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High-resolution 3D seismic data characterize fluid flow systems in the SW Barents Sea

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The flow of fluids through marine sediments is one of the most dominant and pervasive processes in continental margins. These processes control the evolution of a sedimentary basin and its seafloor environment, and have implications for hydrocarbon exploration and seabed ecosystems. Many seep sites at the seafloor are associated with large but complex faunal communities that have received significant attention in recent years. However, there is a need for a better understanding of the driving mechanism of fluid flow in various geological settings, the accumulation of fluids in the subsurface and their focused flow through conduits and/or faults to the seabed.
The Barents Sea is a large hydrocarbon-prone basin of the Norwegian Arctic region. A significant portion of the hydrocarbons has leaked or migrated into the shallow subsurface and is now trapped in gas-hydrate and shallow-gas reservoirs. Furthermore, there are few places in the Barents Sea, where methane gas is leaking from the seafloor into the oceanosphere. Accumulations of free gas in the shallow subsurface are considered a geohazard. They constitute a risk for safe drilling operations and they may pose a threat to global climate if the seal that is trapping them is breached.
P-Cable 3D high-resolution seismic data from the Ringvassøya Fault Complex and the Polheim Sub-Platform provide new and detailed insight into fluid flow controls and accumulation mechanisms. The data shows a wide variety of fluid flow features, mostly in the form of pockmarks, bright spots, wipe-out zones or vertical zones of disturbed reflectivity. Fluids migrate by both diapiric mechanism and channelized along sedimentary layers. Glacigenic sediments generally form a strong boundary for fluid flow in the very shallow section. However, we can recognize pockmarks not only at the seafloor but also at one subsurface layer approximately 50 m below sea floor indicating a former venting period in the SW Barents Sea. At few locations high-amplitudes are terminated at the sub-bottom depth of the gas-hydrate stability zone suggesting the presence of gas hydrates. The boundary between the gas hydrate and the free gas show a very peculiar circular pattern of high amplitudes that probably can be linked to the dynamics of hydrate and free gas at this interface.