

Dynamic equilibrium during calcite-water interactions

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Direct *in situ* experiments using atomic force microscopy (AFM) show that when a calcite (01-14) cleavage surface is in contact with a CaCO₃ solution saturated with respect to calcite, the surface dissolves and grows simultaneously and continuously. Furthermore the growth occurs predominantly through the formation of nanoparticles, probably amorphous. Initial nanoparticles form immediately on contact with the saturated fluid, first seen in areas of increased dissolution, that is, around etch pit edges and large steps. The observations indicate that at potential equilibrium a calcite surface reacts dynamically. This is further evidence that a mineral surface is a complex landscape with varying reactivities dependent on potential reaction sites such as kinks and edges. When in contact with an aqueous fluid, a calcite surface can dissolve and reprecipitate as a result of surface reactivity and solution composition. These interface-coupled reactions are only possible as a result of the formation of a mineral-fluid boundary layer whose composition differs from the bulk fluid composition. This is a possible mechanism for the re-equilibration of trace elements and isotopes near equilibrium.