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Upward-migrating methane induced seismic chimney formation in the Nordland Group, Southern Viking Graben

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The Nordland Group in the Southern Viking Graben hosts seismic chimneys, represented by anomalies in seismic data and determined by residual methane accumulations. These seismic chimneys are generally interpreted as focused fluid flow structures, and thus pose the risk of potential fluid leakage in geological subsurface utilization.

The aim of the present study was to assess two popular scientific hypotheses on seismic chimney formation in the Nordland Group. The first one assumes excess pore pressure to result from buoyancy effects caused by upward-migrating methane and the development of a gas column with a thickness of several hundred meters, whereas the second one considers the load of the Fennoscandian ice sheet to be responsible for occurrence of hydraulic fracturing. In this context, we applied coupled hydromechanical simulations to determine the mechanism inducing the formation of these potential leakage pathways.

Our simulation results demonstrate that hydraulic fracturing in the Nordland Group already occurs before the maximum methane column heights develop below. Consequently, the load of the Fennoscandian ice sheet is not initiating seismic chimneys formation.