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Post-Caledonian brittle fault zones along the SW Barents Sea Margin: Onshore-offshore margin architecture and fault rock-forming conditions

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The architecture of the SW Barents Sea margin off Northern Norway is, both onshore and offshore, controlled mainly by alternating NNE-SSW and ENE-WSW trending, steeply to moderately dipping, brittle normal fault zones. These fault zones constitute at least two major fault complexes that run partly onshore in Troms, linking major horsts and ridges in the South with offshore basins and fault complexes in the North. At least two major transfer fault systems accommodate changes in fault polarity and lateral segmentation along the margin. The onshore fault activity in Troms is interpreted to have occurred in the Late Permian through Early Triassic, with no major fault movement in the Mesozoic and Cenozoic. However, later Mesozoic fault activity has taken place offshore along the Troms-Finnmark Fault Complex, and both further north and south along the margin. The fault activity in Troms is therefore believed to have migrated progressively west in time, to the Troms-Finnmark Fault Complex. This resulted in a short-tapered margin in the region after final continental break-up at ∼55Ma and preserved fault rocks from the Late Permian/Early Triassic stages of rifting onshore. The onshore Late Permian/Early Triassic faulting activity took place during multiple phases, with initial fault movement at minimum P-T conditions of ∼300°C and ∼240MPa (∼10km depth), followed by later fault movement introducing pumpellyite indicating minimum P-T conditions of ∼275°C and ∼220MPa (∼8.5km depth). The studied faults are thought to have acted as fluid conduits, where microstructural evidence suggests that pore pressures locally reached lithostatic levels (240MPa) during faulting. A maximum differential stress of c. 35 MPa prior to-, and during faulting is estimated based on the evidence for lithostatic pore pressure and assuming a typical Mohr-Coloumb failure criterion. Fluid flow is shown to be controlled by healing and precipitation processes through time, with fluid flow localized to the core of the fault zone during deformation and to the damage zone in the following periods (at least months) after faulting. At present, the inactive faults most likely act as fluid barriers, as indicated by healing of fractures, grain growth, and mineral precipitation on fault/fracture surfaces and within open pore space. The onshore faults and their characteristics may be used as analogues to basement-involved fault complexes offshore. The results suggest that an Early Cenozoic uplift of the margin and corresponding erosion in the region was due to unloading and crustal flexure of the short-tapered margin. Combined with a calculated, minimum average exhumation rate of 40m/Ma since the Late Permian/Early Triassic faulting event, this implies that the proposed Late Cenozoic uplift may be explained by erosion alone.