50 Years and counting: Major science from Apollo 17 mission to Taurus-Littrow on the Moon

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The Apollo 17 exploration of the valley of Taurus-Littrow on the Moon, December 11-14, 1972, and subsequent analytical and synthesis of sample analyses, geophysical data, and photographic documentation, provides insights into the development of the lunar regolith, the origin of life and the history of the sun relative to the evolution of that life on Earth, and the nature of the lunar interior among many other details about the history of the Moon. ORIGIN OF LIFE: The finely commutated lunar regolith provides insights into the Earth's surface environment in which replicating life first appeared. In the water-rich regolith existing on Earth soon after crust formation, glass and minerals would rapidly alter to complex phylosilicates (smectitic clay) whose sheet-like crystal structures can evolve inorganically to survive in changing environments but also can provide physical and geochemical templates for the organization of complex organic molecules and simple cellular components. HISTORY OF THE SUN: Data on isotopic ratios of nitrogen 15 to nitrogen 14 in regolith zones in the deep drill core strata indicate that $\delta 15\mathrm{N}‰$ increases linearly with zone maturity (Is/FeO) from as solar wind value of $\delta 15\mathrm{N}‰ = -113 \pm 9‰$. A factor of over 2 change in the slope of a plot of $\delta 15\mathrm{N}‰$ vs. Is/FeO at about 0.550 Ga indicates a significant increase in the average energy of the solar wind. This increase may be the proximate cause of the "Cambrian Explosion" in the quantity and diversity of life forms in the Earth's oceans. LUNAR INTERIOR: Lunar samples 72415 (dunite) and 76235 (troctolite) have symplectitic textures that indicate a geologically rapid decrease of pressure. This suggests that the extremely large, $\sim$3200 km diameter, Procellarum basin-forming impact caused an overturn in the warm upper mantle beneath it. This overturn caused dense, late, and ilmenite-rich cumulates from the crystallization of the Moon's magma ocean to move downward and old, relatively less dense, olivine and plagioclase-rich cumulates to move upward from about 500-400 km depth. The latter then were distributed across the lunar surface by later basin-forming impacts such as Imbrium. The partial melting of the mantle caused by the release of pressure from the basin's excavation also generated the Mg-suite magmas that crystallized in the lower lunar crust at $\sim$4.35 Ga. In addition, the volatiles associated with and included in the Apollo 17 pyroclastic ash deposit (74220 and core 74001-2) include both water and elements with primordial isotopic and elemental ratios. These data indicate that the lower lunar mantle retains primordial geochemical characteristics and did not form by fractional crystallization as part of the accretionary magma ocean, and argue against a giant impact origin. GLOBAL MAGNETIC FIELD: Remnant magnetism in basalt samples from the rim of Camelot Crater indicates the existence of a global, rotation axis oriented, dynamo-driven magnetic field early in lunar history.