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Clay settling in fresh and salt water: new dynamic X-ray micro-CT insights

Monday, 31 May 2021 10:40 (15 minutes)

Complex clay systems are present all over the word and play a major role in many applications. In sedimentation processes for example, it is known that the settlement of clay particles is slow when they are exposed to fresh water. However, when exposed to salt water, the dynamics of the particles drastically change. The clay particles flocculate and results in a separation of an almost pure water section on top and a water and clay suspension below. This flocculation process starts within minutes with a formation of a clear concentration front. Once the flocculation is finished, a dense mass of clay (chemical bounded with positively charged salt ions) remains. On the other hand, if this dense mass of clay (also referred as salt rich glaciomarine salts), is uplifted and no longer exposed to saltwater, rainwater can infiltrate and diffuse the salts out of the clay. In some occasions this may result in massive landslides as the freshwater destabilizes the clay aggregate structures.

As another example, clay minerals such as bentonite are also widely present in various ore bodies, mainly as gangue minerals. For mining industries, the processing of those ore bodies is very challenging as the presence of clay results in poor flotation performance. The coating of the clay on the valuable ore minerals reduces the recovery of those minerals. The presence and addition of salt ions in water may have a significant effect on the slime coatings (Chen and Peng, 2018) and pulp rheology (Huang et al., 2020) enhancing for example chalcopyrite recovery (Jeldres et al., 2019).

In order to better understand the above-described complex interactions of clay, salts and water, an in situ experiment was performed in a TESCAN CoreTOM, enabling 4D visualization and better understanding of the clay behaviour. By using high speed X-ray micro-CT (dynamic CT) we were able to visualize the flocculation pattern, in three dimensions as a function of time, of bentonite clay in fresh water, NaCl solution, and KCl solution. In this study, 8 g bentonite was mixed with 2 g chalcopyrite in 1) 50 mL DI water, 2) 50 ml DI water + 1mol/L NaCl and 3) 50 ml DI water + 1mol/L KCl. The suspension was stirred for 15 min before subsampling. Micro-ct was acquired using scans with a continuous speed of 5.8 sec/ rotation (0°-360°) and a voxel size of 15 µm. In total 100 uninterrupted rotations were acquired with 400 projections each. Both temporal and spatial resolution was sufficient to visualize and analyse the dynamics in three dimensions showing clear differences between the systems. Motions of particles where analysed using the Software GeoDict.

Along with playing a critical role in soil stability and mining applications, bentonite is a widely used clay in many industrial products such as paints, ceramics, drilling fluids, etc. Although commonly used, the bentonite-water systems are not yet fully understood. The authors hope that these initial experiments may open doors towards many other applications and a better understanding of these, and similar, dynamic interactions.

Time Block Preference

Time Block B (14:00-17:00 CET)

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