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Tectonothermal evolution of the Caledonian basement of Mosselhavøya, Ny-Friesland, Svalbard

Summary

The geological structure of the Svalbard Archipelago is very complicated. Metamorphic, igneous as well as sedimentary rocks of Proterozoic up to Quaternary age occur on Svalbard. Numerous episodes of tectonic and volcanic activity as well as periods of calm sedimentation affected the area. The oldest Svalbard's rocks can be treated as equivalents of rock units cropping out in Greenland or Scandinavia. Therefore, the study of these oldest units is very important for understanding the evolution of the whole Arctic region.

The main goals of this work are:

1. Provenance studies of metasedimentary rocks from the northern part of Ny Friesland (the Atomfjella Complex and Mosselhalvøya Group) for information about the sedimentary sources and maximum deposition age coupled with with geochronological studies of metaigneous rocks occurring within the Atomfjella Complex to define the age of protolith formation.
2. Reconstruction of the pressure-temperature conditions of metamorphic events using microchemical analyses of the paraganetic assemblages and rock bulk chemistry for geothermobarometrical calculations and thermodynamic phase equilibrium modeling, as well as geochronological studies to constrain the timing of metamorphic events.
3. Geochemical and isotopic studies of mafic rocks occurring within the Atomfjella Complex as well as similar studies of ultramafics occurring just beneath the suspected Planetfjella thrust for comparison of these two igneous suites and to define the origin of ultramafics (exhumed along the deep-rooted fault vs. emplaced during hyperextension).

The three main research hypotheses tested in the course of this thesis are:

1) Is the Mosselhavøya fault a major terrane boundary?

2) Does Mosselhalvøya Group have a different tectonothermal history than the Atomfjella Complex?

3) Were the Nordaustlandet and Ny-Friesland terranes originally located along the East Greenland margin?

The crystalline basement of the Svalbard Archipelago includes pre-Devonian igneous and sedimentary rocks deformed and locally metamorphosed during the Caledonian Orogeny (Harland, 1985). It is divisible into the Northwestern, Southwestern and Eastern provinces (Gee & Tebenkov, 2004; Dallmann et al. 2015) that are separated by large-scale strike-slip fault zones (e.g. Mazur et al. 2009, Michalski et al. 2012, Faehnrich et al. 2020). All of the basement provinces are depositionally overlain by the Devonian Old Red Sandstone and younger rocks. Although Caledonian orogenesis produced the most-pronounced metamorphic event observed in the Svalbard crystalline basement (e.g., Harland 1985), older metamorphic

and igneous events have been also documented (see e.g., Dallmann et al. 2015 and Majka & Kośmińska 2017 for more details).

The boundary between the Northwestern and Southwestern provinces is inferred to be a strike-slip fault (e.g., Bazarnik et al. 2019) that was modified by and currently lies at the front of the Tertiary West Spitsbergen Fold and Thrust Belt (Harland & Horsfield 1974; Dallmann et al. 1993). The Eastern Province is separated from the other provinces by the large-scale strke-slip Billefjorden Fault Zone (e.g., Gee & Tebenkov 2004; Michalski et al. 2012). The Eastern Province is divided into the West Ny-Friesland and Nordaustlandet terranes which are separated by either the Mosselhalvøya fault or Eolussletta shear zone on the northern Ny-Friesland peninsula. The Eastern Basement Province on the Northern Ny-Friesland peninsula is divisible into metamorphic rocks of the Atomfjella Complex and the Mosselhalvøya Group (alternatively called the Planetfjella Group) to the west and sedimentary rocks of the Veteranen, Akademikarbereen and Polarisbreen groups to the east. The Atomfjella Complex and Mosselhalvøya Group are separated by the Mosselhalvøya thrust fault. The Mosselhalvøya Group is separated from sedimentary rocks to the east by the Eolussletta strike-slip shear zone.

The Atomfjella Complex is assigned to the West Ny-Friesland terrane and further subdivided into four inferred thrust sheets referred to, from west to east, as the Dirksodden, Nordbreen, Rekvika and Finlandveggen nappes (Witt-Nilsson et al. 1998). The nappes are similar in composition and age and consist mainly of psammitic metasedimentary rocks and metaigneous rocks metamorphosed under amphibolite facies conditions during the Caledonian Orogeny (e.g. Witt-Nilsson et al. 1998). The Atomfjella units defines a 150 km long, north-south trending apparent anticline referred to as the Atomfjella Antiform (Witt-Nilsson et al., 1998). Paleoproterozoic granitic gneiss of ca. 1750 Ma age (Johansson et al. 1995, Larionov et al. 1995, Johansson & Gee 1999, Bazarnik et al. 2019) is inferred to be unconformably overlain by quartzite and metapelite in each nappe. Both the igneous basement and the metasedimentary cover are intruded by mafic dykes. Bazarnik et al. (2019) dated one such dykes to ca. 1380 Ma and tentatively suggested this age for entire mafic magmatism within the Atomfjella Complex. At the top of the Atomfjella Complex, close to the boundary with the Mosselhalvøya Group (inferred Nordaustlandet terrane), voluminous lenses of ultramafic rocks occur. Some authors suggested that they provide evidence for the presence of a deeply rooted, large-scale tectonic boundary between the West Ny-Friesland and Nordaustlandet terranes (Witt-Nilson et al. 1988).

The Atomfjella nappe stack is thought to be overthrust from the east by the Mosselhalvøya Group which is generally included with the Lomfjorden and Hinlopenstretet supergroups and assigned to the Nordaustlandet terrane (sensu Witt-Nilsson et al. 1998, Gayer et al. 1966, Gee & Tebenkov 2004, Hellman et al. 2001). Thus, the Mosselhalvøya Group forms the lowermost tectonostratigraphic unit in the western exposures of the Nordaustlandet terrane (Gee & Tebenkov 2004). The unit predominantly consists of semipelite, psammite, subordinate marble and megacrystic plagioclase-rich schist likely derived from felsic volcaniclastic protoliths. It is divided into the Flåen and Lower plus Upper Vildadalen formations (Wallis 1969, Elvevold & Dallmann 2011). The structurally lowermost Flåen Formation comprises garnet-mica schists and feldspathic metasedimentary rocks. The Lower and Upper Vildadalen formations are dominated by quartzite and phyllite, respectively. The grade of metamorphism within the Mosselhalvøya Group increases downwards from greenschist facies in the Upper Vildadalen Formation at the contact with the Lomfjorden Supergroup in the east to upper amphibolite facies in the Flåen Formation at the contact with the Atomfjella Complex in the west. Limited detrital zircon ages from the Mosselhalvøya Group suggest that these rocks were deposited after 950 Ma (Larionov et al. 1998; Larionov personal comm.). The age of metamorphism is estimated to be ca. 415 Ma based on ^{40}Ar-^{39}Ar analysis of muscovite (Gee & Page 1994).

East of the Eolussletta Shear Zone, Tonian Lomfjorden Supergroup is divided into two groups: (1) the Veteranen Group comprising a siliciclastic succession and built mainly of shales, greywackes and quartzites, and (2) the overlying Akademikarbreen Group dominated by limestones, dolomites and stromatolites (Gee & Teben'kov, 2004). In the easternmost part of Ny-Friesland the Cryogenian Hinlopenstretet Supergroup conformably overlies the Lomfjorden Supergroup and is divisible into the Polarisbreen and Oslobreen groups. The former consists of tilloid rocks, shale and carbonate, while the latter includes sandstone and limestone.

The boundary between the West Ny-Friesland and Nordaustlandet is considered a first order tectonic structure of regional importance (Gee & Teben'kov 2004; Elvevold & Dallmann 2011; Lyberis &Manby 1999). As mentioned above, some authors located this major terrane boundary at the base of the Mosselhalvøya Group (Witt-Nilsson et al. 1998, Gee & Teben'kov, 2004, Elvevold & Dallmann, 2011). According to Witt-Nilsson et al. (1998) the occurrence of the numerous lenses of ultramafic rocks near this boundary may suggest that the contact between the Polhem Group (the uppermost unit of the Atomfjella Complex) and the Mosselhalvøya Group could extend to mantle depths and thus mark a major crustal boundary. On the other hand, Lyberis & Manby (1999) emphasize that the strike-slip Elusletta Shear Zone that can be traced from north Ny-Friesland, along western shore of Sorgfjorden towards south-eastern Spitsbergen, where it was recognized in offshore geophysical surveys (Skilbrei 1992).

Results.

Provenance of metasedimentry rocks and age of protolith of metamagmatic rocks studies.

Samples from the Flåen (JB15-57) and lower Vildadalen (JB15-14) formations of the Mosselhalvøya Group yielded subround to round, oscillatory zoned grains with no or very thin metamorphic rims. Rounded zircon fragments are abundant in both samples. The zircon characteristics and age distributions of the Mosselhalvøya Group samples are very similar. They display prominent peaks at 1450-1500, 1640 and 1780 Ma, a broad spectrum of lesser peaks at 1050-1200 and 1350 Ma, and minor peaks at 2600-2750 Ma.

Samples from the Sørbreen (JB15-45) and Vassfaret (JB15-20) units of the Atomfjella Complex contained subround oscillatory zoned zircon with very thin CL-bright rims. Both samples define prominent peaks at ca. 1740, 1970 and 2750-2650 Ma and lesser peaks at 2500-2400, 3000-2900, and 3300-3100 Ma. The samples from the Polhem (JB15-10) and Bangenhuk (JB15-27) units exhibit a very similar pattern but with the most prominent peak at ca. 2000 Ma and the 2750-2650 Ma peak much smaller in both samples. Zircon from the Smutsbreen unit are round to subround with oscillatory zoning commonly truncated at the grain boundaries and overgrown by thin CL-bright rims. The sample displays peaks common to the Sørbreen and Vassfaret samples but also contain additional peaks at 1230 and 1460 Ma. The zircon characteristics and age distributions of a sample from the Rittervatnet unit of the Atomfjella Complex (JB15-38) are more similar to those from the Mosselhalvøya Group samples. The sample yielded subround to round, oscillatory zoned grains with no or very thin metamorphic rims. The Rittervatnet sample displays prominent peaks at 1450-1500, 1640 and 1780 Ma, with broad spectrum of lesser peaks at 1050-1200 and 1350 Ma, and minor peaks at 2600-2750 Ma.

The Multi-dimensional scaling (MDS) analyses were performed for the analysed sample suite. Three main groups of metasedimentary rocks can be observed. Two samples of metavolcanic rocks were also considered using MDS method and form a separate group of the results. Four samples from the Atomfjella Complex (JB15-10, JB15-20, JB15-27 and JB15-45) form Group I. Three samples in this group (JB15-10, JB15-27 and JB15-45) have very tight connection to each other, while JB15-20 is slightly distant. Three younger samples, including two samples from the Mosselhalvøya Group (JB15-14 and JB15-57) and one from the Atomfjella Complex (JB15-38), form very coherent Group II. This group has poor connection with metavolcanics rocks (JB15-03 and JB15-25). Group III containing the sample JB15-50 is located alone and has strong connection with Group I and poor connection with metavolcanic rocks.

Seven samples investigated using the SHRIMP IIe/MC (SIMS) method defined three metaplutonic groups with ages of ca. 1380Ma, 1750 Ma and 2000 Ma. The amphibolite JB15-29 from the Bangenhuk unit yielded concordant age ca. 1373 ± 3 Ma (MSWD = 1.9; n = 46). Concordant analyses from samples JB15-22 and JB15-24 from the Bangenhuk unit defined Concordia ages of 1753 ± 6 Ma (MSWD = 2.6; n = 17) and 1739 ± 7 Ma (MSWD = 2.7; n = 24), respectively. Samples JB15-47 from the Sørbreen unit and JB15-51 from the Instrumentberget unit exibited ages of 1743 ± 7 Ma (MSWD = 2.7; n = 13) and 1739 ± 7 Ma (MSWD = 2.1; n = 34), respectively. All of the late Paleoproterozoic samples yielded populations of euhedral, ocasionally subround, oscillatory zoned zircon. Two metaigneous samples collected from the tectonic window in the Polhem unit yielded subround, oscillatory zoned zircon grains with no or very thin metamorphic. Sample JB15-06 gave a linear array of analyses that defines upper and lower intercepts of 2019 ± 8 Ma and 469 ± 8 Ma, respectively (MSWD = 1.6; n = 48). The observed discordance is interpreted to reflect Pb-loss due to Silurian metamorphism. The population of concordant analyses gives a Concordia age of 2006 ± 8 Ma (MSWD = 1.8; n = 23), which is interpreted as the best estimate of the emplacement age for this sample. Discordant analyses from sample JB15-32 define a linear array with upper and lower intercepts of 2012 ± 13 Ma and 531 ± 72 Ma, respectively (MSWD = 2.5; n = 45). Concordant analyses define a Concordia age of 2000 ± 13 Ma (MSWD = 1.8; n = 21), which is again interpreted as the best estimate of the crystallization age for this sample. Similar Paleoproterozoic ages have not been previously documented in West Ny Friesland.

Geochemical and isotopic studies of mafic rocks

The performed geochemical characterization of amphibolites and ultramafic rocks showed that nearly all major elements (except Si and Fe) as well as LILE, have wide compositional ranges and no obvious trends (Bazarnik et al. 2021). It is conceivable that the Caledonian metamorphism may have affected K, Na and P, as well as LILE, and caused scatter of Al, Ti, Ca and Fe, and likely Si. The trace and REE elements plots are characterized mainly by trends that probably express the original magmatic processes. However, the elements that clearly deviate from these trends are disturbed due to either metamorphism or crustal assimilation. According to the Th/Yb vs Nb/Yb relationship, the studied rocks indicate generally low influence of crustal contamination, with only three samples in the field of MORB-OIB array. Besides the higher content of Mg and some other minor differences in chemical composition, the ultramafic rocks exhibit trends similar to that of amphibolites.

Reconstruction of the pressure-temperature conditions of metamorphic events

Petrographic and analytical data from metamorphic rocks of the Flåen Formation (Mosselhalvøya Group) and the Rittervatnet unit (Atomfjella Complex) indicate that both units experienced multi-stage metamorphism under similar pressure-temperature (P-T) conditions. Two stages of amphibolite facies metamorphism (M1 and M2) are clearly recorded by garnet and staurolite porphyroblasts, and garnet from both units shows pre- to syn-tectonic cores and syn-to post-tectonic overgrowths associated with the main external foliation. The results of thermodynamic phase equilibrium modelling indicate that peak M2 metamorphism occurred at ~7-7.5 kbar and 590-600 °C in both studied terranes. Rutile occurs both as inclusions in garnet (core-rim) and as grains in the matrix, and Zr-in-rutile trace element thermometry confirms the T estimates for M1 and M2 stages of metamorphism. Monazite Th-U-Pb dates obtained by electron microprobe from the Flåen Formation reflect a multistage garnet growth and define a 444.3 ± 6.7 Ma age for the M1 stage and 422.5 ± 6.3 Ma age for the M2 stage. In contrast, monazite dated in the Rittervatnet unit reveal an array of dates that give a weighted mean age of 420.1 ± 3.6 Ma, interpreted here as growth during the M2 stage. We suggest the M2 stage was coeval with a commencement of strike-slip motion along the Billefjorden Fault Zone, whereas the M1 stage reflects initial tectonic burial of the studied units.

Discussion.

The presented detrital zircon provenance analysis has a significant impact on understanding of the tectonostratigraphy of Ny-Friesland. The obtained spectra for the Mosselhavøya Group and the Rittervatnet unit (Group II) unexpectedly showed very high convergence and dependence that strongly suggest common source for all these rocks. This, in turn, poses a question about the presence of the major terrane boundary along the current western boundary of the Mosselhalvøya Group i.e. the Mosselhalvøya Thrust. Therefore, it seems reasonable to redefine the Mosselhalvøya Group as the uppermost part of the Atomfjella Complex. Noteworthy, similar pressure-temperature conditions and age of Caledonian metamorphism reported for the discussed two units support such merger. Furthermore, the lack of detrital zircon ages of ca. 980-950 Ma in the analyzed samples from the Mosselhalvøya Group makes a connection of these rocks with a crystalline basement of the Nordaustlandet terrane difficult. The latter commonly reveals such earliest Tonian peak of felsic magmatism (McClelland et al. 2019).

Hence, it is conceivable that the major terrane boundary between West Ny-Friesland and Nordaustlandet could be located indeed at the contact between the Mosselhalvøya and Veteranen groups as suggested by some previous studies (i.e. Eolussletta Shear Zone of Manby & Lyberis 1991, Lyberis & Manby 1993 or the Vetranen line of Harland et al. 1992) and not at Mosselhalvøya Thrust as proposed by Witt-Nilsson et al. (1998). Detrital zircon Group I of the West Ny-Friesland terrane and Mosselhalvøya Group has very tight connected with the Southwestern Basement Province (Gullichsenfjellet Formation, Höferpynten and Gåshamna formations of the Sofiebogen Group) as well as North-East Greenland (Inuiteq Sø Formation, Trekant Series, Zebra Series, Morænesø Formation and Portfjeld Formation), based on the MDS analyses. However, Group I has no analogues in analysed samples from the Scandinavian Caledonides.

Also, the similarities noticed earlier between Group II and the Brennevinsfjorden and Helvetesflya Groups (Eastern Province, Svalbard), Krossfjorden Group, Richarddalen Complex and Biscayarhuken Formation (Northwestern Province, Svalbard) as well as the St. Jonsfjorden Group, Eimfjellbreane Formation, Isbjørnhamna Group, and the Slyngfjellet , Konglomeratfjellet, and Kapp Berg formations (Southwestern Svalbard Basement Province) are confirmed by the close relationships in the MDS diagram. The Deilegga Group together with the Daudmannsodden plus Comfortlessbreen units, the Kapp Martin, Jens Erikfjellet and Dundrabeisen (Southwestern Province, Svalbard) formations form separate group but very close to Group II. The Group II results is also characterized by strong correlation with the Nathorst Land Group (Greenland), which forms also one group with the Lyell Land Group, Krummedal Supergroup (Greenland) and Pearya terrane (Group A, B and C). However, the connection with the latter is far more distant than with the Nathorst Land Group. Based on the MDS plot Group II and most of the samples from Scandinavia form one group. Especially the Svaerholt Succesion, Rimobäcken nappe, Fuda Nappe and Grapesvare, Pieljekaise, Lillviken and Rimobäcken nappes have strong connection with Group II. To this large group also belong Sørøy Succesion, Leksdal nappe, Sætra nappe, Särv Nappes (Sweden), Lower Seve Nappe and Särv Nappe (Norway), but their link to Group II is much weaker.

The Group III of the West Ny-Friesland terrane is well connected to some of the Southwestern Svalbard Basement Province: Skjerstranda Formation and Sørkapp Land based on the MDS plot. Also this Group has strong lines with samples from the Morænesø Formation and Trekant Series (Greenland). Additionally it has also weak connection with Portfjeld Formation (Greenland) as well. Moreover, the Dala Formation, Gargatis Nappe as well as the Laisvall Formation from the Scandinavia have strong correlation with Group III.

Also, based on the aforementioned similarity between the ultramafites and amphibolites and the confirmed influence of the Caledonian metamorphism on both groups of rocks, we speculate about the common history of them. Moreover, thanks to the identification of metamorphic alterations in ultramafic rocks it was proved that these rocks must be pre-Caledonian and, in turn, older than the alleged terrane boundary. Thus, the ultramafic bodies located close to the top of the Atomfjella Complex cannot mark the large terrane boundary and do not provide any evidence of a deeply rooted tectonic zone, but merely the result of ascension from deeper levels of the mantle.

The strong affiliation of the West Ny-Friesland terrane of Svalbard to Northeastern Greenland suggested by Bazarnik et al. (2019) finds inevitable support in the results obtained in the course of this study based on the both the provenance studies as well as metaigneous rocks dating. The metasedimentary rocks showed similar detrital zircon spectra to Northeastern Greenland. Also the ages of ca. 1380 Ma and 2000 Ma which have not been previously identified in igneous rocks occurring on Svalbard suggest similarity to Greenland – ca. 2000 Ma granitic rocks are known from the crystalline basement of North East Greenland (Kalsbeek et al. 1993, Kalsbeek et al., 2008b; Gilotti & McClelland, 2011). Felsic metavolcanic rocks of ca. 1740 Ma are well known from the Independence Fjord Group in Kronprins Christian Land in North Greenland (Kalsbeek et al., 1999), as well as the mafic rocks cutting them referred to as the Midsommersø Dolerites and dated to ca, 1380 Ma (Upton et al., 2005). The additional presence of ca. 2000 Ma age of felsic magmatism, documented in this work, adds the last missing puzzle piece in the correlation between the West Ny-Friesland terrane and the northern Northeast Greenland Caledonides.. It has been commonly proposed that the basement provinces of Svalbard have been attached to the Greenland (Laurentian) margin (e.g. Harland, 1997; Gee & Tebenkov, 2004; Michalski et al., 2012; Halverson et al., 2018). Based on some similarities of the Eleonore Bay Supergroup (Greenland) and the Lomfjorden and Murchisonfjorden supergroups (Nordaustlandet, Svalbard), such as e.g. Neoproterozoic tillite-bearing clastic sections and overlying Cambro-Ordovician carbonates in these two regions (Gee & Tebenkov, 2004; Gee et al., 2008; Malone et al., 2014) as well as the presence of Tonian metaigneous rocks (Gee & Tebenkov, 2004), the Eastern Svalbard Basement Province has been correlated to eastern Greenland (Harland, 1997; Hoffman et al., 2012; Halverson et al., 2018). However, the differences in the age of magmatism, namely 970-950 Ma in the Nordaustlandet terrane and 950-915 Ma in eastern Greenland suggest that the Nordaustlandet terrane did not originate just immediately adjacent to the latter (McClelland et al., 2019).

Based on both the textural features and analytical results, two metamorphic amphibolite-facies events are recorded in both the Flåen Formation of the Mosselhalvøya Group (Nordaustlandet terrane) and the Rittervatnet unit of the Atomfjella Complex (West Ny-Friesland terrane). The both units experienced M1 metamorphism at low amphibolite facies conditions of ~7 kbar and 545°C followed by another amphibolite facies M2 event at ~7.5-8 kbar and 600°C. The peak conditions of the M2 event were attained at ca. 0.5-1 kbar higher peak P with ca. 50°C higher peak T. The paragenetic assemblages and mineral chemistry indicate that a period of relaxation occurred between peak M1 and M2 events, but temperature conditions likely did not drop significantly. This observation supports calculation of M2 metamorphic conditions based on the chemistry of garnet-II and muscovite and plagioclase in the matrix, whereas the M1 conditions have been deduced based only on garnet-I and the inclusion assemblage within it.

Previous geochronological studies performed in the study area provided a wide range of metamorphic ages between ca. 447¬416 Ma that are generally interpreted to reflect the timing of peak metamorphism or cooling after this peak (Gayer et al. 1966, Ohta et al. 1989, Gee & Page 1994). However, Lyberis & Manby (1999) suggested that peak metamorphism was attained at ca. 444-430 Ma and later shearing processes happened at ca. 410 Ma. The ages obtained in this study support the scenario proposed by Lyberis & Manby (1999), but as outlined above, we suggest that the maximum metamorphic P-T conditions were reached during the M2 event. The older age of ca. 444.3 ± 6.7 Ma yielded by the inner zone of monazite crystals in sample KK13-2 is inferred to reflect garnet growth during M1 metamorphism. The younger monazite population that provided an age of ca. 422.5 ± 6.3 Ma is assigned to garnet growth during M2 metamorphism. Linking monazite nucleation and growth of garnet is supported by the fact that both generations of monazite are relatively Y-poor, which can be explained by sequestration of Y in garnet. However, the monazite-in isograd in typical pelites broadly coincides with the staurolite-in isograd (e.g. Spear 2010), which is a garnet-consuming reaction. Hence, it is suggested that monazite growth commences slightly before or coevally with the staurolite-in reaction, while the low-Y character of monazite attests to the preceding presence of garnet.

Conclusions

Based on the geochronologic, petrological and geochrmical research conducted in the course of this thesis the following main conclusions can be formulated:

1) Based on both petrochronological studies of metamorphism, as well as the analysis of the provenance of meta-sedimentary rocks, it was found that the Mosselhalvøya Group should be included in the Atomfjella Complex and the West Ny-Friesland terrane, and not, as previously thought, the Lomfjorden Supergroup and Nordaustlandet terrane,
2) The terrane border should be moved from the previously established line on the Mosselhalvøy Trust to the east, to the border between the Mosselhalvøya Group and the Veterranen Group (Lomfjorden Supergroup), where the Eolusslett Shear Zone exhibits (also known as the Veterranen line). This conclusion is also supported by the results of geochemical observations and the analysis of ultramafic rocks and amphibolites, as a result of which manifestations of metamorphism were found in both types of rocks. Thus, the theory of genesis about the implementation of ultramafic rocks during the activation of a deep tectonic split in the compression regime was refuted, which was to prove the presence of a large-scale tectonic zone.
3) As a result of comparative studies of the provenance of detritic zircons from the West Ny-Friesland terrane with other regions of the Caledonian orogen within the Arctic, and by analyzing the obtained dates of magmatism episodes in this region, a very close relationship between the rocks of the West Ny-Friesland terrane and the sequences of the north-eastern Greenland, which makes it possible to infer the common origin of these two units. Therefore, the palaeogeographic configuration of this part of the Arctic in the Proterozoic requires a fundamental change.