DEVELOPMENT OF REGOLITHS IN MARS-LIKE ENVIRONMENTS

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The regolith development and weathering processes in the Earth's coldest and driest desert have been investigated. Probably the best terrestrial analogs of the martian surface are found within the Dry Valleys of Antarctica (1,2,3). Surface processes operating in the Dry Valleys are similar to martian surface processes in the following respects: low temperatures (mean temperature of $-17^{o}C$ in Wright Valley), low absolute humidities, diurnal freeze-thaw cycles, low annual precipitation, desiccating winds, low magnetic fields, salt-rich regolith, and oxidizing environment. In the Dry Valleys, physical or mechanical weathering predominates over chemical weathering processes (4). Even though chemical alteration is a secondary weathering process in the Dry Valleys, it is still present and plays an important role in regolith development.

A suite of samples from the valley floors and brine ponds in Wright and Taylor Dry Valleys during the 1979-1980 austral summer was collected. Samples were stored below $-10^{o}C$ since collection. The sample suite includes core samples from (1) permanent brine ponds (Don Juan Pond area) which represented mature sites, (2) brine ponds which were not as advanced in their development (Don Quixote), (3) seasonal evaporite ponds which contain standing water for only one or two months each year during the summer melting period, and (4) soils from a one-meter deep pit on Prospect Mesa Formation which represents some of the oldest soils on the Antarctic continent (5). The soil pit contained samples from above and below the permanently frozen zone.

The results of a study focused on evaporite and salt forming processes. The regolith at the Viking landing sites shows evidence of evaporite-like materials. Samples were studied for their water soluble cations and anions which represented ionic transport above the permanently frozen layer. This process produces the salt enrichments found near the surface. Secondary minerals previously identified in the Dry Valley soils include halite, mirabilite, bloedite, gypsum, calcite, aragonite, monohydrocalcite, soda niter, thenardite, antarcticite, bishovite, sylvite, trona, and limonite (6,7). Comparisons of the total sulfur and chlorine contents of the Dry Valley soils along with their major element compositions with those at the Viking 1 and 2 sites on Mars (3,8,9) indicate the weathering processes operating in the Dry Valleys produce enrichments in S and Cl like those found on Mars (Figure 1).

Comparisons of the differences in Cl contents with evaporite pond maturity is shown in Figure 2. Samples from the center of Don Juan Pond (DJ 2074) contain Cl abundances approximately twice those found at the edge of the pond (DJ 33). The tope of core DJ 33 shows depletion of Cl content (upper 2-3 cm) reflecting the dilution of the salt abundances with wind blown material from the valley floor and valley walls. Samples from the Don Quixote Pond (DQ 35) also show the surface enrichment as compared to the seasonal evaporite pond (WV 52).

From the investigations of the soils and cores from the Dry Valleys, an idealized soil profile for the regolith (8) has been developed which is very applicable to the martian regolith. The soil profile is composed of five basic zones. They are, from top to bottom: an aeolian zone, a salt formation zone, an active zone, a seasonally frozen zone, and a permanently frozen zone. The four zones above the permanently frozen zone are the regions where the majority of the chemical and physical weathering occur. The observed condensates in the Solis Lacus and Noachis-Hellespontus regions (9) could easily be accounted for by this model. The movement of moisture through the regolith with subsequent loss to the atmosphere would leave behind those anions and cations which favor salt formation. The seasonal cycling of moisture from the regolith would result in salt-rich deposits near the surface similar to those observed at the Viking sites.

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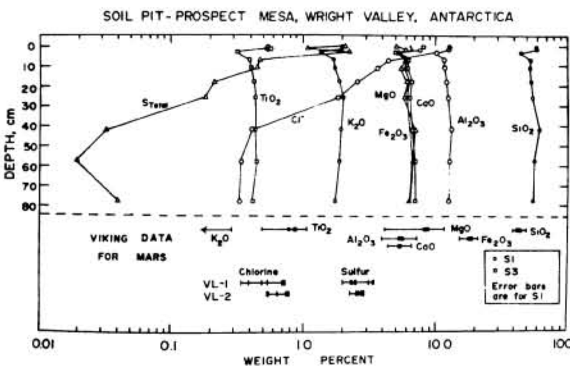

Figure 1. Comparison of the compositional data from Dry Valley soil pit with the Viking 1 site on Mars. Viking data is from Clark (1981, personal communication).

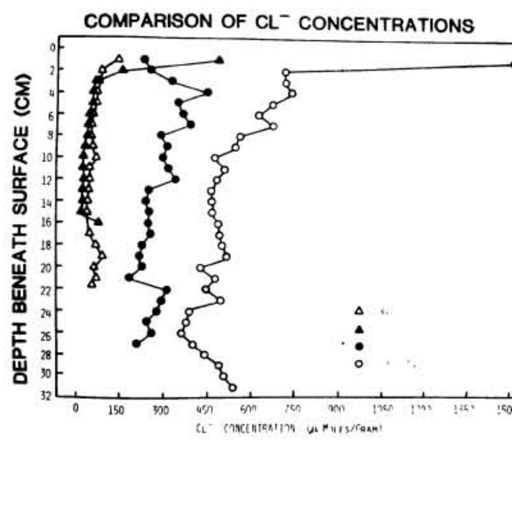

Figure 2. Chlorine concentrations at four sites with different maturity scale: DJ 2074 (open circles), DJ 33 (closed circles), DQ 35 (closed triangles), and WV 52 (open triangles).