Fossil fuel CO_2 in geologic time

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I will present a series of model calculations to forecast the geologic timescale impact of fossil fuel CO_2 release to the atmosphere / ocean carbon pools. Fossil fuel CO_2 release perturbs atmospheric pCO_2 for hundreds of thousands of years, with roughly 10% of the CO_2 release remaining in the atmosphere until it is neutralized by the silicate weathering feedback. I'll show how fossil fuel CO_2 may trigger further release of carbon from the clathrate reservoir. A model of the methane clathrate reservoir in deep sea sediments gets the present-day methane inventory about right, and predicts a strong temperature dependence of the steady state inventory. Finally, I'll show an analysis of the onset of glaciation as a function of orbital forcing and atmospheric pCO_2, to demonstrate the capacity of anthropogenic CO_2 to prevent the onset of the next ice age for up to 500 kyr into the future.

Extrinisic versus intrinisic controls on rates of silicate weathering and CO_2 drawdown

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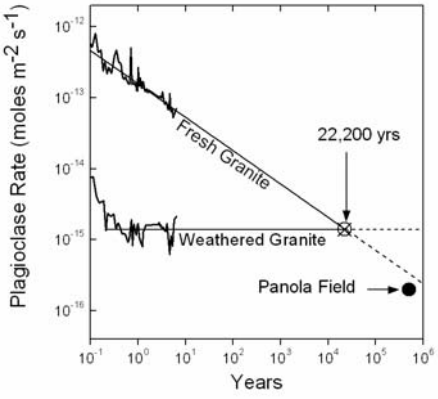
Estimating atmospheric CO_2 uptake over the earths' history by the surfical weathering of silicate rocks requires quantifying reaction rates over a range of chemical and physical conditions. These controls are summarized as intrinsic and extrinsic weathering properties (White and Brantley, 2003). Intrinsic properties are physical or chemical characteristics, such as mineral composition, surface area and defect densities. If intrinsic properties dominate weathering, such characteristics should be transferable between environments, e.g., laboratory and field rates of the same mineral should be comparable. Extrinsic features reflect conditions external to the silicate phase that impact chemical weathering such as solution composition, climate and biological activity. These processes are dependent on the external environmental conditions which are difficult to fully recreate under laboratory simulations. Intrinsic effects on rates are shown below by the difference in experimental dissolution of fresh and naturally weathering plagioclase in Panola Granite. The intrinsic effects are predicted to be neutralized after 22 kyrs. of experimental weathering. Extrinsic controls on natural weathering, which are dominantly saturation-controlled and transport-limited, is shown by the difference in the extrapolated experimental rate and the actual field rate.



Reference

White A. F. and Brantley S. L. (2003) The effect of time on the weathering of silicate minerals: Why do weathering rates differ in the laboratory and field? *Chemical Geology* **202**, 479-506.