Geophysical Research Abstracts
Vol. 19, EGU2017-12557, 2017
EGU General Assembly 2017

K-Ar age constrains on chemically weathered granitic basement rocks (saprolites) in Scandinavia

Annina Margreth (1), Ola Fredin (1,2), Giulio Viola (3), Jochen Knies (1,4), Ronald Sørlie (5), Jan-Erik Lie (5), Else Margrethe Grandal (5), Horst Zwingmann (6), and Christoph Vogt (7)

(1) Geological Survey of Norway, Trondheim, Norway (annina.margreth@ngu.no), (2) Department of Geography, Norwegian University of Science and Technology, Trondheim, Norway, (3) Department of Biological, Geological and Environmental Sciences, University of Bologna, Italy, (4) CAGE - Centre for Arctic Gas Hydrate, Environment and Climate, University of Tromsø, Norway, (5) Lundin Petroleum AS, Lysaker, Norway, (6) Department of Geology and Mineralogy, Kyoto University, Japan, (7) ZEKAM/FB5 Geowissenschaften, University of Bremen, Germany

Remnants of in-situ weathered bedrock, saprolite, are found in several locations in Scandinavia. Saprolites contain important information about past climate conditions and landscape evolution, although their age and genesis are commonly difficult to constrain. It is generally thought that clay-poor, coarse-grained (arêne) saprolites, mostly occurring as thin regolith blankets or in larger outcrops, formed in temperate climate during the Cenozoic, whereas clay-rich (argillic) saprolites, commonly restricted to small, fracture-bounded outcrops, formed in (sub-)tropical climate during the Mesozoic.

Recent methodological and conceptual advances in K-Ar dating of illite-bearing fault rocks have been applied to date clay-rich saprolites. To test the K-Ar dating technique for saprolites, we first selected an offshore site in the Viking Graben of the North Sea, where weathered and fractured granitic basement highs have been drilled during petroleum exploration, and an abandoned kaolin mine in Southern Sweden. Both targets provide independent age control through the presence of overlying Mesozoic sedimentary rocks. Clay-rich saprolites occurring in fractured basement rocks were additionally sampled in a joint valley landscape on the southwestern coast of Norway, which can be regarded as the possible onland correlative to the offshore basement high. In order to offer a sound interpretation of the obtained K-Ar ages, the mineralogical and chemical composition of the saprolites requires a thorough characterization. Scanning electron microscopy of thin sections, integrated by XRD and XRF analysis, reveals the progressive transformation of primary granitic rock minerals into secondary clay minerals. The authigenesis of illite is particularly important to understand, since it is the only K-bearing clay mineral that can be dated by the K-Ar method. K-feldspars and mica are the common primary K-bearing minerals, from which illite can be formed. While progressive leaching of interlayer potassium is observed in micas without significant modification of the mineral structure, K-feldspars are gradually dissolved with concomitant precipitation of illite, smectite and kaolinite. Individual illite minerals are difficult to identify, but low-K contents in smectite point to small amounts of illite-interlayers. This finding is supported by XRD patterns (powder analyses on clay size fractions) that lack a clear 10 Å peak indicating the presence of illite/mica, but show a prominent and slight asymmetric 14 Å peak representing smectite with potential low (<10 %) illite-interlayer content.

In agreement with previous models of diminishing contamination of protolithic K-bearing phases in the finest grain size fractions, K-Ar ages invariably decrease with grain size suggesting that the finest grain-size is predominantly composed of authigenic, syn-weathering illite, whose age can thus be used to constrain the timing of saprolitization. The obtained Late Permian to Late Triassic ages i) are in accordance with independent age constraints supporting previous hypotheses of intense chemical weathering during the Mesozoic and ii) correlate with similar K-Ar ages obtained from nearby brittle faults suggesting a genetic relationship between weathering and brittle deformation. The combined investigation and K-Ar dating of illite-bearing fractured and weathered bedrock provides new insights into the tectonic and climatic evolution of the Scandinavian landscape prior to the major, and often obliterating, Quaternary glaciations.