Evidence of ancient water on Mars by the APXS onboard the Mars Exploration Rover Opportunity

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In January of 2004, one of the two Mars Exploration Rovers (MER) landed in Meridiani Planum [mission details in Squyres *et al*., 2006], a site primarily selected for its hematite signature as observed from orbit by TES [Christensen *et al*., 2000]. As in most terrestrial cases, hematite is formed by aqueous activities and under oxidizing conditions, which makes hematite a tracer for (ancient) water episodes. Lag deposits of iron- and hematite-rich spherules were observed along the rover's traverse by the Alpha Particle X-ray Spectrometer (APXS) [Brückner *et al*., 2006] and the Mössbauer Spectrometer (MB) [Morris *et al*., 2006].

The APXS data are used to determine the chemical composition of soil and rock samples; water (hydrogen) cannot be detected due to the applied method but indirect evidences can be derived. Almost all rocks encountered at Meridiani are sulfur-rich sediments [Rieder *et al*., 2004] making S with up to 12 wt. % a major element. The formation of these sediments are explained by a two-component mixing model of siliciclastic and sulfur-rich end members. Careful inspection of all data obtained during the last three years of APXS operation revealed unique relationships of major and minor element concentrations with S contents. For Si and Al concentrations, a dilution with increasing S contents is observed indicating that these two elements occurr only in the siliciclastic end member. Calcium and Fe show no dilution effects with increasing S; constant concentrations are pointing to an occurance as sulfates and as rock-forming silicates. Besides other phases, ferric sulfates could be detected by the MB [Morris *et al*., 2006]. Similar concentration relationships were also found for minor elements, such as Na, P, and K. Magnesium shows two different effects: a positive correlation with S for samples from the first 220 sols, pointing directly to Mg sulfates, and a rather constant concentration afterwards (no dilution by S). Since all the data are observed over a 10-km distance, the sediments formed in an environment that assisted in mixing and distributing the different compounds on large scales. Liquid water was the most probable carrier of such processes, at least for short episodes.

References

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Miocene incorporation of peridotites into the lower crust during opening of the Algerian basin: Insight from U-Pb LA-ICP-MS analyses

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Sizeable pieces of deep mantle material croup-out worldwide within orogenic belts involving major continental collisions or within regions with rift-thinned continental margins. From their original mantle position these peridotites have been transferred into the crust by tectonic processes involving subduction, collision or extension and, although minor components of most metamorphic belts, the understanding of how and when they were emplaced within the continental crust and their subsequent exhumation is paramount. A U-Pb age of 17.84±0.12 Ma (2σ) was obtained from monazites separated from a diatexite migmatite collected in close proximity to a small peridotite massif incorporated into the lower crustal sequence of the Edough massif (eastern Algeria), a southern segment of the peri-Mediterranean Alpine Belt. Monazites, extracted from a neighbouring deformed leucogranite, yield a similar age of 17.4±1.3 Ma (2σ) whereas coexisting zircon with magmatic characteristics yield an age of 308±7 Ma (2σ) interpreted as dating the magmatic crystallisation of the leucogranite during the hercynian orogeny. These results emphasize the polycyclic evolution of basement rocks preserved in the crystalline units of the western Mediterranean and indicate that part of their metamorphic features was inherited from older events. Taken together with published Ar-Ar datings, the late Burdigalian age of monazites, indicates a fast cooling rate of *c.* 300°C/Ma and is regarded as closely approximating the emplacement of the peridotites into the hercynian basement. This age is significantly younger than those recorded for orogenic peridotites from the Betic-Rif orocline and for lithospheric extension forming the Alboran sea. It is also younger than rifting and back-arc extension opening the Liguro-Provençal basin. The late Burdigalian age is interpreted as dating the incipient rifting event that opened the Algerian basin. At the scale of the western Mediterranean, opening of the Algerian basin provides a link between the late Oligocene-early Miocene extension in the western part (Alboran basin, Valencia trough and Liguro-Provençal basin) and the upper Miocene extension in the eastern part (Thyrrenian basin) of the western Mediterranean.