Formation of metal-bearing overgrowths on dolomite surfaces

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Dolomite, $CaMg(CO_3)_2$, is, after calcite, $CaCO_3$, the most abundant carbonate mineral on Earth. Both minerals play an important role in the functioning of global biogeochemical cycles and they can strongly interact with natural and polluted waters (e.g. waters containing heavy or radioactive metals). Despite this, studies on the reactivity of dolomite are still scarce compared with those on calcite. In particular, very little is known about the interaction between dolomite surfaces with metal-bearing aqueous solutions.

Here we present our recent atomic force microscopy (AFM) and scanning electron microscopy (SEM) observations of cadmium and cobalt carbonate overgrowths on dolomite (104) surfaces. The formation of overgrowths was promoted at room temperature by immersing freshly cleaved natural dolomite crystals into highly supersaturated aqueous solutions with respect to otavite ($CdCO_3$) and sphaerocobaltite ($CoCO_3$).While AFM allowed us to monitor the early stages of the growth process on dolomite (104) surfaces, SEM observations (complemented with energy dispersive X-ray analyses) provided information about the morphology and chemical composition of the overgrowths formed after reaction times longer than 24 hours. AFM and SEM images showed that the nucleation of overgrowths occurred preferentially on dolomite step edges, indicating relatively large substrate-overgrowth interfacial energies. However, in most of the conducted experiments, the spreading of initial two-dimensional islands on dolomite surfaces led to the formation of large areas coated by epitaxial overgrowths. Recorded high resolution AFM images allowed us to determine epitaxial relationships between the dolomite (104) surfaces and the overgrowths.

Our results demonstrate that cadmium and cobalt carbonates, and presumably a large number of other metal carbonates, can grow on dolomite (104) surfaces from aqueous solutions at room temperature. Future work will include the nanotribological characterization and nanomanipulation of the overgrowths using frictional force microscopy (FFM).