

Meso-neoproterozoic evolution of the Caledonian basement of SW Svalbard

Abstract

The North Atlantic Caledonides formed during the closure of the Iapetus Ocean as a result of the collision of Laurentia and Baltica during the early Ordovician to early Devonian. Rock units which were subjected to the Caledonian Orogeny crop out in Svalbard, Scandinavia, Great Britain, east Greenland and Canadian Arctic. Svalbard is a key area in the High Arctic, which is assembled from several pieces. They differ from each other in their stratigraphy, structures, magmatic and metamorphic evolution. These basement provinces are named the Northeastern, Northwestern and Southwestern Basement Province. This thesis focuses on the Southwestern Basement Province, where poly-magmatic and -metamorphic events were documented, some of them not recognized within two other provinces.

The overall goal of this thesis was to propose for the first time one comprehensive model for metamorphic evolution of the Caledonian basement of Southwestern Basement Province. This was achieved through deciphering of Meso-Neoproterozoic and Caledonian tectono-metamorphic history of the abovementioned basement, based on the careful studies of the Southwestern Basement Province where medium- to high-grade metamorphic rocks occur: Wedel Jarlsberg Land, Oscar II Land, Nordenskiöld Land and Prins Karls Forland. The current state of knowledge about the medium- to high-grade metamorphic rocks from Southwestern Basement Province was hitherto rather limited and published petrological and geochronological data was insufficient. Recent discoveries of previously unknown rocks in the Southwestern Basement Province emphasize that little is currently known about the evolution of this key basement area of Svalbard. The collected petrological and geochronological data presented in this thesis contribute new knowledge and allow for a correlation of different medium- to high-grade units which have been treated separately so far. Moreover, a coherent pressure-temperature-time evolutionary model has been formulated for the studied part of the Svalbard Archipelago.

The main achievements of this thesis are:

- (1) the previously unrecognized high-pressure metamorphic rocks were discovered within the Nordenskiöld Land and the Berzeliuseggene unit of the Wedel Jarlsberg Land;

- (2) pressure-temperature conditions of metamorphism were estimated for the garnet-bearing schist of the Berzeliuseggene unit which were metamorphosed during the Torellian Orogeny;
- (3) the unusual, very cold 7-9°C/km subduction geotherm was calculated for the high-pressure rocks of the Vestgötabreen Complex of Oscar II Land;
- (4) the collision of the southwestern Svalbard and an island arc was dated to c. 485 Ma and thus the additional evidence for early Caledonian subduction was provided;
- (5) the previously unrecognized amphibolite facies metamorphism of Ellesmerian (c. 360 Ma) age was documented within the basement which was previously thought to be Caledonian in age.

The petrochronological data obtained in frame of this thesis broaden the understanding of the complicated history of the Southwestern Basement Province. The pressure-temperature-time paths which were constrained for the medium- to high-grade rocks of the Southwestern Basement Province are suggesting that those different rock units share at least partly similar metamorphic history. Some of these units have been metamorphosed during the Torellian Orogeny and then overprinted during the Caledonian Orogeny. The high-pressure rocks of the Vestgötabreen Complex and its equivalents underwent only early Caledonian subduction-related metamorphism. This allows to look at the scattered occurrences of these units as at the puzzle pieces that can be merged together to unravel the architecture of the pre-Caledonian southwestern Svalbard margin. Hence, it is now possible to compare the Southwestern Basement Province to both paleocontinents Laurentia and Baltica and decide whether the Southwestern Basement Province is a part of one or another. The latter has implications for paleogeographical reconstructions and interpretation of mineral resources distribution. A completely novel and surprising outcome of this thesis is the aforementioned discovery of the Ellesmerian metamorphic rocks on the island of Prins Karls Forland – thus far missing puzzle-piece of the High Arctic lithosphere. A tentative tectonic model suggests the existence of the post-Caledonian suture between the Southwestern Basement Province and the Franklinian Margin of Laurentia, a feature that provides the very first, strong line of evidence for connection between the Southwestern Basement Province and the terranes on the NW Passage including the Pearya Terrane of northern Ellesmere Island.

Karolina Kościńska

Key words: Svalbard, Arctic, HP metamorphism, Caledonides, metapelites, geothermobarometry, thermodynamic modelling, QuiG, Zr-in-rutile, geochronology