

Role of Al - Fe (hydr)oxides on mobility and bioavailability of contaminants. Part 2: Arsenic, Uranium and some REE.

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The low mobility and bioaccessibility of arsenic associated with Fe (hydr)oxides in geogenic materials from natural (soils, sediments and fallout dust) and from anthropogenic origin has been demonstrated by different investigations.

The high affinity between Fe and As is well known and has a key role in controlling arsenic mobility in the environment and in treatment of contaminated water. What is not fully established is the role of Al in arsenic fixation by Fe (hydr)oxides. Indirect benefits have been observed in previous investigations. The presence of aluminum was shown to increase the specific surface area and the stability of the iron phases, and to favor arsenic adsorption and fixation (Silva et al., 2010; Ladeira and Ciminelli, 2004). Goethites with structural Al were shown to combine high adsorption capacity and stability under a wide range of environmental conditions, including reducing conditions (dissimilatory reductive dissolution by *Shewanella putrefascians*), relative to other Fe (hydr)oxides (Silva et al., 2010).

The role of Fe (hydr)oxides, mainly the poorly crystalline ones, in the mobility of As was also

confirmed in creeks close to gold mining areas in Minas Gerais State. Such (hydr)oxides associated to gelflocs containing microorganisms, algae, and clay minerals (Figure 1) have proved very efficient to retain As in the area under mining influence (Veloso et al., submitted). Pictures of these gelflocs in water streams (Figure 1a) as well as microscopic features and their chemical composition (Figure 1b) are shown.

Not only the mobility, but also the toxicity of As is attenuated by association with Fe (hydr)oxides. This has been suggested by experiments for assessment of As ecotoxicity with plants (Figure 2) and worms in soils. The higher the maximum adsorption capacity (MAC) of the soil sample, the greater is the As lethal doses (LD₅₀). It is worth of note that the As MAC is directly related to the contents of Al and Fe (hydr)oxides in soils. Such experiments also show that the As ecotoxicity is attenuated by ageing (Figure 2), probably because the association of As with Fe (hydr)oxides becomes more stable over time. (Moraes et al., submitted))

Arsenic association with Al-Fe (hydr)oxides has also a determinant role on As bioavailability, which is the amount of contaminant or nutrient absorbed by the body after ingestion, inhalation or dermal contact. Arsenic in soil, dust and mineral forms is a lot less than 100% bioavailable. Arsenic bioaccessibility (the fraction that is soluble in the gastrointestinal tract and hence may be bioavailable for uptake) in soil and dust from a gold mining area (Paracatu) is typically less than 10% and more likely to be only a few percent in the samples we collected and tested. The low bioavailability of arsenic in the soil and dust in Paracatu has been confirmed by others (Ono et al., 2012).

Preliminary results suggest that Al and Fe (hydr)oxides precipitation is also efficient to treat water contaminated with Uranium and REE (La and Ce). But co-precipitation of U with Al-Fe (hydr)oxides seems to be limited to low amounts of the actinide. Investigations of As precipitation in the presence of Fe and Al indicated that the presence of Al can delay the arsenic removal process at high pH, as well as decrease the stability of the slimes (Mello et al., submitted)

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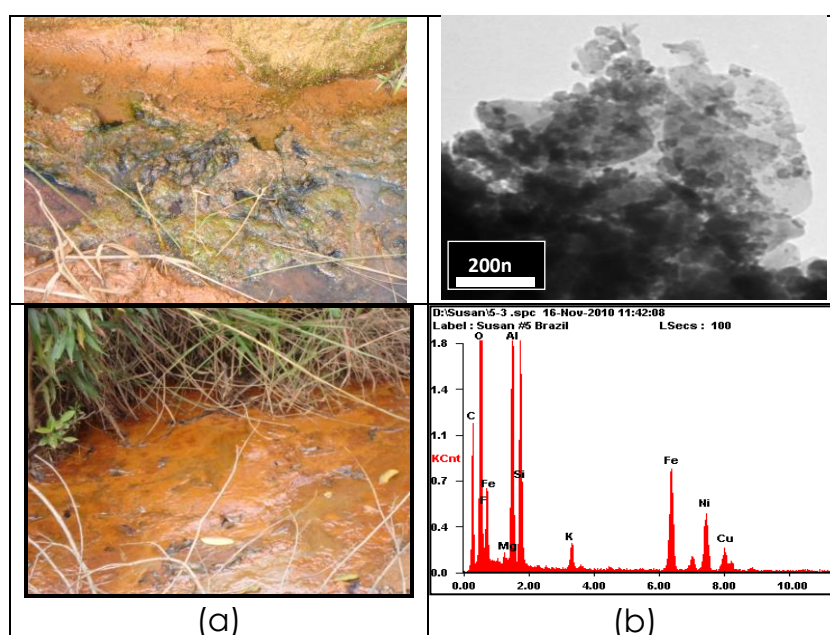


Figure 1. (a) Iron (hydr)oxides gel flocs in water streams close to gold mining area; (b) TEM micrograph and chemical composition of gel flocs.

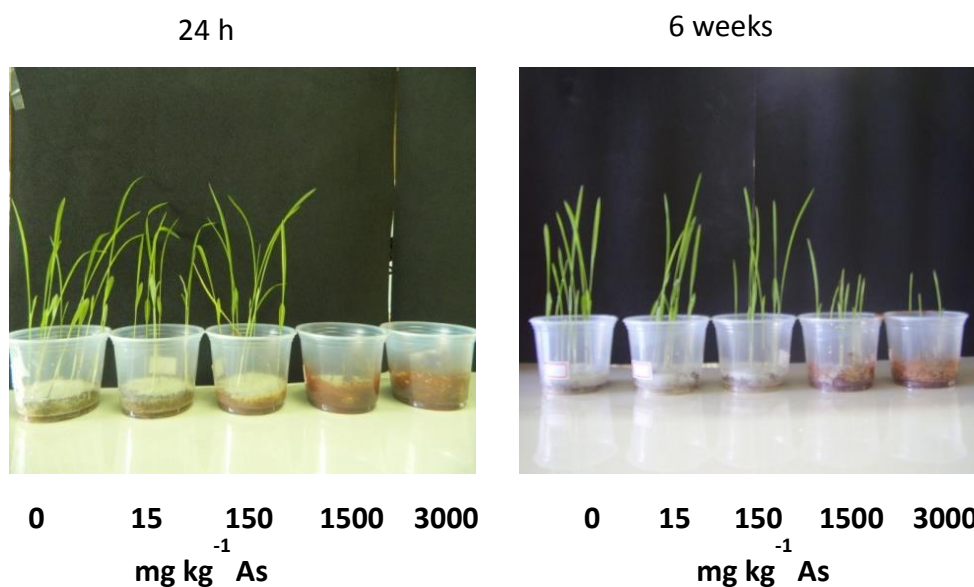


Figure 2. Sorghum plants growth in the presence of increasing doses of arsenic, one day and six weeks after soil contamination.