How the oxidation of Fe(II) affects the immobilization of inorganic contaminants (Cd, As) by *Anoxybacillus flavithermus* bacterial surfaces

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Bacterial surfaces and iron-oxide particles can immobilize a range of inorganic contaminants, such as Cd^{2+} cations or AsO_4^{3-} anions. Their sorption properties have usually been examined separately. However, bacterial surfaces can also get involved in precipitation processes, and in particular in those of iron-oxide nanoparticles. How the sorption and the oxidation of Fe(II) on the bacterial surfaces affects the immobilization of inorganic contaminants by the composite Fe/bacteria systems has received little if any attention. We present here a laboratory study performed with *Anoxybacillus flavithermus*, a thermophilic Gram-positive bacterium. We measured Cd and As(V) immobilization by bacterial suspensions previously exposed to increasing quantities of Fe(II) cations in oxic conditions. Various degrees of oxidation of the Fe were also tested. At neutral and acidic pH, the Cd^{2+} cations tend to adsorb predominantly onto the bacterial surfaces but the AsO_4^{3-} anions adsorb mainly onto the iron-oxide surfaces. Consistently, we observed that Cd^{2+} sorption was increasing and that AsO_4^{3-} sorption was decreasing with increasing pH. Our work also demonstrated that Fe^{2+} cations could effectively prevent the Cd^{2+} cations from forming complexes on the bacterial surfaces. For As, we observed that the gradual release of the adsorbed Fe^{2+} cations, which were then being oxidized in the presence of the AsO_4^{3-} anions, resulted in co-precipitation processes, where the As was being removed by the newly formed particles.

Nd-Hf in upper continental crust: A loess perspective

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Establishing the average chemical and isotopic composition of the upper continental crust is difficult due to the diversity in compositions and ages of this major Earth reservoir. At present estimates exist for major and trace elements as well as for some isotopic systems, but not for the Nd-Hf isotopic couple. The only work addressing this question was published in 1999 by Vervoort *et al.* [1] who defined the “crustal array” for Nd and Hf isotopic compositions. They showed that Nd and Hf are correlated in crustal rocks of various ages and origins, but they could not define an average value.

Here we use an approach similar to that adopted by several previous workers for other geochemical parameters [2, 3, 4]: we use loess because it represents well-mixed material from large areas of upper continental crust. We determined the Hf and Nd isotopic compositions on samples from various locations in the Western Europe loess province and in the Chinese loess province.

The Chinese loess display remarkably uniform ε_{Nd} and ε_{Hf} values at -10 and -11.5, respectively. The Western Europe loess have almost identical ε_{Nd} at -11 but significantly more negative ε_{Hf} at -19.5. This suggests that larger source heterogeneities are registered by the Hf isotopic system than by the Nd isotopic compositions, suggesting that zircon is the main Hf carrier.

Nevertheless, the total isotopic variation defined by all loess remains small compared to the large scatter of the “crustal array” or the huge range of Nd-Hf isotopic compositions reported for oceanic sediments [5]. The average Western European and Chinese values fall in the lowest part of the sand field shown in [5], consistent with the hypothesis that zircon is the Hf carrier. An average value calculated using the European and the Chinese loess provides the following upper crust estimate: $\varepsilon_{Nd} \approx -10.5$ and $\varepsilon_{Hf} \approx -15.5$, a value located in the low part of the “crustal array”.

[1] Vervoort *et al.* (1999) *EPSL* **168**, 79-99. [2] Taylor *et al.* (1983) *GCA* **47**, 1897-1905. [3] Gallet *et al.* (1998) *EPSL* **156**, 157-172. [4] Barth *et al.* (2000) *Chem Geol* **165**, 197-213. [5] Chauvel *et al.* (2008) *Nature Geoscience* **1**, 64-67.