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Neotectonic activity at the Giant Gjallar Vent (Norwegian Sea) indicates a future phase of active fluid venting

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The Giant Gjallar Vent (GGV) is a hydrothermal vent complex that formed during the opening of the North Atlantic at about 55 Ma. Sill intrusions into Cretaceous organic-rich sediments led to the production and subsequent vigorous seafloor venting of methane. A later phase of fluid escape occurred in mid-Oligocene times. The GGV is characterised by two pipes of 440 m and 480 m in diameter that reach up to the Base Late Pliocene Unconformity (BLPU) between the Kai and Naust formations. The unconformity is strongly deformed over an area of c. 18,000 km^2 across the vent, with a positive relief of up to 38 m above the surrounding paleo-seafloor. The overlying sediments of the Naust Formation conformally drape this deformation, smoothing its relief to a maximum of 15 m at the modern seafloor.
The sediment drape indicates present inactivity of the vent system, as does the absence of indicators of active fluid escape in the water column during RV METEOR cruise M87-2 in 2012. However, high-resolution 2D seismic and Parasound data from the same cruise, and exploration-type 3D seismic data acquired by Norsk Hydro, show several indications for recent to ongoing activity at the GGV. Beneath the BLPU, strong frequency attenuation and chaotic reflections indicate the presence of free gas. At the edges of the extent of chaotic reflections, subvertical faults cut the unconformity as well as horizons of the lower and middle Naust Formation, suggesting tectonic activity after deposition of these horizons. Neotectonic activity is further indicated by the extensive occurrence of shallow faults apparent in Parasound records in the immediate vicinity of the vent and up to 16 km away. Some of these faults reach the seafloor.
The observed deformation and faults may be the result of fluids accumulating beneath the BLPU due to increased loading of the oozy Kai Formation by denser glacigenic Naust sediments. Because of the lower permeability of the Naust Formation, the unconformity acts as a seal to upward fluid migration. This probably results in the build-up of overpressure and may explain subsequent deformation of the overlying strata. A small chimney-like feature that extends from the unconformity to just below the seafloor, c. 800 m NE of the northern pipe, shows that the BLPU seal has been penetrated in at least one location. We propose that further loading and gas ascent will lead to a new phase of venting at the GGV in the future.