A REGOLITH SAMPLE RETURN MISSION TO MARS.

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Introduction: The major part of the martian surface is covered by a layer of regolith, which results from the interaction between the lithosphere, the atmosphere and the hydrosphere and is therefore ideal to understand the evolution of the surface conditions [1]. Moreover, the regolith is usually the most favorable environment for life, due to the abundance of nutrients, energy sources and the protection from UV radiations.

Although the regolith is a complex mixture of phases related to various periods and various processes, such complexity becomes an advantage when the number and mass of samples is very limited. Another significant advantage of the regolith is the facility of access and of sampling since it does not require complicated mechanical systems but sampling technologies that have already been used in previous missions like Viking or Phoenix.

This abstract summarizes some important mineralogical properties of the martian regolith, the possible processes at their origin and how these properties could be used by a sample return mission.

Weathering and hydrothermalism are the most important processes having affected the regolith either directly or indirectly by Aeolian remobilization of alteration phases [1]. Phyllosilicates and carbonates are typical phases resulting from aqueous alteration of the Noachian crust [2,3] and can therefore be used as proxies for the prevailing atmospheric conditions (oxydo-reduction, CO_2 / SO_2 partial pressures [4]). Although Ca-carbonates have been observed in the regolith [5], their origin could be related to ancient hydrothermalism, surface alteration in high p_{CO2} or in the present-day conditions [6].

The martian regolith usually contains high concentrations of highly soluble phases like ferric sulfate $Fe_2(SO_4)_3.nH_2O$ (up to 30% in Gusev Crater [7]) or magnesium perchlorate $Mg(ClO_4)_2.nH_2O$ (~1% in the polar soils [8]), which both have eutectic temperatures as low as 205 K [9,10]. Thus these salts may be able to melt through deliquescence processes, providing a source of liquid brines under present-day cold conditions [10]. Moreover, since their hydration varies according to the humidity [11], these salts can provide clues on the water vapor cycle in the recent ages of Mars.

Another important class of minerals are the iron (oxy)hydroxides, especially since the martian regolith contains up to ~20% Fe_2O_3 (Fig. 1). These phases, often characterized by their magnetic properties, can be secondary or inherited from the primary basaltic material (Fig. 1, [12]). They could also result from extremely slow surface oxidation over 2-3 billion years [13]. Therefore, these phases could help quantify the contributions of various processes to the regolith.

Finally, impact gardening is also a major process for two reasons: first it contributes to the homogenization of the regolith and it modifies its chemical and mineralogical properties of the phases [14]. Determining the presence of high P,T phases in the regolith, as well as chemical modification would provide information on the degree of transformation of the regolith by impact processes.

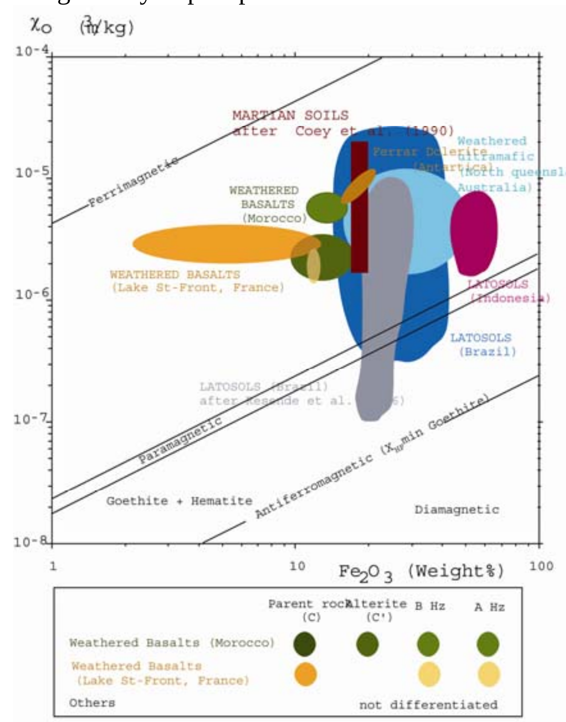

Figure 1. Magnetic susceptibility versus Fe_2O_3 content of the martian regolith compared to terrestrial soils [1]. The combination of paramagnetic and ferrimagnetic components suggest the presence of secondary and inherited phases.

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