to $\sim 10^7$/cm in the top mm and then more slowly to $\sim 10^6/cm^2$ at the bottom of the rock, gives us the energy spectrum of solar flare particles and cosmic rays over $\sim 10^7$ years and tells us that surface erosion is $< 10^{-8}$ cm/year except at impact pits. In both the 12 cm Apollo 11 core and the 40 cm Apollo 12 core, track densities exceed $10^{11}/cm^2$ in several percent of the micron-size silicate grains <u>independent of</u> depth. (Only in grains $\gtrsim$ 50 microns in diameter is a slight decrease with depth noticeable.) The observations support Gold's dust model of the lunar surface by providing strong evidence that many of the grains acquired their high track densities by being irradiated in space as extra-lunar dust. X-ray and microprobe analyses of the micron-size grains are in progress. Large pigeonite crystals (1 mm x 2 mm x 1 cm) in rock 12021 contain tracks of exotic particles, some of which come to rest in the crystal. The particles ionize at an approximately constant rate over distances up to 1 mm and therefore have the signature of magnetic rather than electric particles. Implications for the existence of magnetic monopoles and super-heavy elements will be discussed.