Erosion rates of basaltic terrains and their role in the global carbon cycle

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Basalt covers most of the ocean floor and little more than 5% of the continents. Yet, basalt weathering contributes about 30% of the atmospheric drawdown of CO_2 via silicate weathering on the continents. Weathering of basalts along the oceanic ridges is probably an important negative feedback mechanism for regulating climate on Earth.

Huge amounts of magmatic CO_2 is sequestered via water-rock interactions within the oceanic ridge system, on- and off-shore. These reactions are fast at 20°-260°C, mineralization taking only years to months after CO_2 injections. Majority of the pervasive low temperature alteration of the basaltic crust, glassy and crystalline, is over in less than 3 My from its formation.

Glassy rocks dissolves more rapidly than crystalline rocks at specific Si/O rock ratio, and the difference becomes larger with increased Si content. Furthermore, the specific surface area of the glass, up to few m^2/g for volcanic ash, is much larger than that of crystalline intrusive rocks and the crystalline interiors of lava flows. Basaltic glass dissolves faster than rhyolitic glass. Glassy volcanic ash is most often coated with a very thin metal and proton salts layer that dissolves orders of magnitude faster than the bulk glass. The bulk dissolution rate, consisting of braking of Si-O-bonds, is dictated by the aquatic solution's H^+/Al^{3+} ratio. The dissolution rate of volcanic glasses and plagioclase increases by decreasing the activity of the aquatic Al^{3+} species at pH <7, by complexing anions such as oxalate, F^- and SO_4^{2-}. Oxalate like anions are produced by biological reactions in soil and F^- and SO_4^{2-} can be derived from magmatic gases, infiltration of seawater and volcanic ash and volcanic aerosols fallout.

Riverine alkalinity fluxes are greatest in vicinity of active volcanoes in Iceland, even though some of the alkalinity has been stored within carbonate minerals. Riverine alkalinity fluxes decrease with the age of rocks. Riverine dissolved fluxes increase when eruptions occur within a river catchment, and riverine fluxes can increase as a result of ash and aerosol fallout from volcanoes within and outside river catchments. The most extreme riverine flux enhancement in Iceland is during volcanic eruptions within glaciers, creating Amazon like fluxes lasting for few days.