Deep weathering and mineral exploration in Norway

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The remnants of deeply weathered basement on the mainland of Norway occur as accumulations of clay minerals and grus aggregates along structurally defined weakness zones and locally as up to c. 100 m thick continuous saprolite layers. It is suggested that glacial tills in many tracts of Norway contain significant amounts of reworked saprolite. These are places that were protected to some degree, from glacial erosion and transportation. The observed anomalously high concentrations of REEs and heavy metals such as Cr, Ni, Mo, Zn and Pb in both saprolite and overlying till can be caused by weathering processes where the major elements such as K, Na and Ca have been partly removed by leaching. Deep weathering has also been observed to be super-imposed on several copper-gold deposits in Finnmark (e.g. in Sáđgejohka and Čierte). Chalcopyrite and bornite are frequently replaced by supergene minerals such as digenite, malachite, cuperite, native copper, chrysocolla and limonite. Kaolinite deposits occur on the Varanger Peninsula in the Quaternary overburden as well as in the highly fractured bedrock. K-Ar dating in the 1970s of assumed hydrothermal clay alteration associated with Permian fluorite and sulphide vein deposits, as well as fault zones in eastern and southern Norway (e.g. at Lassedalen and Heskestad) yielded Mid and Late Triassic ages. These ages likely represent the same phase of grus weathering as observed offshore and do not represent hydrothermal alternation associated with the formation of the mineral deposits. K/Ar dating of clay minerals in regional fault zones provided also Late Triassic ages. XRF analysis and mass balance calculations (degree of leaching) of bedrock in these areas commonly show a high degree of mineral alteration. We conclude that the understanding of deep weathering processes and their timing in Norway is a key to a successful mineral exploration programme in Norway.