

SPECTROSCOPIC IDENTIFICATION OF PYRITE TRACES IN PALEONTOLOGICAL DATA. L. Maldanis¹, D. Galante¹, J. Xavier-Neto², F. A. Lima¹, F. Rodrigues³ and C. A. Perez¹

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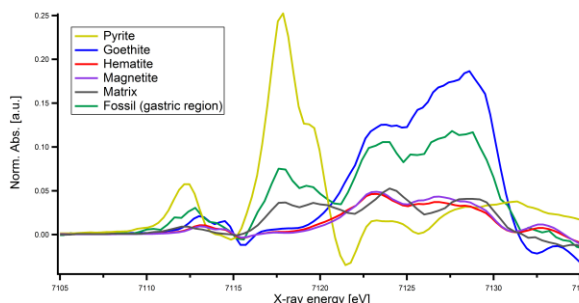
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Introduction: Early life on Earth is supposed to have sulphur-based metabolisms, which was indicated by pyrite mineral found in 3.5 billion years old microfossils [1]. Besides these biochemical inferences, the presence of this mineral is an important indicative of microbial activity. Pyrite is a sulphur-iron mineral, with formula FeS_2 , produced through reaction of detrital iron minerals with H_2S . This H_2S is, in turn, produced by the reduction dissolved sulfate by bacteria using sedimentary organic matter as a reducing agent in low oxygen conditions [2]. As pyrite is a ubiquitous early diagenetic mineral present in all kind of rocks, it has gained great focus in studies that aim microbial fossil finding, correlating the morphological structures found with chemical basis that corroborate life traces.

Methods and Results. To identify pyrite traces among the contributions of different minerals present in a fossil sample, we performed X-ray absorption spectroscopy, particularly X-ray absorption near edge structure (XANES), in which the absorption spectra of the atom of interest provides information about its oxidation state and neighbor atoms. We analyzed iron spectra of Cretaceous calcium carbonate matrix and some structures of a Brazilian Santana fossil fish and compared the results with different Fe^{2+} (pyrite, siderite) and Fe^{3+} minerals (magnetite, goethite and hematite). The spectra of Fe^{2+} and Fe^{3+} bearing minerals were very different, with Fe^{2+} ones displaying absorption edges shifted to lower energies than Fe^{3+} minerals. Pyrite showed a very particular spectrum, that allowed differentiating it from the other Fe^{2+} mineral, siderite. This spectrum had visible contribution in the fossil matrix and fossil structures spectra, identifiable for peaks in the same region of the pyrite edge on the derivative-spectra. Contributions of magnetite and hematite were also visible in the fossil spectra, through the edge and post-edge spectra structure.

Conclusions. Our results show that XANES spectroscopy is an efficient tool for the searching of pyrite traces in fossils and rocks, even in the presence of other minerals. The pyrite absorption spectrum has a structure that allows its easy recognition, making it feasible to apply this approach for finding pyrite traces in early life searching studies. The current advances on synchrotron instrumentation are producing X-ray microprobes that will soon be applicable even to sub-cellular scales, allowing the direct study of single microfossils.

Figures:



XANES derivative-spectra of iron minerals pyrite, goethite, hematite and magnetite, and of a fossil sample and its matrix. It is possible to see pyrite contribution in these spectra by the peak between 7115 and 7120 eV, characteristic of the pyrite spectrum.

References: Use the brief numbered style common in many abstracts, e.g., [1], [2], etc. References should then appear in numerical order in the reference list, and should use the following abbreviated style:

[1] Wacey, D., et al. (2011) *Nature Geoscience*. 4: 698-702.

[2] Berner, R. A. (1984) *Geochimica et Cosmochimica Acta*, 48, 605-615.