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TITLE: The Seven Sisters Hydrothermal System: First Record of Shallow Hybrid Mineralization Hosted in Mafic Volcaniclasts on the Arctic Mid-Ocean Ridge

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ABSTRACT:

We document the discovery of an active, shallow, seafloor hydrothermal system (known as the Seven Sisters Vent Field) hosted in mafic volcaniclasts at a mid-ocean ridge setting. The vent field is located at the southern part of the Arctic mid-ocean ridge where it lies on top of a flat-topped volcano at ~130 m depth. Up to 200 °C phase-separating fluids vent from summit depressions in the volcano, and from pinnacle-like edifices on top of large hydrothermal mounds. The hydrothermal mineralization at Seven Sisters manifests as a replacement of mafic volcaniclasts, as direct intraclast precipitation from the hydrothermal fluid, and as elemental sulfur deposition within orifices. Barite is ubiquitous, and is sequentially replaced by pyrite, which is the first sulfide to form, followed by Zn-Cu-Pb-Ag bearing sulfides, sulfosalts, and silica. The mineralized rocks at Seven Sisters contain highly anomalous concentrations of ?epithermal suite? elements such as Tl, As, Sb and Hg, with secondary alteration assemblages including silica and dickite. Vent fluids have a pH of ~5 and are Ba and metal depleted. Relatively high dissolved Si (~7.6 mmol/L Si) combined with low (0.2?0.4) Fe/Mn suggest high-temperature reactions at ~150 bar. A ?13C value of ?5.4? in CO2 dominated fluids denotes magmatic degassing from a relatively undegassed reservoir. Furthermore, low CH4 and H2 (<0.026 mmol/kg and <0.009 mmol/kg, respectively) and 3He/4He of ~8.3 R/Racorr support a MORB-like, sediment-free fluid signature from an upper mantle source. Sulfide and secondary alteration mineralogy, fluid and gas chemistry, as well as ?34S and 87Sr/86Sr values in barite and pyrite indicate that mineralization at Seven Sisters is sustained by the input of magmatic fluids with minimal seawater contribution. 226Ra/Ba radiometric dating of the barite suggests that this hydrothermal system has been active for at least 4670 ± 60 yr.

SOURCE: Minerals

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