

Search for organics and life on Mars

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Mars lies at the frontier of planetary science and the question of whether life arose on Mars has been widely debated. A combination of energetic ultraviolet radiation, the extreme dryness and the presumed oxidizing nature of the soil make Mars' present surface an inhospitable place for terrestrial organisms. However, conditions in the early history of Mars including a denser atmosphere and persistent liquid water at the surface may have been more favourable for life in the past. Also there is new evidence for a geological history in some areas of volcanic or periglacial activity as shown by Mars Express and Mars Reconnaissance Orbiter. We may expect to find remnants of extinct life or eventually extant life in subsurface environments. Even without an active ecosystem on Mars the surface should not be totally devoid of organic carbon. Meteoritic infall ought to result in measurable levels of carbon compounds in the surface regolith. Apart from organic molecules, minerals may preserve evidence of the former presence of life processes over long time-scales. In order to support future endeavours to search for life on Mars we have to understand the processes that may alter organic matter on the martian surface, how we can distinguish biologic from abiologic organic matter and how we can trace the influence of microbial catalysis. A strategic search for life on Mars needs a thorough interdisciplinary preparation phase that includes Mars laboratory simulations, computational studies, extensive terrestrial field tests at Mars analog sites such as the Atacama desert and Mars Desert Research Stations. We discuss *in situ* instrument development focussed on the future identification of organics and biosignatures on Mars. We shall review the perspectives for life detection and characterisation of organics on Mars, using advanced instrumentation for ExoMars and future Mars missions.

Behaviour of As in sequential sediment extractions observed by μ Sy-XRF analysis

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Naturally As contaminated groundwaters frequently occur around the world and pose a serious threat on human health. The concentration of dissolved As in aquifers, however, is not necessarily determined by the levels of As in the ambient sediment but rather by the type of fixation. Knowledge of the preferential associations and the fixation of As is often gained by means of sequential extractions. These methods are easy to use but they do not provide information where and how exactly As is bound within a mineral grain. Furthermore, little is known about possible geochemical changes that actually occur within a grain during sequential extraction. Therefore, μ Sy-XRF was applied to study the micro-scale distribution of As and other elements in sediments from an As-burdened aquifer of the Red River Delta, Vietnam. The sediments were sequentially extracted following the scheme of Keon *et al.* [1].

In the untreated samples, elevated As concentrations were detected in Fe bearing phyllosilicates (<60 ppm), sulphides (<140 ppm) and Fe oxy-hydroxide coatings (<140 ppm). In the coatings, As is positively correlated with Fe and other heavy metals like Zn, Cu, Mn or Ni. The distribution of As within distinct mineral phases often showed very heterogeneous patterns. Samples which released high fractions of As during phosphate leaching still showed distinct Fe coatings on the sediment particles. The release of As in this leaching step was also evident from the disappearance of correlation between As and Fe as well as from a higher Fe/As ratio compared to untreated samples. The Fe oxy-hydroxide coatings were dissolved to a large extent during subsequent extraction steps. Preferential release of Fe compared to As during this Fe leaching steps was indicated by lower Fe/As ratios compared to the untreated samples. The correlation between As and Fe was preserved only in association with K, indicating the presence of both elements in silicate structures. It can be concluded that μ Sy-XRF analysis is suitable to better understand the effect of sequential extractions on sediments.

[1] Keon *et al.* (2001) *Environ. Sci. Technol.* **35**, 2778-2784.