Strontium isotopes, basalt weathering and Phanerozoic CO_2

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Using a combined model for the strontium and carbon cycles that considers the terrestrial weathering of volcanic and non-volcanic silicate rocks, the weathering of younger and older carbonates, basalt-seawater reaction, and marine carbonate burial, the ratio of volcanic (mainly basalt) weathering to total silicate weathering is calculated as a function of time from the oceanic record of $^{87}Sr/^{86}Sr$. The volcanic proportion is then used to modify the equations for calculating atmospheric CO_2 levels over Phanerozoic time via the GEOCARBSULF model by the addition of a new non-dimensional volcanic weathering factor. The effect of uplift and physical erosion on weathering is also modified by using only the distribution over time of the abundance of sandstones and shales, and not Sr isotopic data that had been used previously.

Results indicate large variations in the volcanic proportion of silicates undergoing terrestrial weathering over time with the proportion varying mainly with the rate of basalt-seawater reaction. Lower CO_2 values than GEOCARBSULF were found for the early Paleozoic and for the Mesozoic with the degree of lowering depending primarily upon the intrinsic weatherability of volcanics vs nonvolcanics. An increased minimum in CO_2 during the Late Ordovician is in agreement with the presence of a continental glaciation at that time, and, using intrinsic volcanic/non-volcanic weatherability = 2, variations of Jurassic and Cretaceous CO_2 agree with the independent work based on liverwort delta ^{13}C values.

[1] Berner, R.A. (2006a) *Am. J. Sci.* **306**, 295- 302. [2] Berner, R.A. (2008, in press) *Am. J. Sci.* **307**.

The oxidation state of Uranium in mantle melts

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The oxidation state of U exerts a first order control on its partitioning during partial mantle melting. An understanding of U partitioning, and its abundance relative to other members of the U decay series, is important for interpreting U series disequilibrium, with implications for the rate of melt transport at mid-ocean ridges.

U L_{III}-edge X-ray absorption near edge structure (XANES) spectra were recorded for a synthetic mid-ocean ridge basalt (MORB), and a number of CMAS (CaO-MgO-Al_2O_3-SiO_2) compositions, containing 0.5 wt % U_3O_8, equilibrated at 1400 ˚C and controlled oxygen fugacities (fO_2) at one-atmosphere. Spectra were obtained for both quenched glasses, and *in situ* at magmatic temperatures (Berry *et al.* 2003). *In situ* measurements allowed changes in the spectra in response to the imposed fO_2 to be followed in real time. The spectra were recorded in fluorescence mode at the Australian National Beamline Facility (beamline 20B), Photon Factory, Japan.

The spectra exhibit systematic variations in absorption edge energy and crest intensity with fO_2. These changes occur between -4 and +6 log units of the nickel-nickel oxide (NNO) fO_2 buffer. The fO_2 range of the spectral variation indicates that U^{4+} must oxidise to U^{6+} through two stepwise one-electron reactions, involving a U^{5+} intermediate, rather than a direct two-electron process. The results also suggest that U^{5+} may be the dominant oxidation state at the fO_2 conditions of MORB generation.

[1] Berry A.J., Shelley J.M.G., Foran G.J., O'Neill H.St.C. & Scott D.R. (2003) *J. Synch. Rad.* **10**, 332-336.