

Probing iron oxide interactions with organic matter by X-ray spectroscopy.

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Abstract

Iron oxides have been shown to promote the preservation of 1/5th of the total organic carbon pool in marine sediments (1). These iron-organic matter phases are formed within the oxic layer of marine sediments through oxidation of dissolved iron(II) produced during weathering and diagenetic recycling (2). However, it remains unclear what type of interaction (adsorption of organic matter onto the surface of oxides or co-precipitation to form iron-organic complexes) is formed between iron and organic matter in these systems. In this work, iron oxides were synthesized by oxidizing a solution of Fe(II) in seawater at constant, near circumneutral pH to closely mimic natural environmental conditions. Synchrotron X-ray absorption techniques (XANES and EXAFS) were used to probe the local environment of iron using beamline X26A at the Brookhaven National Laboratory. We determined that iron oxides precipitated in the presence of organic matter have a shifted iron K α edge with respect to organic free iron oxide minerals, demonstrating that iron-OM co-precipitates are likely a prevalent form of iron in sedimentary environments. Using this shift in K α edge the approximate contribution from organic free iron oxides and organic rich mononuclear iron compounds of our synthetic Fe(III)-OM precipitates were determined using linear combination fitting.

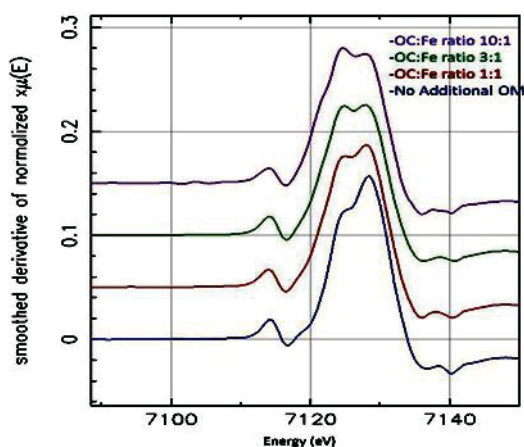


Figure 1: The first derivatives of stacked normalized iron K α edge XANES spectra with OC:Fe ratios varying from 10:1 to 1:1.

[1] Lalonde et al. (in press) *Nature*. [2] Canfield, D. E. The geochemistry of river particulates from the continental USA: Major elements. (1997) *Geochim. Cosmochim. Acta* **61**, 3349–3365

Synchrotron radiation characterization of ferruginous bodies from human lung tissue

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Introduction

Exposure to asbestos fibers is well known to be associated with respiratory diseases such, mesotheliomas and lung cancer. *FB* (**Figure 1**) are the result of a coating process, taking place in the host organism, of a variety of fibers such as asbestos (crocidolite, amosite, chrysotile) and phyllosilicate fibers (talc, mica, kaolinite), coal dust, oxalate, and fiberglass. This coating was generally accepted to be a protective mechanism produced by macrophages to segregate the cytotoxic fibers from the organic tissues [1]. However, more recently, other authors suggested that the coating material may enhance the cytotoxic properties of the asbestos fibers by increasing the production of free radicals [2,3,4,5,6]. In spite of the large attention devoted to this subject, the exact nature of the coating, along with the biological effect of *FB*, is still not clear. This is mainly due to the difficulty of sampling large enough amounts of *FB* using reliable isolation procedures, and to their microscopic dimensions (2-5 μ m diameter, 20-90 μ m length). The use of state of the art synchrotron radiation microprobe techniques gave the first direct characterization of single *FB*.

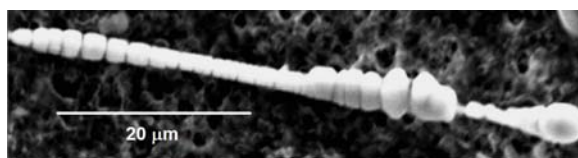


Figure 1: SEM image of a *FB* collected from human lung tissue.

Results and Conclusion

Human lung tissue rich in *FB*, owing to professional exposure, were collected from two subjects who were affected by lung cancer. μ XRF high resolution elemental maps of *FB* (2 μ m pixel size) were acquired on ID18F at ESRF, and μ XANES spectra were recorded at selected points at the Fe edge on ID21. μ XRF revealed that the external coating is mainly composed of Fe, Cu, Zn, and As (plus Ge and Ba in one subject) distributed in different areas of the *FB*, while μ XANES gave the first direct confirmation that iron is mainly present as ferritine.

[1] Mace et al. (1980) *Cancer. Lett.*, **9**, 95. [2] Ghio et al. (2004) *Toxicologic Pathology*, **32**, 643. [3] Hardy et al. (1995) *Aust. Chem. Rev.*, **90**, 97. [4] Lund et al. (1994) *Aust. Occup. Environ. Med.*, **51**, 200. [5] Pooley (1972) *Environ. Res.*, **5**, 363. [6] Pascolo et al. (2011) *Particle and Fibre Toxicology* **8**, 7.