The influence of biofilms on fluid flow and contaminant transport in porous media

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Subsurface biofilm growth is a relatively novel and cost-effective method of bioremediation. Multiple injections of nutrients into the subsurface stimulate biofilm growth, forming a biobarrier. Biobarriers are known to reduce hydraulic conductivity, as well as immobilise metals in the matrix of the exopolymeric saccharides (EPS), produced by bacterial cells.

This research focuses on observing the influence of biofilm growth on transport in homogenous and heterogeneous column experiments under various nutrient conditions, as well as visualising and quantifying biomass of these biofilms *in situ* using x-ray micro computed tomography (μCT). This study will provide insight into materials and processes pertaining to groundwater vulnerability and assess the viability of biofilms to reduce the transport of aqueous metal contaminants. Biofilms were grown under continuous flow conditions in glass columns. A *Pseudomonas putida* culture was injected into the columns for biofilm growth. A decrease in hydraulic conductivity, column outflow and fluid velocity through the duration of the flow experiments was observed, which signifies bioclogging took place in the columns. Biomass distribution was examined using extraction methods and protein/ carbohydrate analysis. Additionally, syringe column experiments were carried out in order to observe and quantify microbially mediated mineral precipitation using μCT. In separate experiments *Sporosarcina pasteurii*, a ureolytic strain, was injected into the syringes to enable biofilm development and also $CaCO_3$ precipitation. The distribution of biomass, mineral precipitates and fluid flow paths in these experiments were visualised using x-ray μCT. Preliminary μCT imaging illustrates that for microbial processes in porous media, both biofilm growth and $CaCO_3$ precipitation as a result of ureolysis, can be visualised and quantified using CT techniques and software.

High-pressure single-crystal elasticity of $MgSiO_3$ and $(Mg,Fe)SiO_3$ perovskites at pressures of the Earth's lower mantle

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Sound wave velocities obtained in seismology are at the moment the only direct measure of the properties of the Earth's lower mantle. In order to use such measurements to constrain the chemical and thermal state of the Earth's interior, however, knowledge of the pressure dependence of acoustic wave velocities of model minerals are essential. $MgSiO_3$ perovskite-type structures, with the end-member composition or containing some amount of Fe or Al, have been the subject of several studies, since are likely the primary lower mantle constituent. Experiments, however, are limited either to room pressure conditions [1, 2] or to aggregate materials [3, 4] due to the challenge of synthesizing and recovering high-quality single-crystals of this high-pressure mineral. Therefore the best knowledge so of the full elastic constant tensor of orthorhombic (Mg, Fe)SiO_3 perovskites results from first principle calculations [5, 6].

We succeeded to synthesize and select good quality single crystals of MgSiO3 perovskite (Mg - end member) and (Mg, Fe)SiO3 perovskite containing up to 4% of Fe. The crystals are prepared for high-pressure brillouin measurements using FIB (focused ion beam) technology providing double side parallel cutting of the surfaces with required dimensions and quality.

We present the data of simultaneous measurements of sound velocities (by brillouin spectroscopy) and density (by single crystal x-ray diffraction) vs. pressure of the perovskite single crystals loaded in diamond anvil cell with He pressure medium. Behavior of elastic constants calculated from these data and effect of Fe will be discussed in the presentation.

[1] Sinogeikin *et al.* (2004) *Geophys Res Lett* **31**, L06620. [2] Jackson *et al.* (2004) *Geophys Res Lett* **31**, L10614. [3] Murakami *et al.* (2007) *Earth Planet Sci Letters* **256**, 47–54. [4] Jackson *et al.* (2005) *Geophys Res Lett* **32**, L21305. [5] Karki *et al.* (1997) *Am Mineral* **82**, 635–638. [6] Kiefer *et al.* (2002) *Geophys Res Lett* **29**, 1539.