

**REGOLITH MIXING RELATIONSHIPS ON THE SURFACE OF MARS:
INFLUENCE ON MINERALOGY AND GEOCHEMISTRY**

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Due to the cessation of active plate tectonics several billions years ago, the Martian sedimentary record represents a long term archive of the exogenic cycle. Meteoritic and aeolian gardening is an important physical process acting on this record. The fingerprint of chemical fractionations and mineralogical transformations may provide insight into the processes involved in primary material degradation and sediment formation and they may allow to reconstruct the environmental conditions on the ancient Martian surface. In this context the main target is to identify chemical trends or mineral phases that are diagnostic for specific processes and environments. Weathering under warm and wet conditions would have produced typical secondary mineralogical remnants such as clay minerals [1]. Hydrothermal activity and acid fog weathering would produce sulphates and chlorides [2], and biological activity could be the source of carbonates and iron oxides such as magnetite [3]. In particular the variation of element concentrations with depth may allow to reconstruct past changes in the contributions from different source materials [4, 5] and in soil formation processes, which involve volcanic aerosols and hydrothermal activity [2, 6].

Given that the evolution of the rate of meteoritic infall is known a depth profile of the Ni concentration in the Martian regolith may give insight into the evolution of the rate of soil formation during the geologic past. Pristine, cosmic material, which is continuously delivered to the Martian surface through meteoritic infall, contains considerable quantities of organic matter – the prerequisites for the evolution of life. Organic material has, however, not yet been detected on the surface of the planet. The lack of organic material on the Martian surface despite of the continuous meteoritic delivery is ascribed to the reactivity of the Martian soil [7]. This is obviously a result of intense atmosphere-surface interaction under strong UV solar-radiation and has important influence on future human space-flight and Exobiology in general - and possibly involves adsorbed superoxide [8]. Such radicals not only drive the degradation of organic matter, they may also contribute to oxidative weathering of primary minerals [9]. It is known from earlier missions, that iron and sulphur occur in high oxidation states in the Martian regolith, and provided, that this is not the case in the magmatic and meteoritic precursor materials, the Martian surface may act as an oxygen sink and in this respect may have a considerable effect on the evolution of the Martian atmosphere [10].

We present a study of regolith mixing relationships, in particular stressing the meteoritic contribution in the Martian soil by means of least squares (LS) analysis of chemical data from APXS-*Mars-Pathfinder* (MPF) [11] and XRF-*Viking* [12] measurements. Despite of other possible soil formation processes, the soil composition may be represented as a mixture of primitive cosmic material (CI-chondrite), the MPF-soil free rock (SFR) and physical weathering products of MPF-andesites (PWP). In our LS analysis 13 major elements were taken into account. The SFR and CI-chondrite compositions were taken from [11] and [13], respectively. Prior to LS analysis a CIPW normative calculation was done on the SFR chemistry. In analogy to Antarctic weathering scenarios, minerals with high susceptibility to physical disintegration were assigned to a fraction of detritus PWP according to their normative ratios in parent andesites. To account for the uncertainties inherent in analytical data from Mars, the individual element concentrations were weighted accordingly. The convergence of linear regression lines to a single point indicate the existence and the composition of a Global Dust Unit (GDU). GDU material appears to be intimately admixed to MPF surface soils and also to *Viking* deep soil samples. Some GDU material also appears to adhere to MPF rock samples. According to the inferred meteoritic contribution, 1.4 wt.% C is missing in the Martian soil. Similarly, 0.4 wt.% Ni should be present in surface soils. This is more than APXS X-ray mode data would suggest. Secondary fluorescence of Fe_{K α} may have reduced the Ni_{K α} radiation in the presence of abundant iron. Alternative in-situ analytical techniques, such as Laser-induced Plasma Spectroscopy (LIPS), may help to resolve this problem. APXS spots were targets of vis/NIR reflectance analysis during the Pathfinder mission. Consequently, the oxidation states of these samples can be determined by means of terrestrial analogue calibration. Three dimensional regression analysis of oxidation states suggests that the meteoritic fraction is main source material for oxidation processes. Based on terrestrial analogue calibration the product phases may comprise nanophased ferric oxides, which are thought to be present on the Martian surface [14].

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