Quantitative analysis of environmental biofilms with STXM

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Biofilms are a complex mixture of cells and extracellular polymeric substances (EPS). The EPS serve many functions, including: (i) sorption of organic (e.g., antimicrobial agents) and inorganic (e.g., metals) compounds; (ii) trapping of particulates such as organic debris, humic substances, clays and other minerals; (iii) compound transformations. X-ray absorption spectroscopy using synchrotron light sources can identify and quantify chemical species in wet, complex matrices at a spatial resolution of better than 50 nm. We present STXM images, spectra and derived quantitative chemical maps (Ca, K, Fe, Mn, Ni, protein, lipid, carbohydrate, nucleic acid, etc) of wet riverine biofilms [1,2]. The biofilms are grown in annular reactors using South Saskatchewan river water as the inoculant. The biofilms are examined after exposure to controlled amounts of trace metal ions (e.g. Ni^{2+} at 1-10 ppm) [2] or after growth in the presence of organic antimicrobial compounds (e.g. chlorhexidine, at 100 ppb). The methods to detect and quantify the trace amounts will be described. Typical results will be presented and compared to complementary studies of the same sample (in some cases the same regions) by confocal laser scanning microscopy and transmission electron microscopy. These studies are contributing to research projects on:

(1) applications of biofilms for trace metal remediation (see **Fig 1)**
(2) understanding antimicrobial resistance of biofilms
(3) Ca biomineralization (**Fig. 2**).

1) J. R. Lawrence et al., Appl. Environ. Microbiol. 69 (2003) 5543
2) J.J. Dynes et al, Environ. Sci. Tech. (2005) .
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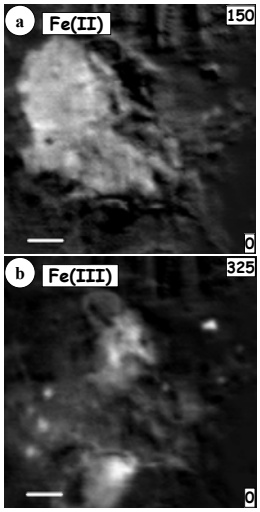

Fig 1 Distributions of (a) Fe^{2+} and (b) Fe^{3+} in a metal-rich, bio-mediated deposit in a riverine biofilm.Ni and Mn are also present in this region [2]. Scale bar is 1 micron (ALS STXM-11)

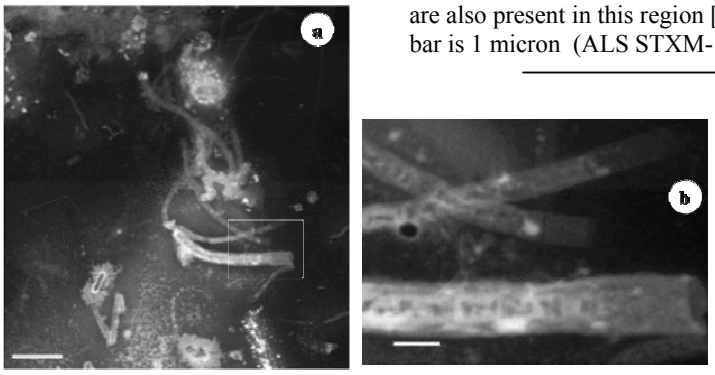

Fig. 2 STXM-derived map of Ca (on/off 2p resonance) in a riverine biofilm. (a) Scale bar is 5 micron. (b) Expansion of the box region. Scale bar is 1 micron. (ALS STXM5.3.2)