Structural framework and the timing of landscape-forming faults - a study from Western Norway

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Brittle fracture and fault networks control the location of topographic features such as valleys and ridges and active faulting can lead to topographic rejuvenation. In Western Norway, however, it is debated how much faulting has contributed to rejuvenating of the topography during the late Mesozoic and Cenozoic. Geometric and temporal constraints on the brittle evolution are therefore important to obtain a comprehensive picture of the post-Caledonian topographic evolution of this region. In this study, we combine remote sensing, structural field measurements, paleo-stress analysis and isotopic dating to study the brittle evolution of a larger region of Western Norway. The region spans from the Sognefjord in the south to the Møre margin in the north. Lineament studies reveal important lineament sets trending N-S, NE-SW, E-W and NW-SE. Field observations show that these lineament sets correspond to both dip-slip and strike-slip faults, some of them parallel to ductile precursor structures and some cutting the ductile fabric. Epidote, chlorite, quartz and zeolite are the dominant mineralizations on fracture and fault surfaces. There is no clear correlation between the type of mineralization and fracture orientation in the region. Paleostress analysis on fault-slip data (n = 173), including faults reactivating older structures, show a good fit with a general E-W extensional regime. However, a considerable amount of faults (n = 115) formed under a strike-slip regime, which has so far not been documented in the region. We combine these findings with K-Ar fault gouge dating from six faults where five fractions (6-10 µm, 2-6 µm, 0.4-2 µm, 0.1-0.4 µm, <0.1µm) from each sample were analysed. These faults represent two of the four fracture sets observed, trending N-S and NE-SW, respectively, and show either strike-slip or dip-slip kinematics. XRD-data from these gouges show that K-feldspar and smectite are the main sources of potassium. The ages show a spread from the Triassic to the Cretaceous, where older ages can be affected by K-feldspar inherited from the host rock. Our results point to an important phase of Mesozoic strike-slip faulting in the region, with steep faults controlling the location of several major valleys. Extensional dip-slip faults might have contributed to the rejuvenation of the footwall topography.