ESRF	**Experiment title:** Iron sulfide biomineralization in magnetotactic bacteria	**Experiment number:** SC-3917
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Names and affiliations of applicants (* indicates experimentalists):

Jens Baumgartner* (1), Damien Faivre (1), Carmen Valverde Tercedor (1), Christopher Lefevre* (2), Guillaume Morin (3), Mihaly Posfai* (4), Teresa Perez Gonzalez*(1)

(1 Max Planck Institute of Colloids and Interfaces, Potsdam, Germany, 2 CEA Cadarache, France; 3 Université Paris Marie Curie, France; 4 University of Pannonia, Hungary)

Report:

Magnetotactic bacteria are aquatic organisms that intracellurly mineralize ferrimagnetic crystals as actuators that enable their navigation in response to the geomagnetic field. Most investigated bacteria form particles of magnetite, a mixed-valence iron oxide. Some strains have been observed to produce greigite, an isomorphous iron sulfide. Both in the magnetite and greigite producers, mineral precursors to the final biomineral phase have been observed and are suspected to play roles in the crystal growth and morphological selection. The only greigite producer that is obtainable in axenic culture and therefore can be investigated in depth is *Ca. Desulfamplus magnetomortis* BW-1. Here we report on our Fe K-edge X-ray absorption spectroscopic experiments at ID26 on iron sulfide biomineralization in the magnetotactic bacterial strain *Ca. Desulfamplus magneotmortis* BW-1 with the aim to identify potential precursor minerals to greigite in the bacterium. XANES and EXAFS were recorded in fluorescence mode on liquid He cryostat-cooled (~10 K) cell pellets of BW-1 at different stages during mineralization. Fig. 1 shows a selection of Fe K-edge XANES spectra of a mineralization time series of BW-1.

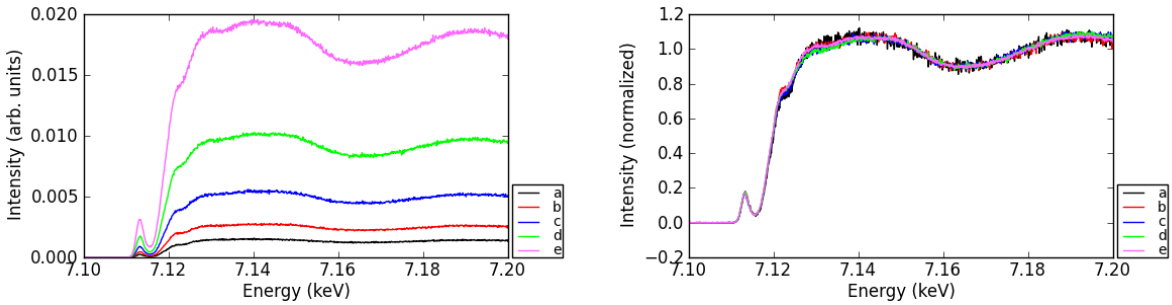

Fig. 1. Absolute and normalized Fe K-edge XANES of bacteria at (a-e) t=0, 24, 48, 72, 96 h after induction, respectively. Spectra are consistent with amorphous FeS.

We find that the obtained spectral intensity increases over time in agreement with the formation of material over time. However, unexpectedly the spectral line shape remains the same over time as can be seen from

normalized data indicating no phase evolution. To identify the formed compound phase, we synthesized several iron sulfide reference compounds and recorded their Fe K-edge XANES (Fig.2).

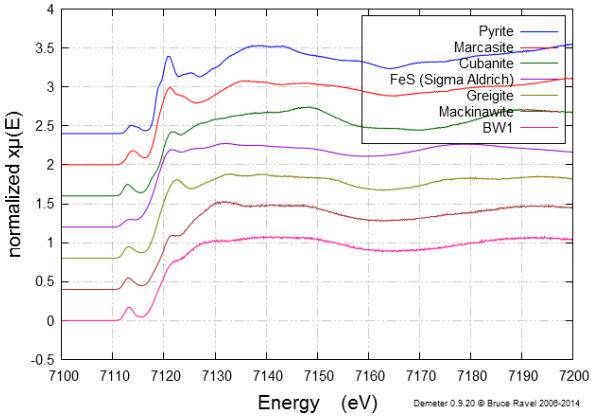

Fig.2. Fe K-edge XANES of BW-1 and reference Fe-S reference compounds.

We find that the observed phase is likely an amorphous FeS that is produced extracellularly due to the bacterium's metabolism. The amount of material formed exceeds the intracellurlarly mineralized material, masking spectral features of intracellular mineral precursors of interest. Therefore, to characterize the intracellular mineral precursor a sample preparation protocol is under development to obtain cells without the extracellular metabolic side products for future experiments.

We had also intended to study the bacteria by valence-to-core X-ray emission spectroscopy; however, due to the masking of the phases of interest and beam damage effects on the extracellular amorphous FeS, we successfully only obtained vtc-XES spectra for reference compounds (greigite, cubanite, troilite/pyrrothite, goethite, green rust II, hematite, mackinawite, marcasite and pyrite). To assess further possible analytic techniques for their potential to investigate the bacteria, we successfully recorded resonant inelastic X-ray scattering data of the bacteria and reference compounds (Fig.3).

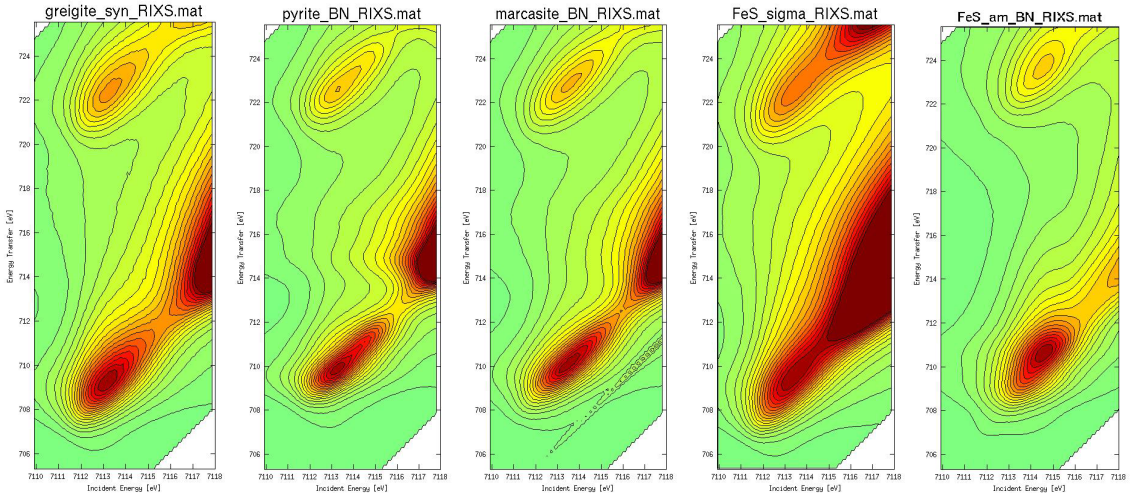

Fig.3 RIXS of greigite, pyrite, marcasite,troilite/pyrrothite, BW-1