Molecular exchange rates at mineral-aqueous solution interfaces

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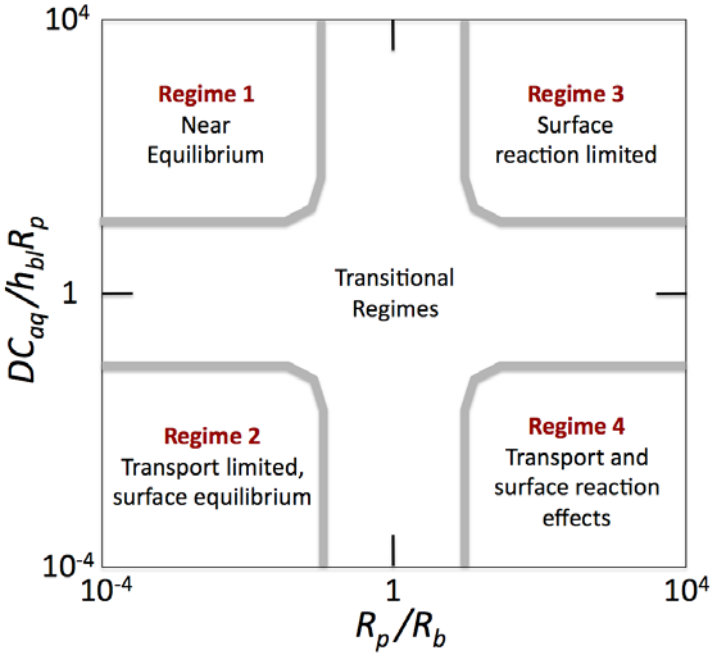
EFRC: Nano-scale Control of Geologic CO_2



Mineral precipitation domains as function of precipitation rate (R_p). Most precipitation from aqueous solution occurs far from equilibrium. The far-from equilibrium dissolution rate (R_b), defines the boundary between surface equilibrium and kinetic/transport control.

Geochimica et Cosmochimica Acta, v. 75 (2011) 1039–1056

- Predicting rates of dissolution and precipitation of minerals during carbon sequestration is critical to making long-term predictions of storage security
- Trace metal and isotopic contents of minerals are key indicators of rates and chemical conditions; but they are controlled by a largely unknown parameter - the rate of exchange at the mineral surface between attached molecules and those in solution
- This study shows that exchange rates for calcite can effectively be measured by monitoring subtle shifts in Ca isotopic ratios that occur during mineral precipitation
- A model based on this concept can account for most of the trace metal (eg. Sr, Mn) and isotopic data available for calcite precipitated from aqueous solutions. Applicability to other minerals and conditions is being tested.
- An important conclusions is that mineral *dissolution rates* provide a critical estimate of molecular exchange rates in mineral-aqueous solution systems, in a manner analogous to gas-liquid and gas-solid systems (Figure)
- Available data suggest that exchange rates decrease drastically as conditions approach equilibrium.