A confocal Raman proxy for affinities and fossilization mode of Silurian acritarchs

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The application of Raman spectroscopy to paleontology has opened a new era in microfossil analyses at the sub-micrometer scale. Confocal Raman spectroscopy permits investigation of fossil organic micro-objects in three dimensions without the need to extract the specimen from the surrounding rock matrix.

We applied Raman to study *in situ* Early Silurian organic-walled enigmatic microfossils, classified traditionally to an informal taxonomic group the Acritarcha. Based on the detection of internal spore-like bodies, acritarchs have been re-interpreted as vegetative cells of unicellular green algae (Chlorococcales) [1]. To verify the identity of the internal bodies as spores we used confocal Raman microscopy to examine their chemical and mineral content. Chemical maps of the spore-like bodies showed kerogen carbon mixed with ferrous-oxide (hematite) on the surfaces and quartz that fills the interiors. The presence of kerogen at the surface of the internal bodies underscores their biological origin, rather than as an artifact of the fossilization process.

The Raman spectroscopy results elucidate the complex fossilization history of the studied acritarchs. Early diagenetic mineral (ferrous-oxide and silica) precipitation played a key role in the preservation of their fragile spore-like reproductive structures.

[1] Kazmierczak & Kremer (2009) *Acta Palaeont. Polonica* **54**, 541–551.

Mineral surface processes: Key to understanding contaminant dynamics

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Chemical and biological processes at mineral surfaces control the behavior of inorganic and organic contaminants in soil and aquatic environments. Additionally, mineral surface processes play important roles in rock weathering, secondary mineral formation, biomineralization, corrosion, and many other fields of geochemistry. Therefore, mineral surface processes have been studied extensively during the past decades, and the use of advanced experimental, spectroscopic, microscopic, and computational techniques has led to major advances in our understanding of mineral surface processes at the macroscopic to molecular-scales. However, in order to apply this detailed knowledge to modeling contaminant dynamics, several major challenges still have to be overcome. Some important areas of current and future research include: (i) The surface and pore structure and biogeochemical reactivity of nano-crystalline, and nano-porous solids, (ii) the influence of organic surface coatings, biofilms, and adsorbed natural organic matter on mineral surface processes such as adsorption, dissolution, and crystal growth, (iii) redox reactions occuring at mineral surfaces, and their influence on mineral transformations, (iv) the relationships between physical, chemical, and biological heterogeneity in soils and sediments, and (v) the influence of all these factors on contaminant speciation and spatial distribution. These complex interactions must be understood quantitatively in order to improve biogeochemical models of contaminant dynamics.

This keynote presentation will provide an overview of the state of knowledge in some of these important research areas, and highlight recent research. The discussed examples will serve to illustrate that a molecular-scale understanding of mineral surface processes is a key to understanding contaminant dynamics, but that investigations of complex interactions between multiple sorbate species, sorbents, bacteria, and/or organic matter are equally essential.