Biofilm structure and biochemistry with soft X-ray scanning transmission microscopy

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Biofilms are microbial communities consisting of single or multiple species (e.g., bacteria, algae, fungi) surrounded by an extracellular matrix, with complex architectures and biochemistry. The mapping of the distribution of macromolecules (e.g., protein, lipids, polysaccharides) and bioaccumulated antimicrobial agents in microbial biofilms is highly relevant to understanding biofilm formation, manipulation, and control. The analytical capability of soft X-ray scanning transmission X-ray microscopy (STXM) can be useful to probe how the nature, distribution, and role of macromolecules is affected by antimicrobials in antimicrobial-challenged biofilms.

Single species or mult-species natural biofilms were grown in flow-cells or rotating annular reactors, either in the presence or absence of antimicrobial agents. Quantitative component maps were derived for the macromolecules and of selected antimicrobials by spectral fitting of C 1s image sequences using linear regression procedures.

Discussion of Results

STXM provided evidence that the morphology of the cells, as well as the spatial distribution and relative amounts of the macromolecules in the biofilms and within the cells were different for each microbial species and antimicrobial. Cellular morphological and biochemical changes were indicative of adaptive responses and are specific to the antimicrobial agent applied and microbial species.

This presentation will show how STXM is improving our understanding of bacterial resistance mechanisms in antimicrobial-challenged biofilms.

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Origin of a carbonate-hosted gem corundum occurrence in southeastern British Columbia

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Despite much previous research, the origin of gem corundum (Al_2O_3) deposits remains unclear, and as a result only primitive exploration strategies exist for different deposit types. The newly discovered marble-hosted Goat sapphire and ruby occurrence in British Columbia was studied to: (1) characterize the mineralization; (2) develop a genetic model for mineralization at this occurrence; and (3) develop an exploration strategy for gem corundum in carbonate-hosted deposits.

The corundum-bearing marble is hosted within pelitic and calcareous schist within the Paleozoic Monashee cover sequence near the Frenchman Cap dome. There are three types of laminations within the marble: (1) diopside-bearing laminations; (2) apatite ± K-feldspar ± zoisite ± pyrite ± titanite-bearing cataclastites; and (3) Cr-muscovite and phlogopite schist laminations which can host gem corundum. Peak metamorphic assemblages within the micaceous laminations are corundum + calcite + muscovite + rutile + anorthite + K-feldspar ± diopside. Lenses enriched in muscovite within the laminations are rimmed by K-feldspar and anorthite. Corundum is formed at or near peak metamorphic conditions on the high temperature side of the equilibrium: muscovite corundum + K-feldspar + H_2O.

Oxygen stable isotope data of coexisting calcite ($\delta^{18}O$=15.0 to 15.1 ‰ ± 0.1) and corundum ($\delta^{18}O$=10.9 to 11.1 ‰ ± 0.1) give $\Delta^{18}O_{cal\text{-}cor}$ = 4.0 to 4.2 ‰. These data are consistent with equilibrium fractionation at peak metamorphic conditions with temperatures between 500-600 °C.