Gold-rich chimneys at the Beebe Hydrothermal Vent Field

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Gold is heterogeneously distributed across the Beebe hydrothermal vent field, an active vent system developed on basaltic crust at 4960m below sea level in the Cayman Trough. Analysis of a range of chimney types and hydrothermal precipitates from the vent field shows that the highest gold contents (up to 93 ppm) are found within beehive 'diffuser' chimneys, which develop a highly porous pyrrhotite framework. This structure allows vent fluids to effuse slowly while allowing ingress of seawater to cool the fluid. The prevalence of pyrrhotite in the samples, lack of sulfates, association between pyrrhotite and gold grains, and results of thermodynamic modelling, suggests gold precipitates under highly reduced conditions within beehive chimneys even during mixing with seawater. In contrast, focussed high temperature chimneys, with a single orifice, maintain high temperatures to the primary vent orifice and much of the gold is lost to seawater. Despite this, the high temperature chimneys are relatively gold enriched, which hints at a further underlying cause for high gold at the BVF such as interaction with mantle-derived peridotite. Estimates of the depth of hydrothermal circulation from SiO_2 geothermobarometry, coupled with observations of the extreme thinness of crust at the Cayman Trough, indicate that the hydrothermal cell may extend below the basaltic crust and interact with peridotite. Since peridotite has been shown to be gold-rich compared to the basaltic product of partial melting, it may represent a source for anomalously high gold at the BVF.

The BVF adds to growing evidence that slow- and ultraslow- spreading mid-ocean ridges are particularly conducive to producing gold-rich hydrothermal deposits.