Constraints of carbon uptake by seafloor weathering of ocean plates

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Seafloor weathering plays an important role in the long-term carbon cycle through the sequestration of seawater CO_2 during silicate weathering and carbonate precipitation. The uptake of carbon by seafloor weathering within lava sequences is investigated using drillcore from fourteen Ocean Drilling Program and Deep See Drilling Program sites, with crustal ages of ~6–170Ma. Carbon is stored as carbonate that forms by low temperature reaction between basalt and seawater, primarily within the upper most few hundred metres of the lavas. The CO_2 content of the drillcores identify two populations: Cenozoic sites (6.8 to 74 Ma) with low CO_2 contents (0.2–0.9wt%) and Mesozoic (110 to 170 Ma), sites with significantly higher CO_2 contents (2.0–4.1wt%). Carbon isotopes indicate inorganic precipitation. Temperatures of carbonate precipitation increase with crustal age (0 to 6^{o}C and 12 to 19^{o}C), suggesting that higher bottom water temperatures may have facilitated carbon uptake. Strontium isotope ratios and trace element contents indicate that carbonate generally precipitates from seawater with a basaltic contribution. Calcite Mg/Ca and Sr/Ca ratios decrease with decreasing temperature due to the combine effects of basalt interaction and changes in bottom seawater chemistry with time. This study shows the influence of temperature and trace elements concentration of seawater on carbonate precipitate through geological time.

Excess air as a proxy for hydrostatic pressure?

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Dissolved conservative atmospheric gases in groundwater (e.g., noble gases) are usually found to exceed their respective atmospheric solubility equilibrium concentrations. This so-called ‘excess air’ in groundwater is most likely the result of the dissolution of entrapped air bubbles within the quasi-saturated zone. Excess air has been suggested as a tracer for past environmental conditions prevailing during groundwater recharge. The amount of excess air, which is often expressed as the relative supersaturation of Ne (ΔNe), has especially been used to constrain the pressure conditions at recharge.

However, the formation of excess air and the physical processes involved have only sparsely been studied. Recent experimental and modeling results shed light on the formation of excess air and its evolution in space and time. The results show that the composition of the excess air component changes considerably during the progressive dissolution of entrapped air bubbles.

Simple lumped-parameter models have been developed to parameterize the excess air component using dissolved noble gas concentrations in groundwater samples, and to deduce the amount and fractionation of excess air, the amount of initially entrapped air, the temperature prevailing during recharge, and the pressure factor, giving the pressure in the gas phase relative to atmospheric pressure. Whereas some of these parameters (noble gas temperature, pressure factor) have proven to be quite robust and providing correct estimates over the entire process of gas bubble dissolution, our investigations imply that other parameters (amount and fractionation of excess air) only yield appropriate values during the very early stage of gas bubble dissolution.

Although ΔNe changes significantly during the course of bubble dissolution field data usually show a good correlation between ΔNe and the hydrostatic pressure estimated using the above mentioned lumped-parameter models. Therefore ΔNe seems to be a reliable proxy for hydrostatic pressure in such cases. However, if no additional data are available caution should be exercised when interpreting ΔNe in terms of hydrostatic pressure.