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Lithological Variation with Depth and Decoupling of Maturity Parameters in Apollo 16 Regolith Core 68001/2

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Abstract - Using ferromagnetic resonance (FMR) and instrumental neutron activation analysis (INAA), we have determined the maturity (surface exposure) parameter I_s/FeO and concentrations of 25 chemical elements on samples taken every half centimeter down the 61-cm length of the 68001/2 regolith core (double drive tube) collected at station 8 on the Apollo 16 mission to the Moon. Contrary to premission expectations, no ejecta or other influence from South Ray crater is evident in the core, although a small inflection in the I_s/FeO profile at 3 cm depth may be related the South Ray crater impact. Regolith maturity generally decreases with depth, as in several previously studied cores. We recognize five compositionally distinct units in the core, which we designate A through E, although all are similar in composition to each other and to other soils from the Cayley plains at the Apollo 16 site. Unit A (0–33 cm) is mature to submature throughout (I_s/FeO : 89–34 units) and is indistinguishable in composition from surface soils collected at station 8. Unit B (33–37 cm) is enriched slightly in a component of anorthositic norite composition. Unit D (42–53 cm) is compositionally equivalent to 80 wt% Unit-A soil plus 20 wt% Apollo-16-type dimict breccia consisting of subequal parts anorthosite and impact-melt breccia. Compared to Unit A, Unit E (53–61 cm) contains a small proportion (up to 4%) of some component compositionally similar to Apollo 14 sample 14321. Unit C (37–42 cm) is unusual. For lithophile and siderophile elements, it is similar to Units A and D. However, I_s/FeO is low throughout the unit (<30 units) and in a bluish-gray zone at 41 cm depth I_s/FeO drops to 1.6 units, the lowest value that we have observed in several hundred Apollo 16 soil samples. Samples from the bluish-gray zone also have low Zn concentrations, <10 $\mu\text{g/g}$, compared to 20–30 $\mu\text{g/g}$ for the rest of the core. Although both values are consistent with fragmented rock material that has received virtually no surface exposure, the abundance of agglutinates in the bluish-gray soil of Unit C is moderately high, typical of a submature soil that would ordinarily have $I_s/FeO \approx 30$. We believe that the anomalously low values of I_s/FeO and Zn concentration result because the soil was heated to ~800–1000 °C, probably during an impact. This temperature range is sufficient to volatilize the surface-correlated Zn and agglomerate the nanophase metal giving rise to the FMR signal, but is not great enough to sinter the soil. Alternatively, the unusual soil interval may represent a disaggregated or incipient regolith breccia, although there is no significant difference in the texture or clast-matrix relationships between Unit C and adjacent units.