Structural Variations in Biogenic and Synthetic Schwertmannite

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INTRODUCTION.

The mineral schwertmannite is an amorphous iron oxy-hydroxy-sulfate that occurs widely in contaminated environments mainly where the dissolution of pyrite provides the necessary ions for its formation. Bacterial oxidation of sulfate and iron leads then to the precipitation of schwertmannite. In nature the micro-morphology of schwertmannite is a globular aggregation of whiskers resulting in a structure that is commonly referred to as schwertmannite hedge-hogs (Fig. 1). Size, microstructure as well as building conditions indicate that these hedge-hogs are bacteria that were overgrown by schwertmannite whiskers (Ferris et al 2004). To check this hypothesis we conducted experiments on pure bacteria cultures that precipitate schwertmannite. From these cultures the organic and inorganic matter was fixed and further investigated by TEM and SEM.

BIOLOGIC INVESTIGATIONS.

Our results show that the investigated species, *Leptospirillum ferrooxidans,* is not overgrown by mineral and furthermore that schwertmannite hedge-hogs are massive mineral aggregations and do not show any signs of bacterial cells. In the investigated samples extracellular polymeric substances (EPS) where present and connected to bacteria cells as well as to schwertmannite needles. The excretion of EPS allows a control on the mineral precipitation outside the cell and can prevent a lethal encrustation of cells. Furthermore the cells can gain additional energy by liberated protons during precipitation of schwertmannite when it occurs spatially close.

CRYSTALLOGRAPHIC INVESTIGATIONS.

Studies dealing with schwertmannite use different pathways to synthesize schwertmannite. The quality of the product is usually checked by XRD. As schwertmannite is an amorphous phase the signal to noise ratio is usually bad and the presented data is very noisy. We used several of the existing recipes to compare the obtained products by means of SEM and a special XRD technique that allowed us to measure diffractograms with an excellent signal to noise ratio compared to what is found in literature.

This study showed that there are distinct morphologic differences resulting from very different pathways of synthesis, ranging from globular spheres over broccoli shaped particles to the well-known hedge-hogs. The fact that hedge hogs can not only be found by bacterial synthesis underlines the finding that schwertmannite hedge hogs do not form by an overgrowth of bacteria cells.

The comparison of the high quality diffractograms shows major differences in line width and in intensity of the different schwertmannites. This does not only indicate that the synthetized samples are not the same phase but also raises strong doubts on the topic if schwertmannite is a single phase or a mixture of several phases as it was proposed before.

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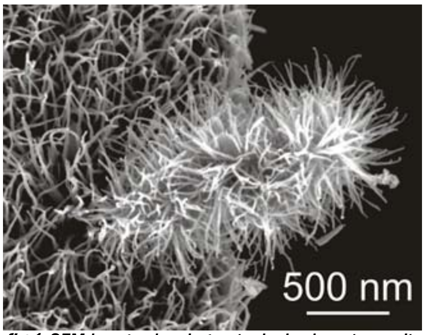

fig 1. *SEM image showing a typical schwertmannite hedge hog that can be easily misinterpreted as a bacteria cell that was overgrown by schwertmannite whiskers.*

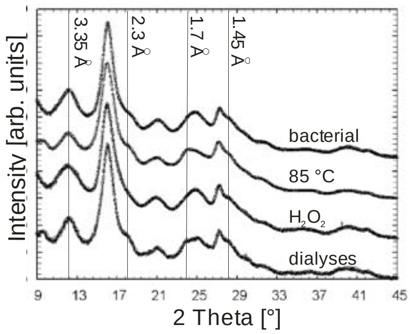

fig 2. *Diffractograms of schwertmannites that were synthesized in different conditions. The obtained diffractograms differ in intensity as well as peak broadening of several marked reflections. The used wavelength was 0.709 Å (Mo Kα).*

REFERENCES.

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palabras clave: Biomineralización, Schwertmannita, Óxidos de hierro, Medios contaminados, Microestructura, SEM, TEM, DRX.

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