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Rare earth element (REE) mobility during seafloor weathering

LAURENCE A COOGAN AND KATHRYN GILLIS
University of Victoria

The role of seafloor weathering in the global carbon cycle and in controlling the composition of seawater over geological time periods is uncertain. To investigate this we have studied the role of seafloor weathering on REE distributions within the lavas of the Troodos ophiolite. This ophiolite was formed and altered in the late Cretaceous under high bottom water temperatures. Additionally, sedimentation rates were slow facilitating fluid ingress into the crust. In combination these factors led to extensive seafloor weathering. Surprisingly large scale REE mobility is suggested by the widespread occurrence of large negative Ce anomalies within the upper 100 m of the lavas (down to Ce/Ce* of 0.25) and smaller negative Ce anomalies within the deeper lavas. That the Ce anomalies are generated by interaction with seawater is confirmed by a strong correlation with the bulk-rock Nd isotopic composition (epsilon Nd ranges from 2 to 8 in the altered rocks with the freshest clustered around 8, umbers that record seawater REEs have epsilon Nd of -6). This correlation can be quantitatively explained by fluid-rock reaction with REE exchange between seawater and the lavas controlled by linear kinetics. Exchange of REE between the ocean crust and seawater occurs with little change in the abundance of most REEs suggesting that the ocean and seafloor lavas are approximately in REE exchange equilibrium. This may be fortuitous or may reflect seawater being approximately in REE exchange equilibrium with minerals in the altered lavas (and/or similar composition sediments). The large extent of seafloor weathering recorded by the REE mobility suggests an important role for seafloor weathering in ocean chemical cycles during greenhouse climates with high bottom-water temperature. Widespread Nd isotope exchange between seawater and the upper ocean crust during such times may have important implications for using Nd isotopes of tracers of ocean circulation at such times.