The effect of water-rock ratios on microbial weathering of basalt

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Rock weathering has an important influence on biogeochemical cycling. It controls nutrient flux in the biosphere and long term climate through CO_2 drawdown. However, weathering does not only occur by chemical and physical factors. Microorganisms play a role in the weathering of rocks. This, however, is little understood and one major question is why weathering rates are so different in the laboratory compared to the field.

This work aimed to understand the influence of water-rock ratios on the rate of microbial weathering of basalt.

To investigate how pH and rates of elemental release were affected by changing the water-rock ratio, batch cultures of the acidophilic iron-oxidising bacterium *Acidithiobacillus ferrooxidans* were set up in polycarbonate flasks and monitored for 37 days. The iron required was provided by basalt from the volcano Eldfell in Heimaey, Iceland. Three different water-rock ratios were used: large (800ml media, 2g basalt), medium (100ml, 2g) and low (25ml, 25g).

An optimum water-rock ratio was found to be the medium ratio, which achieved the highest cell numbers, . Additional experiments showed that in the low ratio case neither an increase in pH due to rock weathering reactions or high heavy metal concentrations present in rocks was the cause of cell death. XANES at the Fe-K edge analysis showed localised areas of heamatite but the surface of the rock also showed Fe oxidation without a change in gross mineralogy. It is proposed that Fe^{3+} ions bind to the rock surface and preventing the release of reduced iron to provide energy for the bacteria, which might cause rapid reduction in Fe availability in the low water rock ratio environment.

This work has implications for the rates of rock weathering in natural environments where water-rock ratios may effect the balance between optimum energy and nutrient supply, as for example in the case of organisms in vesiculated basalt (low water-rock ratio) and acid mine drainage sites (high water rock-ratio). Water-rock ratio effects may contribute to differences in laboratory and field-measured weathering rates.

More precise than ice: Radioisotopic dating of the laschamp excursion

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A brief period of enhanced ^{10}Be flux that straddles the interstadial warm period known as Dansgaard-Oscheger event 10 in Greenland and Antarctic Isotope Maximum 10 in Antarctic ice cores is but one consequence of the weakening of Earth's magnetic field associated with the Laschamp excursion. This ^{10}Be peak in the NorthGRIP ice core has been dated at 41,250 years Before Present (y BP) via multi-parameter counting of annual layers. Uncertainty in the age of the ^{10}Be peak is, however, no better than ±1,630 y at the 95% confidence level, reflecting accumulated error in identifying annual layers. The age of the Laschamp excursion, determined using new ^{40}Ar/^{39}Ar, unspiked K-Ar and ^{238}U-^{230}Th data from three lava flows in the Massif Central, France, together with the ^{40}Ar/^{39}Ar age of a transitionally magnetized lava flow at Auckland, New Zealand, is 40,700 ± 950 y BP and includes both analytical and systematic (^{40}K and ^{230}Th decay constant) uncertainties. Taking the radioisotopic age as a calibration tie point suggests that the layer-counting chronologies for the NorthGRIP and GISPII ice cores are more accurate and precise than previously thought at depths corresponding to the Laschamp excursion.