

The role of submarine basalt alteration in global biogeochemical cycles

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The submarine alteration of silicate minerals in the oceanic crust during on-axis and off-axis hydrothermal circulation drives chemical exchange between the oceanic hydrosphere and lithosphere and is understood to be a key process in the biogeochemical cycle of numerous elements. Furthermore, alteration of silicate minerals in the oceanic crust and subsequent sequestration of carbon as carbonate minerals has been suggested to contribute to regulating Earth's carbon cycle over geological time. Indeed, basalt weathering across Earth's surface environment (terrestrial or submarine) is likely a key component of any silicate weathering feedback on Earth's carbon cycle. Understanding the controls on the alteration or chemical weathering of the oceanic crust and the subsequent carbonate mineralisation is critical for determining the stability of Earth's carbon cycle over geological time. It has been recognised for some time that bottom water temperature plays a role in basalt alteration, but the role of changes in major ion chemistry and basalt-hosted microbial communities remains enigmatic. Here we will consider several aspects of the role of off-axis, ridge-flank silicate alteration on global biogeochemical cycles. First, we will discuss the role of seawater magnesium concentrations on silicate mineral alteration in the oceanic crust, and the influence this has on secondary mineral assemblages including anhydrite and carbonate minerals. Second, the relative evolution of the calcium versus strontium isotopic composition of hydrothermal fluids, as preserved in carbonate veins of a range of ages, and modelled using the dual porosity model hints at a buffering effect on the calcium and strontium concentration and isotopic composition of hydrothermal fluid. We suggest that the buffering effect may help explain the decoupling between the response time of certain elements and the calculated residence time of these elements over the Cenozoic, further underlining the importance of submarine silicate alteration in global biogeochemical cycles.