Hydrothermal Exploration of the Gakkel Ridge, 2014 and 2016

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In 2001 the AMORE expedition of RV Polarstern and the USCG Healy detected abundant hydrothermal plume signals along the Gakkel Ridge from ~6°W to ~90°E. Here we report results from two follow-on RV Polarstern expeditions, in 2014 and 2016. Ultra-slow ridges like Gakkel are of interest because of their potential to host diverse styles of seafloor venting, including systems associated with ultramafic rocks that generate fluids rich in H_2 and CH_4. Such systems may have direct relevance to the origins of life, both on Earth and elsewhere in our Solar System. On Gakkel Ridge, vent exploration was conducted using a CTD-rosette to track hydrothermal plume signals in the water column and the OFOS deep-tow camera system to survey the underlying seafloor. In 2014, at the *Aurora* site (83°N 6°15'W; 4050m) close to the westward termination of Gakkel Ridge, hydrothermal plume signals were detected close above a topographic high made up of pillow basalts. Away from that mound, the seafloor was covered by sediment and both the sedimented seafloor and the axial high were disrupted by fissures and pock-marks. The overlying plumes, which were rich in particles, ^3He, Fe, Mn and CH_4, carried a CH_4:Mn ratio indicative of ultramafic- rather than basalt-hosted venting, even though only basaltic rocks were observed at the seafloor. Black smoker venting was imaged by OFOS at this site. In our 2016 study of the *Langseth Ridge* formation, hydrothermal activity was also associated with an axial volcanic ridge (AVR), at 86°58'N 55°45'E (3150m). There, in the Eastern Volcanic Zone, sediment cover was much less than at *Aurora* and fresh pillow lavas were ubiquitous. Vertical E-W fissures cut through the AVR, and plume signals were strongest along its north flank. As at *Aurora*, the plume was enriched in both CH_4 and H_2. But within the buoyant plume and youngest parts of the non-buoyant plume, strong Eh anomalies and high concentrations of dissolved CH_4 and H_2 were accompanied by low or absent optical back-scatter signals, indicating that the source of the venting, here, was not a conventional "black smoker" vent. Microbial studies at both sites indicate that chemosynthetic plume activity is primarily associated with hydrogen consumption.