Provenance reconstruction within Caledonian basement provinces of Svalbard using detrital zircon geochronology

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The Caledonian Basement of Svalbard is characterized by a complicated internal structure with several records of Neoproterozoic and early Paleozoic tectonothermal events distributed unevenly across multiple crustal fragments. Common geological record led to dividing the Caledonian Basement of Svalbard into three basement provinces or terranes that have affinities to either parts of the Laurentian margin or the Pearya Terrane. The Southwestern Caledonian Basement Province of Svalbard remains the most enigmatic part in this tripartite division and bears great potential for studies focusing on resolving the Mesoproterozoic to early Paleozoic evolution of Svalbard's Caledonian Basement, preceding its final Silurian to Devonian assembly.

The aim of the thesis is to resolve the variable provenance of the Caledonian Basement of Svalbard by designating the various crustal fragments into groups that are characterized by similar timing of deposition and source areas. This is achieved through U-Pb detrital zircon geochronology performed on multiple Proterozoic metasediments in the Southwestern Caledonian Basement Province. The statistical analysis of the detrital zircon age spectra from the contemporaneously deposited metasedimentary protoliths allows to distinguish the crustal fragments by provenance typical for the Laurentian and Baltican margins, as well as the Pearya Terrane and other Arctic Terranes. Insights on the Early Paleozoic evolution of the Proterozoic metasediments are provided by structural analysis and Th-U-total Pb monazite petrochronology.

The Meso- to Neoproterozoic metasediments of Svalbard represent a wide range of sedimentation related to the assembly and break-up of the Rodinia supercontinent. The analyzed metasediments can be divided into three lithotectonic groups: (i) metasediments predating the Grenvillian/Sweconorwegian Orogeny, (ii) the late Mesoproterozoic to early Neoproterozoic syncollisional metasediments intruded or metamorphosed during early Tonian magmatic event, (iii) Neoproterozoic metasediments predating a c. 710 Ma deformation event. The first group is represented by the Eimfjellet Group that was deposited during the Mesoproterozoic extensional stage, predating the final assembly of Rodinia. Archean to Paleoproterozoic detrital zircon age signatures of this group are similar to detrital zircon age signatures of coeval metasediments in the eastern Laurentian and western Baltican margins.

The second group is represented by the Isbjørnhamna Group, St. Jonsfjorden Group and the Müllerneset Formation. These metasediments display predominantly Paleoproterozoic to Mesoproterozoic detrital zircon age spectra that are characteristic for the Grenvillian foreland basin. More proximal sediments in the upper part of the redefined Isbjørnhamna Group show correlation with the Timanian margin of Baltica and document its interaction with the Grenvillian foreland basin. This pinpoints the position of the southern part of the Southwestern Caledonian Basement Province to the northern extent of the Baltican margin in the late Mesoproterozoic to early Neoproterozoic. The third group is represented by the Deilegga and Nordbukta Groups, which display mainly Mesoproterozoic and minor Paleoproterozoic detrital zircon age spectra. Coeval metasediments of the western Baltican margin and the Pearya Terrane are characterized by similar detrital zircon age spectra, in contrast to metasediments of the eastern margin of Laurentia that are dominated by either Paleoproterozoic or latest Mesoproterozoic age signatures.

The correlations between the late Mesoproterozoic to Neoproterozoic metasediments of Southwestern and Northwestern Caledonian basement provinces of Svalbard confirm that the assembly of Svalbard occurred due to the activity of multiple transcurrent faults that continue across the traditional boundaries of the Caledonian provinces of Svalbard. The Meso- to Neoproterozoic connections between Baltica, Svalbard and the Pearya terrane, as established by the detrital zircon geochronology, are confirmed by their comparable early Caledonian evolution. The separation of southwestern Svalbard and Baltica most probably occurred in the Silurian during the activity of the Northwest Passage, and is highlighted by coeval activity of the sinistral northwest-southeast trending Vimsodden-Kosibapasset Shear Zone that juxtaposes the two different crustal levels of the Southwestern Basement Province of Svalbard. The field studies performed in the Oscar II Land suggest that the primary early Caledonian structures are obliterated by the Early Devonian north-northwest to south-southeast trending sinistral strike-slip shearing documented by the U-Th-total Pb dating of retrograde monazite growth to 410 ± 8 Ma.

The results obtained with the detrital zircon geochronology and the Th-U-total Pb dating of monazite, combined with the structural studies, suggests a two-stage model of Svalbard assembly. First, the peri-Baltican fragments of the Southwestern and Northwestern basement provinces of Svalbard were transported towards the northern Laurentian margin along the Northwest Passage, perpendicular to Caledonian Orogen in the Silurian. Subsequently, the peri-Laurentian fragments of Svalbard, including the Eastern Caledonian Basement Province, were translated parallel to the orogeny as a result of escape tectonics.

This formed the independent Barentsia microplate during the Scandian collision in the Early Devonian. The interaction between the escape of the Barentsia microplate and the activity of the Northwest Passage resulted in a complicated picture of two separate tectonic events imposed on each other with multiple crustal fragments forming Svalbard's Caledonian Basement. Therefore, the results presented in this thesis provide a significant advancement for the understanding of the interaction between the two scenarios observed in present time, including the development of the Scotia Plate-style subduction zone and the syn-orogenic escape tectonics observed in southeast Asia and Anatolia.