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Evidence for propagating, active tensional faulting in Upper Kåfjord valley, Troms County, Norway

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New concepts governing margin extension and post-rift passive margin evolution are appearing from onshore and offshore studies. In Norway topographic escarpments, creation, preservation and destruction of landforms, and drainage patterns are related to structural templates created during the Jurassic rift phase. Contradicting the notion that post-rift isostatic compensation, thermal subsidence, and topographic degradation mark a passive margin's final evolutionary phases, we present geological evidence for currently-active tensional deformation, accommodated by release faulting, in uppermost Kåfjordalen and Signaldalen. In Signaldalen, propagation of the deformation tip has introduced active normal faulting to Finland.

Ground observations indicate a large normal fault defines the eastern border of the Lyngen 'Alps' peninsula. There, a series of exceptionally well-preserved triangular facets adorn a sharp, elevated escarpment. To the east a swarm of small NE-trending normal faults are exposed in roadside outcrops near the mouth of Kåfjord, dipping both to the NW and SE. Displacement across the fault swarm is asymmetric, the greatest component of motion being down-to-the-NW in the direction of the Lyngen Fault. Another set of NE trending, NW dipping faults crop out at Revsdalfjellet. We interpret these faults to reflect splays to the Lyngen Fault.

The hanging wall of the Lyngen Fault is characterized by numerous clusters of fault-controlled rockslides. We interpret the valleys of Signaldalen, Skibotndalen, and Kåfjordalen, located in the hanging wall of the Lyngen Fault, to have formed at least partly under the influence of release faults that accommodated hanging wall flexure and failure. Other fault scarps, trending more NW-SE, crop out at two Kåfjord rockslide sites, Nomandalstinden and Litledalen. Mineralized surfaces exhibiting dip-slip slickenlines indicate most of these faults are true tectonic features, not simply gravitationally-driven 'sackung' planes-of-failure. We interpret these structures as release faults. The regional-scale geometry observed in the Lyngen region is satisfyingly similar to that predicted by fault theory.

Active deformation in the region is evidenced by multiple data. During the late 1990s four small seismic events with epicentres directly along the northernmost trace of the main Lyngen fault were recorded by NORSAR. Satellite Interferometry (InSAR) data indicate ground motion consistent with the accumulation of strain across a large normal fault. Road survey data also suggest the footwall horst is undergoing upward strain relative to the hanging wall. These data suggest at least one segment of the Lyngen Fault is currently locked. Elsewhere, deformation is ongoing. Narrow, deep, structurally-guided canyons have been opened within the gently-sloping uppermost ends of Kåfjordalen and Signaldalen. Many such canyons run parallel to hillside slopes for long distances, indicating they do not represent ordinary down-slope drainage. Some drainages appear to crosscut foliation surfaces and are characterized by regular (commonly sinistral) geometric 'steps.' Several small grabens offsetting Quaternary deposits have been recognized on air photographs; one, visited in the field, evinces vestiges of a second graben inside it – clear evidence for multi-stage, very recent, activity consistent with eastward propagation of active extensional tearing predicted by the release fault model.

These faults can be placed within the context of post-rift normal fault guided reactivation of the Norwegian margin. As Scandinavian Mountain asymmetric uplift continues episodically in response to onshore erosion and offshore deposition, the apex of normal faulting marches inexorably east –a 'tectonic promise' from Norway

to Finland.