Supercritical venting and VMS formation at the Beebe Hydrothermal Field, Cayman Spreading Centre

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The Beebe hydrothermal field is the world's deepest hydrothermal vent site at ~5000 metres below sea level on the ultra-slow spreading mid-Cayman rise. The fluid venting at Beebe is supercritical due to stable high temperatures of ~401ºC and a low salinity of ~2 wt% NaCl. This salinity indicates phase seperation has occurred, requiring higher temperatures at depth. As such, the site offers a unique opportunity to study minerlization and hydrothermal processes *in-situ*, at P-T conditions normally expected deep within the crust.

The hydrothermal system shows two distinct mineral and chemical assemblages. Focussed vent chimneys, those with a single or few active orifices, contain less than 1 wt% zinc and display a simple mineralogical assemblage of chalcopyrite in the chimney inner wall, through to bornite and then a pyrite/anhydrite mixture on the exterior. So-called "beehive" chimneys, which are more uniformly permeable and vent fluid from many smaller orifices, are zinc-rich and display an assemblage of sphalerite, pyrite, marcasite and pyrrhotite. Samples of mound talus are almost exclusively pyrite, with a subordinate assemblage of oxides, sulfates and chlorides. The asymetrical morphology of the sulfide mound and talus is strongly contolled by its location atop a volcanic edifice and position adjacent to a prominent fault scarp, with virtually all the talus spreading down-slope towards the west, whilst east of the field is sulfide-free. Metalliferous sediment collects in depressions below the vent sites that shows limited pelagic or hemipelagic input, preserving relatively high copper and zinc contents.

The extreme physical conditions found at Beebe make it an ideal end-member seafloor hydrothermal system for the study of metal mobility, hydrothermal circulation and VMS formation under high pressure supercritical conditions.