Microbial activity below the Iheya North deep sea vent constrained by quadruple sulfur isotopes

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Sulfate reduction is the predominant microbial metabolisms in the subseafloor environment. The sulfate reduction is generally slow due to the limitation of substrates under the stationary seafloor. On the other hand, hydrothermal system may host active microbial sulfate reduction possibly due to the water circulation. In 2009, a drill ship “CHIKYU” drilled Iheya North hydrothermal system in the Okinawa Trough. For evaluating the sulfate reducing activity, we analysed sulfur isotopes (^{32}S/^{33}S/^{34}S/^{36}S) of pore water sulfate and mineralized sulfide extracted from the core samples. The observed ^{34}S-enrichment and decreased sulfate concentration in the upper and intermediate section suggest sulfate reduction took place below the seafloor. On the basis of our model calculation, apparent isotope effect $^{34}\varepsilon$ is estimated to be –21‰ and the occurrence of sulfate reduction is only in the upper part of the subseafloor hydrothermal system, that is the recharge zone of seawater. The observed fractionation together with the slight Δ^{33}S enrichment all indicate that the sulfate reduction is not thermochemical process but microbial process with high reaction rate. Also, roughly ~50% of mineralized sulfide is estimated to have been deposited from microbial reduction below the seafloor . The rapid seawater circulation in the Iheya North hydrothermal system may be critical to support active microbial sulfate reduction below the seafloor.

A database for calculating geochemical reactions of CO_2 and gas mixtures at high (*P*, *T*, salinity)

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For calculating gas properties at high pressure an equation of state for gases [1] was programmed in PHREEQC, version 3 [2]. The solubility can be calculated from the fugacity coefficient of the gas and its aqueous molar volume, with accurate results in solutions of various salinities up to 1000 atm and 200°C.

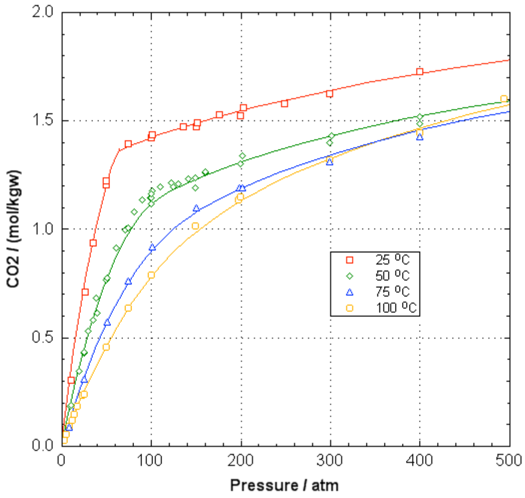

Figure 1. Solubility of CO_2 in pure water as a function of pressure, 25-100°C. Data from literature, lines from PHREEQC.

For modeling gas solubilities and mineral scales at high *P*-*T* and saline conditions, Pitzer.dat was adapted [3, 4].

[1] Peng and Robinson (1976) *Ind. Eng. Chem. Fund.* **15**, 59-64. [2] http://wwwbrr.cr.usgs.gov/projects/GW-C_coupled/phreeqc/index.html [3] Pabalan and Pitzer (1987) *GCA* 51, 2429-2443. [4] Holmes and Mesmer (1986) *JSC* **15**, 495-517.

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