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結晶粒径温度計を用いた上部海洋地殻の温度構造の復元
A New Geothermometer Using Crystal Size Variations of the Sheeted Dikes: Insight Into the Thermal Structure of The Upper

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Elucidation of hydrothermal system beneath the mid-ocean ridges is critical to understand cooling of lithosphere and physico-chemical evolution of the earth's surface and interior, and migration of deep bioshpere. Hydrothermal fluids are driven by thermal gradient which plays a fundamental role in hydrothermal circulation and thermo-chemical evolution of the oceanic crust.

Thermal structure of the upper oceanic crust has been estimated by numerical modeling and metamorphic temperatures based on equilibrium mineral assemblages and homogenization temperatures of fluid inclusions. However, metamorphic temperatures may not always represent the ambient temperatures of the host rocks as they are in equilibrium with the fluids that supply or remove heat from the host [1].

We present a new method of estimating the thermal structure of the ancient upper crust formed at the Oman paleospreading axis on the basis of the crystal size variations of the sheeted dike complex. A numerical simulation of crystallization in a dike (Rc) shows that the ambient wall rock temperature (Twall) is correlated with logarithm of crystal size in the center of a dike [2]. This enables us to estimate the wall rock temperatures at the time of the dike intrusion using the crystal size variations in the dike:

Twall =Tm [logRc - logRc(0)]/0.44 + Twall(0)

Tm is the liquidus temperature. A variable with (0) means a reference value.

Because dike intrusion is limited to a narrow volcanically active zone (less than 1 km in width) beneath the fast-spreading ridge axes, the groundmass crystal sizes of the sheeted dikes represent the thermal structure of the upper crust at the ridge axis. A well exposed and preserved paleoridge segment in the Oman Ophiolite [3, 4] provides ideal sites for the crystal-size geothermometry.

Application of the crystal-size geothermometry demonstrates that the estimated geotherm through the dikes at a paleoridge segment end along Wadi Fizh shows constantly low-temperatures in the upper dikes and remarkable high gradient 1.1degC/m in the lower dikes toward the gabbros. In contrast, the estimated geotherm along Wadi Hayl is consistently higher than that along Wadi Fizh and does not show any stratigraphic variation but remains in a limited range from 540 to 790degC, which is higher than any observed fluid temperatures on the present ridge axes. The thermal structure along Wadi Fizh indicates advective heat transfer by hydrothermal circulation of cold seawater in the upper dikes and conductive heat transfer in the lower dikes. However, the high geotherm in the segment center cannot be reconciled with heating by hydrothermal fluids but requires high heat supply by repeated dike intrusions.

References:

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キーワード: 中央海嶺, 海洋地殻, オマーンオフィオライト, シート状岩脈群, 結晶粒径, 温度構造
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