

The Chemical Impacts to the Ocean From Subaqueous Volcanism

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Submarine volcanism is the predominant form of volcanism on the surface of the earth occurring mostly at mid-ocean ridge spreading centers and hotspot submarine volcanos. While there have been extensive investigations of hydrothermal fluids created during the interaction between hot rock and seawater, there have been few studies of the physical and geochemical effects of direct lava-seawater interaction. The geochemical signature observed in this setting is distinct when compared to other forms of water-rock interaction and provides insight into the reactions that take place when molten rock and seawater interact. The frequency of submarine volcanism in both the contemporary and ancient oceans has important geochemical implications on the flux of many chemical species to the oceans, and on resultant increases in oceanic productivity that might arise from these eruptions and their subsequent hydrothermal activity.

We will present the results from oceanographic-geochemical studies from the eruptions of Loihi (1996), Macdonald (1989), and Axial (1998) seamount Volcanos. These data will be presented in the context of our geochemical study on the direct interaction between lava and seawater at the shoreline of Kilauea Volcano. In addition, geochemical data gathered from the October 2001 response to seismic activity in Middle Valley along the Juan de Fuca Ridge may also be presented.

The results demonstrate that the geochemical imprint on the ocean from submarine eruptions is dominated by the release of acidic magmatic gasses rich in carbon dioxide, sulfur compounds and minor elements. In addition to the gaseous acids, acid is also generated by ion-exchange between seawater and the molten rock (Na-metasomatism). These acids act in concert to strip major and minor elements from the volcanic rocks, thereby releasing them to the ocean. The result is that the major and minor element chemistry is dominated by three types of reactions: volatile release from the magma, ion exchange, and congruent dissolution of the volcanic rocks. The release of Fe during this interaction could be important in near-surface eruptions because Fe is a limiting nutrient in the growth of oceanic phytoplankton and its presence in trace amounts can promote primary productivity.