Incorporation of heavy metals into recent travertine formations at the Eyjafjallajökull volcano

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The release of heavy metals from water-volcanic rock-gas interaction and pristine volcanic ash-water interactions pose a serious environmental problem for water supplies. Thus it is interesting that the concentrations of waterborne pollutants monitored in the vicinity of active volcanoes are often much lower than predicted. Released heavy metals from the iniaial water-rock interactions are probably scavanged by and/or reincorporated into secondary precipitates including aluminium silicates, iron (hydr)oxides and carbonates. The purpose of this study was to investigate the capacity of naturally formed travertine to immobilise heavy metals.

Following the eruption of the Eyjafalljökull Iceland volcano in the spring 2010, a new strong outlet of riverine CO_2 was observed via the river Hvanná, which indicates deep degassing into the water. A white mineral layer; at some places several cm thick, for hundreds of meters downstream was observed. The precipitation was identified solely as calcite with X-ray diffraction. Low concentrations of riverine Al and Fe provide a unique opportunity to examine the scavenging role of the precipitating carbonates exclusively. A gradual decrease of: conductivity from 1.8 to 1.1 mS/cm, alkalinity from 20.8 to 8.8 meq/kg, concentration of Ca, Mg, Cd, Cu, Mn, Sr, Ba and CO_2, and increase in the pH from 6.5 to 8.5, strongly correlated with the amount of precipitated travertine. Dissolution experiments show that bulk travertine incorporates the same metals. The water temperature was below 5 °C and an elevated atmospheric CO_2 partial pressure was detected near the river. The river water degassed downstream and pH increased, resulting in calcite supersaturation and precipitation. Our thermodynamic models suggest that, in addition to $CaCO_3$, Mg-, Sr- and Ba-carbonates and two phyllosilicate phases were supersaturated.

Our study provides valuable information for assessing environmental impacts for, e.g. volcanic eruptions or carbon capture and storage (CCS) projects in basaltic rock, such as the Icelandic multi-collaborator project 'Carbfix'.

Enzymatic and abiotic hydrolysis of glucose phosphate adsorbed on goethite

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Organophosphates constitute a substantial part of the total phosphorus in soil. However, hydrolysis of the phosphate ester bond may be required in order to produce bioavailable phosphate. Adsorption on mineral surfaces can facilitate abiotic hydrolysis, but has also been suggested to block enzymatic hydrolysis. In this study we have investigated the enzymatic and abiotic hydrolysis of glucose-1-phosphate and glucose-6-phosphate adsorbed at the water-goethite interface. Sugar monoesters such as these have been indicated to occur at significant concentrations in soils.

To study the kinetics and molecular mechanisms of the abiotic and enzymatic hydrolysis we have used wet-chemical and spectroscopic techniques. Ion chromatography was used to obtain quantitative data, while a setup for simultaneous infrared and potentiometric titrations was used to investigate *in situ* the goethite-water interface reactions. We found that glucose phosphate forms three surface complexes on goethite in the pH range 3 – 10 differing in protonation states and hydrogen bonding interactions with neighboring surface groups. Below pH 7 the glucose-1-phosphate complexes are stable with respect to hydrolysis whereas at higher pH values a small extent of hydrolysis is detected. With glucose-6-phosphate the trend is reversed, i.e. hydrolysis occurs at low pH values. When an enzyme (acid phosphatase) is added the hydrolysis increases considerably. This increase coincides with adsorption of enzyme, and all experimental data indicate that the enzymatic hydrolysis is a strictly interfacial process. Furthermore, the enzymatic hydrolysis is strongly dependent on the amount of glucose phosphate adsorbed since the properties of the surface affect the enzyme's mode of adsorption and hence it's activity.