Multiphase brittle tectonic evolution of the Mid-Norwegian margin, central Norway, reconstructed by remote sensing, paleostress inversion and K-Ar fault rock dating

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Basement terranes commonly contain complex fault networks developed during repeated episodes of brittle deformation. The Mid-Norwegian margin (from 62 to 63.8 °N) exposes a complexly fractured terrane formed mainly by Caledonian basement rocks. The margin recorded a prolonged brittle deformation history spanning the Devonian to Paleogene time interval. It is characterised by a pervasive NE-SW structural grain due to the ductile-brittle multiphase activity of the Møre-Trøndelag Fault Complex (MTFC).

In order to develop a time-constrained tectonic model of the area, we applied a multidisciplinary approach combining remote sensing, field work, paleostress inversion, microstructural analysis, mineralogical characterization, clumped isotope thermometry on carbonates and K-Ar dating of fault rocks from key representative faults. We present herein the preliminary structural-geochronological data of a still ongoing study of two regions along the Mid-Norwegian margin, the Hitra-Frøya and Kråkenes-Runde areas. These key areas represent the intersection regions between the Mid-Norwegian- and the other sectors of the margin.

The brittle structural record of the entire Mid-Norwegian margin was analysed by remote sensing of lineaments using high resolution LiDAR data followed by ground-truthing of the obtained results during field work. Three main sets of lineaments were identified: i) (E)NE-(W)SW-trending lineaments, parallel to the coastline and to the MTFC; ii) N(NW)-S(SE)-trending lineaments; iii) WNW-ESE-trending lineaments. The main sets of faults and fractures were further characterised by their fault rock association and coating. All generations of faults contain thin coatings of chlorite, variably thick epidote and quartz mineralisations and calcite veins and coatings, locally associated with acicular zeolite. Samples of calcite and related gouges were collected from different sets of faults. Carbonate clumped isotope thermometry constrains the range of temperature of calcite growth between 140 and 30 °C, indicating that calcite precipitated at different thermal conditions during a multiphase structural evolution. K-Ar data collected so far from synkinematic illite separated from fault gouges yield Jurassic-Paleogene ages.
The structural network of the margin is interpreted as reflecting a sequence of different deformation episodes. In order to resolve the orientation of the stress field for each recorded event, we applied paleostress inversion with the Win-Tensor software [1]. The preliminary results suggest that at least three tectonic stages affected the margin. A NE-SW strike-slip dominated transpression possibly reflects the late stages of the Caledonian orogenic cycle. A pure and oblique extensional (E)NE-(W)SW stage is associated with the Jurassic North Sea rifting, followed by a NW-SE Paleogene extensional reactivation observable throughout the margin.

To conclude, a new multidisciplinary database for the reconstruction of the brittle deformation history of the Mid-Norwegian margin is presented. The proposed approach aims to define the temporal and structural characterisation of each single tectonic episode. Such an approach is also pivotal toward the correlation with the deformation history of the corresponding offshore domains, as well as the comparison in time with other segments of the Norwegian margin.