
Fluid inclusion study of salt-dome related hydrothermal development on Axel Heiberg Island, Canadian Arctic Archipelago

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In several sites, adjacent to evaporite diapiric structures on Axel Heiberg Island, Nunavut, a region with 500 m of permafrost, saline water flows perennially at constant flow rates and temperatures (+6°C), despite a mean annual air temperature of -15°C. These springs were interpreted as Holocene phenomena related to deglaciation; however a network of veins were recently discovered on the steep glacial trough of White Glacier in Expedition Fiord (WG). The host rocks are brecciated limestone and sandstone, anhydrite, and altered basalt, marginal to a large evaporite dome. Acicular, radial aggregates of calcite line fractures and cavities, with textures identical to but coarser than those observed in the active springs. Spar calcite fills the centre of larger cavities. Marcasite, pyrite (rare chalcopyrite) and quartz occur in several veins, and epidote and chlorite where they cut basalt. Thermochronology suggests that rocks now at surface were at temperatures of ~100°C until the Miocene.

Fluid inclusions in calcite (5–10 µm) have salinities that fall into two distinct groups: one very low, ca. 1.5 and another ca. 16 NaCl wt% equivalent. Primary inclusions that occupy growth zones in some of the coarser acicular calcite crystals have Th (L+V→L) ranging from 100°C to 300°C (n = 26) independent of salinity, but restricted range in Th within individual groups of inclusions in different areas of the host carbonate (i.e. variable from assemblage to assemblage). These values are considerably higher than the average temperature of the brines in the active springs. Despite the similarities of the WG site with perennial springs, our data are incompatible with models invoking shallow-circulating fluids related to deglaciation. We propose a model by which deeply-circulating basinal fluids were expelled in recurrent pulses during diapiric rise of salt in the Tertiary and mixed with low-salinity surficial waters, thereby establishing a long-lasting plumbing system as a precursor to active spring discharge.