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Relationships between brittle deformation, weathering and landscape development during the Mesozoic in Scandinavia

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Pre-Quaternary weathering is generally considered responsible for the formation of rather common, yet poorly constrained, saprolite remnants onshore Scandinavia. Understanding the genesis of these weathering products and placing them into an adequate tectonic and climatic framework is currently of great interest for two reasons. First, the origin of the landscape in Scandinavia, where deep weathering is thought to have played a fundamental role, is the subject of a lively debate hinged around the number and age of episodes of regional uplift and denudation. Second, there have been recent discoveries of major hydrocarbon reserves within weathered basement highs in the North Sea immediately offshore Norway. Invariably, these basement highs are also severely fractured and faulted and a genetic relationship between brittle deformation, weathering and landscape development is suggested by a number of observations.

Within the recently launched BASE project, we aim to establish a temporal and conceptual framework for brittle tectonics, weathering patterns and landscape evolution by constraining the age and rate of weathering and by isotopically dating selected faults intimately linked to weathered basement blocks.

Initial efforts have focused on fractured and weathered granitoid rocks of Caledonian age exposed in western Norway. There, saprolites are found as small pockets within a joint valley landscape, which was likely stripped by Quaternary glaciations. Saprolite distribution is mostly structurally controlled as deep weathering and alteration occur predominantly in association with fractures and along faulted corridors. Structural analysis has allowed the geometric and kinematic interpretation of the exposed fracture and fault patterns and we could assign them to a number of distinct brittle deformation episodes characterised by robust paleostress tensors.

The K-Ar dating of illites separated from structurally constrained faults indicates a long strain localization history accommodated by the repeated structural reactivation of existing structures. A significant episode of EW crustal extension is documented in the Permian down to the Triassic. Its magnitude takes on regional significance from comparison to other new fault gouge K-Ar results from eastern Norway, inferences to rifting along the Baltica-Laurentia suture and numerous late Permian dykes. Localised Cretaceous strike-slip faulting is also documented by the new ages and occurs together with other strike-slip and reverse kinematics episode of hitherto still undetermined age. Dating of the saprolites by the same method shows that also weathering occurred in the Permian and in the Triassic and that discrete alteration occurred in the Cretaceous in association with faulting. The temporal coincidence of deformation and weathering episodes supports a close genetic link between the two processes and suggests the importance of brittle deformation coupled with deep weathering in shaping the pre-Quaternary landscape of western Norway.