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SOIL DEVELOPMENT AND SAMPLING STRATEGIES FOR THE RETURNED MARTIAN SURFACE SAMPLES. Everett K. Gibson, SN4, Expt. Planetology, NASA Johnson Space Center, Houston, TX.

Sampling of the Martian surface materials should be based upon the experience which has been gained from the study of soils and rocks collected in cold, dry environments-i.e. Dry Valleys of Antarctica. Previous studies (1) have suggested that some of our best terrestrial analogs of the Martian soils are represented by those found in the polar deserts of Antarctica. Special sampling considerations must be taken into account when obtaining these samples because they represent at least five distinct types of materials.

Weathering of planetary regolith materials occurs from both chemical and physical interactions of the planet's surface materials with the atmosphere and, if present, the hydrosphere and biosphere along with extraplanetary objects which may produce cratering. The net result of weathering processes is to modify the original surface materials and produce secondary materials that are products of equilibrium between the atmosphere and interacting particles with the solid body. In order to adequately study weathering processes and regolith development occurring on Martian-like surfaces, simulation studies must be carried out in the laboratory under controlled conditions or study analog materials in the field. Our studies have concentrated on studying soils from the Dry Valleys of Antarctica which are from the Earth's coldest and driest desert. 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, oxidizing environment and the near absence of biological activity. In the Dry Valleys, physical or mechanical weathering predominates over chemical weathering processes (2). 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.

From the studies of the soils and cores collected from the Dry Valleys, an idealized soil profile has been developed for a cold, arid planetary surface similar to what is expected to be present on Mars (excluding the polar regions). The soil profile is composed of five basic zones: 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 physical and chemical weathering occur. The aeolian zone (upper most region of the soil profile-typically less than 2 cm thick) represents the region where activity is occurring daily. Effects of the surface winds, temperature fluctuations, moisture deposition, and radiation evnironment are recorded within this regolith zone. The salt formation zone represents the area where salts are forming and deposited. Salts are associated with the duricrust and their presence has recently been reviewed (3). The salt zone will typically be located within 5 cm of the surface. The active zone represents the region of transition between the salt zone and the frozen zones where the abundances of surface deposited salts decrease as a function of depth and daily temperature fluctuations and are damped as compared to the upper zones. The seasonally frozen zone represents the region of the regolith which undergoes melting-thawing and freezing, depending upon the season. The permanently frozen zone remains at a temperature below the frost point throughout the Martian year. In such a region ice is stable on a yearly basis. The observed condensates in the Solis Lacus and Noachis-Hellespontus region (4) 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. Such salt deposits have also been observed in the Dry Valleys of Antarcitca (1).

Sampling experiences obtained from the collection of bulk soils and subsurface cores in the Dry Valleys have shown that it is extremely difficult to obtain samples from the seasonally frozen and permanently frozen zones. Titanium strengthen core tubes which were identical to those used to collect the lunar cores were used to collect soils from the Dry Valleys. In every case where soils from permanently frozen zones were attempted to be collected, the core tubes were damaged during the attempt to collect samples. The cores were driven into the ground using a five pound hammer. The tool-steel strengthen bit and the bottom of the cores were severly damaged and the collection of samples failed to occur in a recoverable manner. If the samples are to be obtained from the Martian regolith in regions where permanently frozen soils might exist, extreme caution must be exercised to prohibit the loss of valuable collection equipment and not damage the vehicle transporting the collecting devices. As demonstrated by the Viking sampling arm, the upper tens of centimeters of the regolith should provide materials from the aeolian, salt, and active regions of the soil profile. However, collection of material from the seasonally frozen and permanently frozen must be undertaken using the utmost caution.

References:

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