Investigating the Causes of Variability in the Intensity of Hydrothermal Alteration of Ocean Crust Formed at Intermediate to Fast Spreading Rates

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Abstract

The hydrothermal alteration of the oceanic crust at the ridge axis and on the ridge flanks has a profound influence on the oceans and atmosphere and through subduction of altered crust, the chemistry of the upper mantle. Hydrothermal inputs play a fundamental role in controlling seawater composition and influence many of the records (e.g., Sr, S or O) we use to reconstruct past climate, erosion and other major other Earth processes. If possible, quantifying the chemical and isotopic exchange fluxes from the alteration of the ocean crust will provide a solid foundation for assessing changes in the more complex and variable systems draining the continents. At least in terms of seismic structure, ocean crust formed at intermediate to fast spreading rates is relatively uniform and should most closely relate to the ideal "Penrose" stratigraphy. Consequently, observations from deep drill hole into fast spread crust can be

reasonably extrapolated to describe the seawater-basalt exchange over significant portions of the ocean basins. Here we compare lithologic, wire-line, alteration, mineralogic, isotopic (87Sr/86Sr, δ18O), and trace element profiles from DSDP/ODP Sites 504, 801, 843, 896, 1149, 1179, 1224, 1243, and 1256, combined with regional geophysical data, to determine the geologic factors that influence the variability and intensity of alteration in intermediate to fast spread ocean crust. These holes sample ocean crust formed between 6.9 and 170 Ma, but are constructed from contrasting eruptive lava styles (e.g., pillow lavas, sheet flows, massive flows, breccias), and have endured very different tectonic and sediment burial histories. Basement topography, the nature of the uppermost volcanic rocks, and the rapidity and thickness of sediment cover strongly influence the intensity of chemical and isotopic exchange. Unfortunately, progress in establishing these exchange budgets is greatly hampered by poor core recovery during hard rock drilling and a paucity of comprehensive wireline logging and imagery.

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