Thermal properties of seafloor massive sulfide deposits

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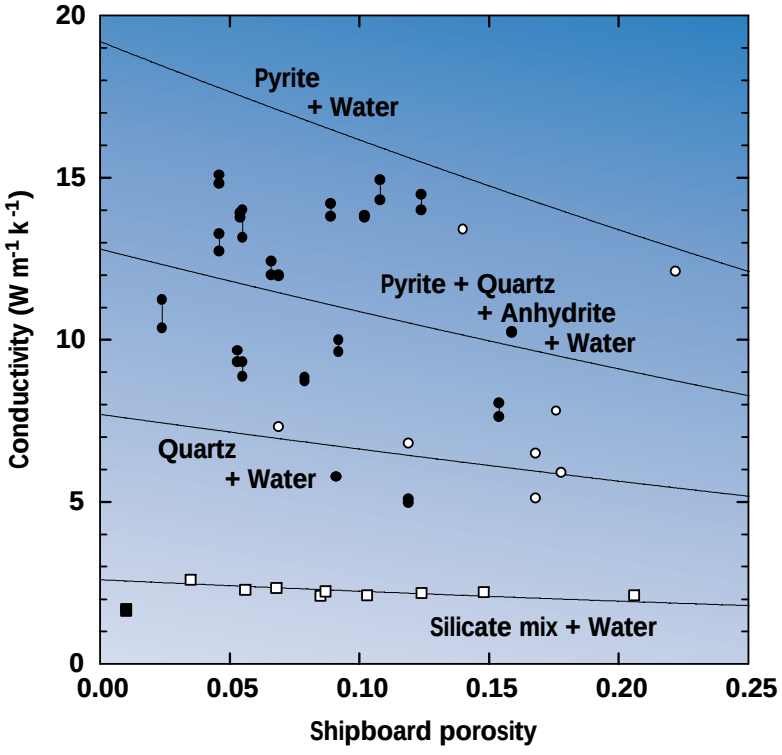
Knowledge of thermal conductivity values for sediment and rock is essential for calculating heat transfer from Earth's interior into the oceans. Yet few values of thermal conductivity have been determined for the massive sulfide mounds deposited at major seafloor hydrothermal sites. Results from work on ODP samples from the Mid-Atlantic Ridge and Middle Valley in the Pacific indicate that seafloor sulfide bodies may focus conductive heat flow, in addition to being the location of spectacular convective thermal transfer through black smokers and diffuse venting [*Rona et al,* in press].

Our studies more than double the preexisting number of land and sea thermal conductivity measurements on sulfides/sulfates by reporting 35 new values determined by two different methods for samples cored by ODP Leg 158 from the volcanic-hosted active sulfide mound in the TAG hydrothermal field in the rift valley of the Mid-Atlantic Ridge near 26°N, 45' W. Fifteen measurements were made on the ship using the half-space method with a needle probe on seawater-saturated half-rounds of cores of heterogeneous mixtures of sulfide (predominantly pyrite), quartz, and anhydrite breccias. Values range between 6.1 and 10.4 W/m-K; one measurement on anhydrite produced a value of 5.4 W/m-K. Twenty values were measured by the divided bar method at the Pacific Geoscience Centre on minicores extracted from other half-rounds of cores with similar mixed compositions and saturated with distilled water. These values range between 5.0 and 14.9 W/m-K. Typical thermal conductivity values of seafloor sediment and basalt range between 1 and 2 W/m-K.

Measurements of sediment-hosted sulfides cored by ODP Leg 139 at Middle Valley of the Juan de Fuca Ridge exhibited similar high values of thermal conductivity, ranging from about 4 to 14 W/m-k for sulfide samples (see figure). The marked contrast in thermal conductivity between seafloor massive sulfide bodies and surrounding seafloor materials measured at TAG and Middle Valley opens new directions for field and modelling studies of the combined roles of conduction and convection in heat transfer at seafloor hydrothermal sites.

References:
Rona, P.A., E.E. Davis, and R.J. Ludwig, Thermal properties of TAG hydrothermal precipitates, Mid-Atlantic Ridge, and comparison with Middle Valley, Juan de Fuca Ridge, Eds: P.M. Herzig, S.E. Humphris, and J. Miller, *Proc of ODP, Sci Results, 158,* in press.



Thermal conductivity vs. porosity for normal silicate seafloor sediments and basalts (squares) and hydrothermal precipitates collected during ODP Legs 139 (open circles) and 158 (solid circles) from Middle Valley and TAG deposits. Various theoretical "mixing lines" are shown for reference.