From high-T Hydrothermal Alteration To Near-Surface Weathering – The Alteration History of the Rolvsnes Granodiorite, W Norway

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The Rolvsnes Granodiorite, comprising the major extent of the northern part of Bømlo Island, Western Norway, has been proposed to be an onshore analogue to the weathered basement rocks at Utsira High hosting significant petroleum resources. A total of 205 meters of core in three boreholes was collected crosscutting both fault zones and apparently tectonically undisturbed rocks. Four distinct lithologies were identified in the drillholes: A medium-grained (grano-)diorite, a range of biotite granites, a porphyritic granite, and aplites/pegmatites. All rock types display evidence of hydrothermal alteration as either pervasive discoloration or more localized veining. Early propylitic alteration of the granodiorite is easily observed macroscopically as distinct greening, caused by primary amphibole being replaced by epidote, and calcic plagioclase cores being altered to epidote+muscovite+quartz. The extent and transition of the alteration steps can be observed in the hyperspectral logs. A second generation of epidote can be observed as 1-2 mm veins crosscutting all lithologies. With decreasing temperature and/or higher fluid/rock ratio, biotite is altered to chlorite. Late infiltration of carbonic fluids is evident from calcite veins cutting former alteration types, and ankerite/Fe-rich dolomite + Fe-oxide veins associated with open fractures.

The clay mineralogy is dominated by smectite and kaolinite, and several meter long sections of the drill cores are near or completely disintegrated from drilling and core handling due to the high smectite content. Kaolinite and smectite may occur together as alteration products, but in open fractures kaolinite is found as infilling in vugs and fractures lined with quartz or associated with the Fe-carbonates, with little or no smectite. This indicates that during late fluid circulation in the faults, kaolinite was precipitated directly from the fluid, and that smectite in the smectite-rich zones was a part of a low temperature pervasive alteration event.

K-Ar dating of the clay-rich alteration zones from this and former studies show a large range of ages, with the ages of the finest (<0.1 μm) fraction ranging from 31 Ma to 281 Ma. The oldest ages are likely mixed or inherited from early events, but apparent clusters around 30-50, 110-140, 200-210, and 265-280 Ma may provide indications of periods of low temperature alteration.