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Structural constraints on the separation history of the Lofoten Ridge from the mainland

Thomas Scheiber (1,2), Johan C. Faust (1), Marco Brönner (1,3), and Giulio Viola (4)

(1) NGU - Geological Survey of Norway, Trondheim, Norway, (2) Western Norway University of Applied Sciences, Sogndal, Norway, (3) Department of Geoscience and Petroleum, NTNU, Trondheim, Norway, (4) Department of Biological, Geological and Environmental Sciences, University of Bologna, Italy

The Lofoten Ridge forms the southern part of the Lofoten-Vesterålen archipelago, northern Norway, and is one of the most prominent topographic features along the Norwegian coast. It corresponds to a structurally segmented basement high characterized by Alpine-type topography. The ridge is separated from the Norwegian mainland by the SW-NE trending Vestfjorden Basin, which represents the seaward continuation of the E-W trending Ofotfjorden. We present new structural data from the onshore bedrock domain in the Ofotfjorden and inner Vestfjorden regions combined with paleostress analysis, remote sensing and geophysical data, to reconstruct the local pre-rifting and rifting history of the North Norwegian margin with particular focus on the separation of the Lofoten Ridge from the mainland.

Bedrock lineaments extracted from a 10 m digital elevation model cluster into two major sets: a set of predominantly E-W-striking lineaments (Set 1), and a set of mainly NNE-SSW- to NE-SW-striking lineaments (Set 2). Set 1 lineaments are particularly abundant close to the shorelines of Vestfjorden and Ofotfjorden and generally correspond to subvertical, localized sinistral and ductile to brittle shear zones and brittle fractures. Syn-deformational biotite and/or muscovite characterize Set 1 structures. These structures are interpreted as belonging to a large-scale anastomosing post-Caledonian shear zone whose core remains in the fjords. A cumulative horizontal sinistral displacement of c. 2 km is estimated across Ofotfjorden on the basis of the offset of easily mappable lithological boundaries across the fjord. Set 2 lineaments correspond to fully brittle faults, which are associated with cataclasite and fault gouge. They are very common to the N/NW of Ofotfjorden/Vestfjorden but very rare S/SE of it. This spatial distribution of Set 2 structures is interpreted as indicating that the large-scale shear zone defined by Set 1 structures, once formed, probably acted as a decoupling structure between the crustal units located to the N/NW and those to the S/SE of the fjords. During multiple episodes of later (post-sinistral shear) extension strain was accommodated by the shear zone itself (brittle reactivation of Set 1 structures) and by Set 2 faults, which led to further significant structural segmentation of the Lofoten Ridge and adjacent crustal blocks N/NW of the fjords. To constrain the timing of fault activity 40Ar/39Ar dating of fault-related micas and K-Ar dating of fault gouges is ongoing.