Experimental constraints on anoxic water-rock interaction: Implications for the early Martian surface

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Interactions between anoxic water and rock-forming minerals played a fundamental role in cycling electrons between the early Martian crust and atmosphere. A recent experimental and modelling study [1] demonstrated that interactions between anoxic surface waters and alkaline subsurface waters triggered a series of reactions that generated magnetite and H_2 at Gale Crater and other sites of ancient Martian crust. However, lingering uncertainties in reaction rates and mechanisms leave open a number of questions. For example, what is the full range of aqueous environments that produce H_2 through Fe-mediated chemistry? How can the global climatic impact of these reactions be more quantitatively assessed? In addition, considering the role of CO_2 in modifying these reactions has important implications for understanding carbonate mineral formation, and their associated kinetic barriers, on the planet's early surface.

To investigate the processes involved during the interaction between anoxic fluids and Fe-rich minerals, we synthesised pure fayalite and reacted this with anoxic waters under varying water-rock ratios, pH, and dissolved CO_2 content. Solution chemical analyses and a variety of material characterisation techniques reveal the competing kinetic processes controlling the formation of Fe-(II)-(III)-oxides, Fe-carbonates, and/or Fe-silicates.

As well as an insight into a fundamental but little-studied process, these experiments have practical application in understanding the potential climatic significance of low temperature reactions that may lead to H_2 generation. They also assist in reconciling the unresolved issue of a CO_2-dominated atmosphere with the general paucity of carbonate minerals preserved at the Martian surface; a key question as NASA's *Mars 2020* mission draws closer.

[1] Tosca, N. J. *et al*. (in press), *Nature Geoscience*.