Mechanisms of copper immobilization by bacteria during precipitation of iron oxides

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This project focuses on interactions between bacteria and iron oxides, and the effects of such interactions on the behaviour of dissolved copper ions. Laboratory experiments were performed to track the fate of dissolved copper and iron during the gradual, incremental oxidation of dissolved Fe(II) and precipitation of iron oxide in the presence of *Anoxybacillus flavithermus* cells. The experimental data reveal significant and complex controls on copper immobilization, related to progressive changes in 1) ratio of copper to dissolved Fe(II) concentration, inferred to result from competition for bacterial sorption sites; 2) ratio of precipitated iron oxide to bacteria, inferred to result from desorption of Fe(II) initally associated with the bacterial surface; and 3) reaction time, inferred to result from increasing quantities of biogenic dissolved organic matter. Surface complexation models are developed to describe the experimental data. This study demonstrates that the immobilization of metal cations in bacteria-bearing settings should not be examined independently of progressive oxidation, hydrolysis and precipitation of iron.

Mars as a planetary oligarch

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There is considerable uncertainty as to how and when Mars formed [1,2]. In particular, its small mass compared to Earth and Venus is difficult to explain and some have suggested that Mars could be a stranded planetary embryo (also called an oligarch) that escaped collision and merging with other embryos [3]. A diagnostic parameter to assess this idea is its accretion time, which can be calculated using ^{182}Hf-^{182}W systematics of martian meteorites [2,4]. Unfortunately, the Hf/W ratio of the martian mantle is very uncertain, resulting in model age estimates that range between 0 to 15 My after solar system birth. To better constrain the Hf/W ratio of the martian mantle, we have measured the concentrations of Lu, Hf, U, Th by isotope dilution, as well as ^{176}Hf/^{177}Hf isotopic ratios of 43 chondrites from all major groups of chondrites [the methodology is described in ref. 5].

We estimate the Hf/W atomic ratio of the martian mantle to be 3.51±0.45 . Using this Hf/W ratio, the measured value of $\varepsilon^{182}W_{Mars\ mantle}$=+2.6 [2,4] can only be reproduced with an accretion timescale of ~2 Myr [6]. This is consistent with a stranded planetary embryo origin for Mars. Objects formed in the first few million years of the formation of the solar system would have incorporated enough ^{26}Al to melt. We thus demonstrate that a magma ocean powered by ^{26}Al-decay must have been present on early Mars. This changes our perspective on the formation of our planet as we have now identified a sample of the embryonic material that the Earth was made of. For example, Earth may have inherited its missing Xe problem [7] from a Mars-like precursor.

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