Geophysical Research Abstracts
Vol. 18, EGU2016-12961, 2016
EGU General Assembly 2016

Characterization of depositional age and structure of sedimentary successions by U-Pb TIMS and LA-ICP-MS dating of volcanic horizons and detrital zircons: an example from the western Trondheim Nappe Complex, Scandinavian Caledonides

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Revealing the absolute depositional age of non-fossiliferous sedimentary successions represents a long-lasting challenge in Earth Sciences. Lacking age control hampers the correct interpretation of the temporal evolution of depositional systems, and, if deformed, of the architecture of fold-and-thrust belts. Dating of detrital zircons within clastic sedimentary successions has over the past decades become a popular method to approximate the absolute depositional age and to characterize the source areas of such rocks. If combined with other geochronological information, such as dating of contemporaneous volcanic horizons, a much better resolution of the stratigraphy and structure of non-fossiliferous sedimentary successions can be achieved.

The western Trondheim nappe complex in the central Scandinavian Caledonides is a classical area in this respect. On top of Late Cambrian to Early Ordovician ophiolitic fragments, various volcanic, volcano-clastic and clastic successions tell a complex story of island-arc formation, ocean closure and continent collision. Several famous fossil horizons indicate deposition during the Middle to Upper Ordovician (ca. 470-445 Ma), but large areas lack an absolute age control and several contrasting stratigraphic schemes and structural interpretations have been presented in the past.

In this contribution we present the results of LA-ICP-MS detrital U-Pb zircon dating of clastic horizons as well as U-Pb TIMS zircon dating of volcanic horizons and magmatic clasts in conglomerates in order to characterize the depositional age and structure of the western Trondheim nappe complex in more detail. Together with field observations, including way up criteria, the zircon data enable significant revisions of existing stratigraphic and structural models. At least four (volcano-)sedimentary successions can be distinguished above the ca. 480-485 Ma greenstones: (1) ca. 470-463 Ma shales, limestones and andesitic porphyrites (Hølonda and Fanabekken), (2) ca. 455-453 Ma turbidites (Krokstad) and shales (Dicranograptus), (3) ca. 450-447 Ma limestones (Kalstad) and calcareous sandstones (Hovin), rhyolitic tuffs (Høgknippen-Håråkletten) and black shales (Tømmerås) and (4) <430 Ma conglomerates (Lyngestein) and silt- and sandstones (Sandå). The four units are separated by major unconformities of both Taconian and Scandian age, which cut through the different successions at different stratigraphic levels. The maximum depositional ages defined by detrital zircons correspond well with volcanic eruption ages of rhyolitic horizons, and together these two geochronological approaches confidently allow the temporal and structural characterization of these partly non-fossiliferous sedimentary successions.