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Biogeochemistry of brines in the Northern Red Sea

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Interaction of seawater with Miocene evaporites below the seafloor is the main reason for the formation of brine filled deeps in the Red Sea. Dense, sodium chloride-rich brines (S$\sim$260 $\%_{\circ}$) have accumulated in sea floor depressions along the axis of the Red Sea, where young ocean spreading to rifting occurs opening from south to north. The brines are separated from the overlying Red Sea Deep Water by steep geochemical and physical gradients, and they have accumulated high concentrations of gases (CO_2, H_2S, hydrocarbons, and He). Hydrothermal input mainly controls the brine carbon and sulfur geochemistry in the central part, but northern Red Sea deep brines show only limited influence of hydrothermalism. There strong (bio)-geochemical processes were observed in microbial and geochemical studies. Geochemical tracer studies (DIC, δ^{13}C-DIC, CH_4, SO_4^{2-}, H_2S, δ^{34}S-H_2S, δ^{34}S-SO_4^{2-}, He, Ne, Ar, Kr, Xe) were conducted in brines and at brine-seawater interfaces of northern Red Sea deeps between 24 and 26˚N along the Red Sea axis. The dissolved inorganic carbon content in the brines is up to 8 times higher than in Red Sea Deep Water and the pH is controlled by biogenic carbonate dissolution in the slightly acid brines. Carbonate dissolution is most likely controlled by surface/volume-dependent dissolution rate and the brine-shell contact time, which controls the carbonate content of underlying sediments. Organic carbon degradation by sulfate reduction is determined as a major process in a methane saturated brine, where sulfide oxidation at the brine-seawater interface further decreases pH. Noble gas concentrations and methane isotope data give evidence for degassing processes near the brine-seawater interface. Degassing frequency probably controlled by CO_2 accumulation and oversaturation within the brine was calculated for the different brine systems.