The effect of flow rate on iron oxide driven sulfide turnover in aquifers

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The interaction between sulphide and ferric oxides

$$2\ FeOOH + H_2S \rightarrow S^\circ + 2\ Fe^{2+} + 4\ OH^- \quad (1)$$

is of paramount importance for the redox state of ground waters. Being a reaction between a mobile and an immobile species, its turnover may be affected by ground water flow rates. In this poster, we will present results from column experiments where the turnover of sulfide was studied at six different flow rates (0.05–1.4 m/d) with a constant supply of sulfide (c = 200 µmol L^{-1}) buffered at pH 7 with $NaHCO_3$ (I = 1 mmol L^{1-} NaCl). Column material consisted of quartz grains coated with goethite (c ~ 0.2 weight %).

Flow rates significantly reduced turnover of sulfide

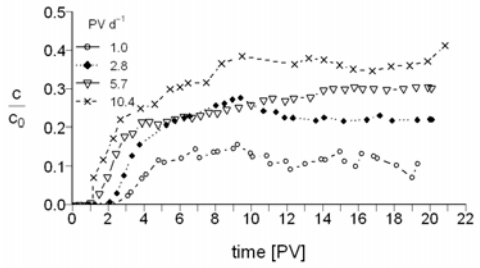

Figure 1: Turnover of sulfide at different flow rates.

Mass balance revealed sulfide consumption rates ranging between 645 µmol d^{-1} at the highest flow rate and 82 µmol d^{-1} at the lowest rate. Two hypothesis can be derived from these observations.

- the faster the flow rate the higher the turnover is. This effect is probably due to the fast reaction between sulfide and ferric oxides with a maximum at pH 7 (Peiffer *et al*, 1992).

- Consumption rates decrease slower than the hydraulic residence times suggesting that the residence time has some influence on the overall turnover rate. The efficiency ε of the system, i. e. the ratio between turnover rate and load is highest at the lowest flow rate (ε = 0.83) compared to the highest flow rate (ε = 0.65) which suggests some transport limitation to occur under these conditions.

We have applied the Damköhler concept to discuss these findings

[1] Peiffer S., dos Santos Afonso M., Wehrli B., Gächter R. (1992) *Environ. Sci. Technol*., **26**, 2408-2413.

Argon isotopic compositions of deep undegassed mantle: New constraints from the western Galápagos

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Early studies of noble gases in ocean island basalts, primarily from Loihi Seamount, revealed $^{40}Ar/^{36}Ar$ ratios close to atmospheric, which were interpreted as evidence for air-like mantle argon isotopic compositions. Atmospheric contamination is a serious complication, there are few data, and there are large uncertainties in deep mantle argon isotopic compositions, particularly from putative undegassed reservoirs. We have measured He, Ne, and Ar in a suite of submarine glasses from the western Galápagos, with a focus on Fernandina, which is considered to be the center of the hotspot. The Fernandina glasses have unradiogenic $^3He/^4He$ (up to 29 Ra) coupled with neon isotopic compositions that are close to solar in the three isotope neon diagram. These characteristics are consistent with derivation from a deep undegassed reservoir. The highest measured Fernandina $^{20}Ne/^{22}Ne$ and $^{40}Ar/^{36}Ar$ values, 12.7 and 4300, respectively, are among the highest ever found at ocean island basalts. Step crushing experiments reveal systematic mixing trends between air and different mantle components; $^{40}Ar/^{36}Ar$ within individual samples are well correlated with $^{20}Ne/^{22}Ne$, which allows correction for atmospheric contamination. The air-corrected $^{40}Ar/^{36}Ar$ (by extrapolation to solar neon) for Fernandina range from 5700 to 8000 which are significantly higher than previous estimates from glassy ocean island basalts. Samples from adjacent western Galápagos volcanoes, having lower $^3He/^4He$ are characterized by higher $^{40}Ar/^{36}Ar$, and there is a broad correlation between helium and argon, demonstrating argon isotopic heterogeneity in the Galápagos hotspot. Some of the argon isotopic variability may be related to mixing with normal depleted mantle (having high $^{40}Ar/^{36}Ar$) but the existence of discrete Ne-Ar correlations suggests that mixing took place prior to melt aggregation. These data demonstrate the presence of non-atmospheric argon in the undegassed mantle, which has important implications for argon isotopic evolution and terrestrial K/Ar ratios. The new He, Ne, and Ar data (coupled with previous data) are supportive of mantle models that allow significant undegassed material in the deep mantle.