Rocky constraints on catabolic energy supply in the subseafloor

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Reactions between circulating seawater and oceanic basement release reduced components, which can be used as electron donors by chemolithoautotrophs in the subseafloor. High-temperature axial hydrothermal vent systems show a pronounced influence of basement composition on metabolic diversity, with ultramafic hosted systems supporting a greater range of catabolic reactions, including anaerobic ones [1].

We investigate the influence of temperature (2-110°C), rock composition (basalt vs. peridotite), and permeability on energy availability for a subseafloor biosphere away from axial vents where seawater circulation through fractured basement takes place at lower temperatures.

In fresh basalt, oxidation of ferrous iron is the main energy source at low temperatures (<25°C) and under oxic conditions. Increasing extents of alteration of glassy lava will build up palagonite rims as diffusive barriers between the fractures and unaltered glass, which slow down the rates of alteration. Palagonite has little or no ferrous iron and is enriched in U and K. Unless new fractures form and allow circulating seawater to interact with fresh material, the principal source of energy will change to dihydrogen produced radiolytically by U and K. At moderate temperatures (25-60°C), recharge of oxygenated seawater is sluggish and anaerobic metabolic reactions become more important. At high temperatures (60-110°C), the metabolic energy demand has increased relative to the energy supply, making growth more difficult for microbes.

In mantle peridotite, abundantly exposed in rift mountains along slow spreading ridges and commonly strongly serpentinized, oxidation of ferrous iron is also the main energy source at T<25°C. Brucite dissolves in contact with cold seawater, increasing permeability of the rock and pH in the interacting fluid. Serpentinites are often pervasively affected by low-T reactions, indicating that new permeability develops in the course of interaction with seawater. At T>25°C, dihydrogen yields are very high throughout. While the increased energy supply and permeability will facilitate microbial growth, high pH and the dearth of CO_2 in the interstitial solutions may impedete it.

[1] Amend *et al*. (2011) *GCA* **75**, 5736 - 5748.

Contaminant geochemistry and migration in three different mine sites in Finland – Comparison of anthropogenic and geogenic contamination for risk assessment

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Areas with bedrock abundant in ore minerals have naturally high amount of harmful elements in soil as well as in ground and surface waters. After the beginning of the mining the anthropogenic contamination also tends to increase. Thus, it is important to estimate the effects of mining activity and water treatment methods to the geogenic background when assessing the long term effects to the surrounding environment. In this study, geochemical and anthropogenic contaminant geochemistry and transport in soil at three different mine sites in Finland: Suurikuusikko, Siilinjärvi and Luikonlahti, were characterized by using extraction methods and mineralogical studies. Water samples were analyzed for metal and metalloid concentrations, anions and physico-chemical properties. Also groundwater and geochemical modeling software were used to study the groundwater flow paths and hydrogeochemistry.

The results show that the geogenic background, the hydrogeology of the site and concentrations of harmful elements in mine wastes and waters must be considered in risk assessment of mine sites. When evaluating the risks, the concentration levels must be compared to geochemical background, but also the ratio of available, potentially mobile and total concentrations must be studied, because the mining activities tend to increase the proportion of potentially mobile and available elements. Due to residues of chemicals used in enrichment process and weathering of minerals during the process, the concentration profile of harmful elements in waters can be used to distinguish the anthropogenic and geogenic contamination. Results also indicate that fractures of crystalline bedrock are important pathways for contaminant migration to environment and should be studied using geophysical methods and groundwater flow modeling when assessing the environmental effects of mines.

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