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2.1. Tectonic and lithology

Tectonic development

The Svalbard Archipelago, with Spitsbergen as its largest island, is located in the north-western margin of the Barents Sea Shelf. The geotectonic development of Svalbard proceeded in a series of phases that are evidenced in the main structural levels, distinguished by Ohta *et al.* (1989):

1) formation of Palaeoproterozoic and Lower Sylurian bedrock of Svalbard, the so-called 'Hecla Hoek' Succession (Hoel 1918, 1929; Orvin 1934, 1940)
2) relatively stable evolution of Carboniferous–Mesozoic platform,
3) formation of the western Spitsbergen fold-and-thrust belt and related grabens in the Upper Mesozoic and Caenozoic Eras (Fig. 2.1.1).

The Precambrian and Lower Palaeozoic Hecla Hoek series underwent an extremely complex tectonic evolution, due to the long and multiphase history of the Caledonian orogeny. Harland & Wright (1979) were the first scientists to distinguish three main tectonic units: eastern, central and western terranes. The detailed description of individual terranes was given by Harland (1985, 1997), who differentiated additional subterranes within complex units. Krasil'shchikov (1979) and Birkenmajer (1981) proposed dividing the Caledonian bedrock into four terranes. Otha *et al.* (1989) presented quite a different view, as they distinguished only two terranes in the Caledonian bedrock of Svalbard. The north-western part of the Wedel Jarlsberg Land lies within the western terrane (Harland & Wright 1979).

The age of tectonic deformations of the Prevendian rocks in allochthonous structural units cannot be clearly defined. Tectonic events, which are known to have occurred at the western terrane (the Wedel Jarlsberg Land) presumably during the Prevendian Era, were described by Birkenmajer (1975) as Torellian and Werenskioldian phases.

The reconstruction of the location of Svalbard terranes and their correlation in the Vendian Period seems much easier and much more credible. At least two global-scale glacial episodes (Harland 1997; Hoffman *et al.* 1998), marked by levels of phyllites, prove that the distinguished terranes were part of structural units of one supercontinent – Laurentia.

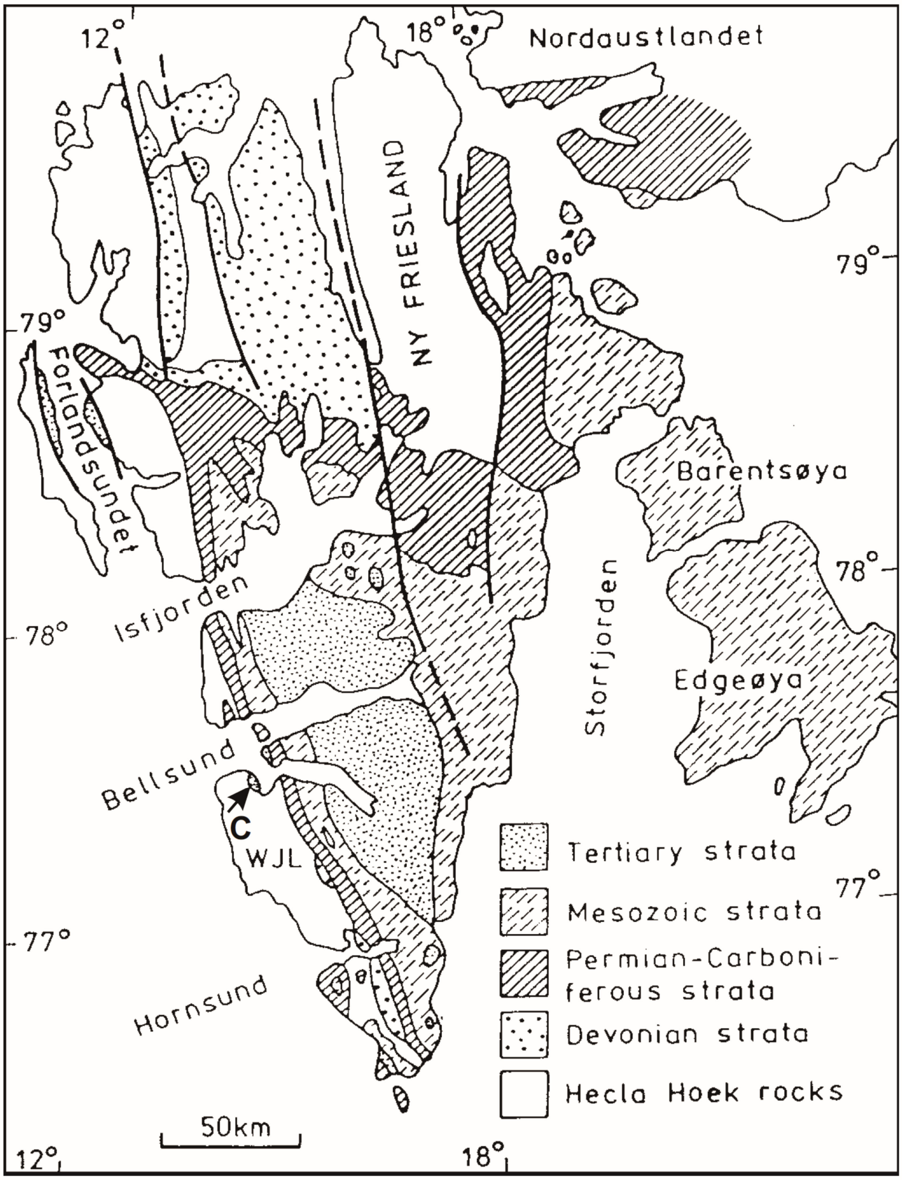

Fig. 2.1.1. Simplified geological map of Svalbard (after: Birkenmajer & Zastawniak 2005): C- Calypsostranda (Bellsund), WJL- Wedel Jarlsberg Land.

The Upper Vendian Period of the Iapetus seafloor spreading within the western terrane (the Wedel Jarlsberg Land) was characterised by fast subsidence and related volcanic phenomena (Harland 1997).

The next stage covers Cambrian and Ordovician Periods showing relatively calm tectonic activity for the western Svalbard terrane. Birkenmajer (1975, 1991) distinguishes at least two tectonic episodes in this part of Spitsbergen: Jarlsbergian and Hornsundian diastrophisms resulting in folding deformations in older rocks and in local metamorphisms, as well as uneven elevation of a part of the region, especially at the south. The presence of slightly metamorphic rocks in the Wedel Jarlsberg Land indicates limited spatial movements of the Earth crust.

The end of the Ordovician Era saw the intensification of the tectogenetic processes connected with the Caledonian orogeny reaching its climax in the Silurian Period. The western terrane was associated with the subduction zone, which is evidenced by the tectonically disturbed sequence of sedimentation from that period (e.g. Ohta *et al.* 1986). The Caledonian orogenic movements in this region were induced by the Laurentia-Baltica collision, which resulted in the closure of the Iapetus Ocean. The movements were accompanied by intensive metamorphic, volcanic and plutonic phenomena (granite plutonism, magmatism, gneiss magmatism) (Birkenmajer 1975).

The Caledonian movements in the Devonian Period were of non-continuous nature (Gee *et al.* 1992; Harland 1997). The intensification of folding occurred in several phases, intertwined by relatively calm tectonic periods of increased denudation of elevated areas, whereas folds accumulation was controlled by the presence of structurally preconditioned sedimentation basins. Caledonian folding, resulting in the final unification of separate terranes, terminated in the Devonian Period and conditioned the increased denudation and erosion of the folded elevated area and intensive sedimentation in intermontane basins.

Intensive tectonic phenomena were only observed at Spitsbergen after a relatively stable geological period lasting from Carboniferous through Cretaceous Epochs. As a tectonic collage, Spitsbergen evolved from the tectonically dynamic orogenic area to a stable, platform-type sedimentary setting of the Barents Shelf (Harland 1997). Apart from a great eustatic transgression of sea level, having its climax in the Albian age, the Cretaceous at Spitsbergen was also marked by intensive volcanic activity stemming from opening of the Atlantic.

The displacement of Greenland towards the north in the Upper Palaeocene led to its collision with Spitsbergen and moving Spitsbergen to the southern east. That resulted in the creation of the thrust-and-fold belt at the western Spitsbergen, in the period from the Upper Palaeocene through the Upper Eocene. That 300 km long and 100 km wide orogene with the NNW-SSE orientation is a truly unique formation, as it was formed outside the main world orogenic zones. The evolution of the northern part of the Atlantic Ocean in the Upper Tertiary Period brought elevation of the north-western margin of the European Shelf. Due to the Tertiary tectonic activity in the north-western part of the Wedel Jarlsberg Land (WJL), grabens (e.g. Calypsostranda) and a series of tectonic discontinuities within the Caledonian bedrock units were formed.

Main tectonic units and lithology of WJL

A major part of the analysed area represents old Caledonian tectonic formations that were renewed or reconstructed as a result of Tertiary tectonic activity (Dallmann *et al.* 1990; Birkenmajer 2004, 2006, 2010) (Fig. 2.1.1). Palaeogenetic tectonic movements brought new tectonic discontinuities or renewed old fault zones. In the north-western part of the Wedel Jarlsberg Land several main fault systems can be distinguished, e.g. (Fig. 2.1.2A):

1) main Recherchebreen strike-slip fault discontinuity zone,
2) a group of Crammerbreane and Josephbukta dip-slip faults,
3) Maria-Theresiatoppen strike-slip faults
4) NW-SE-trending Calypsostranda dip-slip fault.

Palaeogenetic tectonics and its fault systems make it possible to differentiate the following tectonic units in the analysed area (Dallmann *et al.* 1990; Birkenmajer 2004, 2006, 2010) (Fig. 2.1.2A):

1) Renardbreen Block (RB) made up of the Middle and Upper Proterozoic rocks, enclosed by the system of Crammerbreane, Josephbukta and Calypsostranda faults from the east, and separated from the monocline Gåshamna formation rocks by the Dunderdalen thrust fault from the south;

2) Chamberlindalen Block (ChB) made up of the Upper Proterozoic rocks, lying between the system of Crammerbreane, Josephbukta and Calypsostranda faults at the west and the left-oriented Recherchebreen strike-slip fault at the east;

3) open tectonic Calypsostranda Graben (CG), filled with Upper Palaeogenetic clastic sedimentary rocks, separated from the Renardbreen block by the Calypsostranda fault and two parallel discontinuities, defined by Dallmann (1989) and later on by Birkenmajer (2006, 2010) as normal gravitation-slip faults lying to the west from the Calypsostranda fault, between the Scottelva and Bohlinryggen Peak;

4) Martinfjella Block (MB), is enclosed to the east by two submeridional strike-slip left-lateral faults: the Recherchebreen Fault in the west, and the Antoniabreen Fault in the east (Birkenmajer 2004). They build him a massive quartzites and dolomites and carbonate rocks and phyllites folded during the Caledonian orogeny. In addition Caledonian tectonic involvement of the block within it there is a wide minor discontinuities, which run generally perpendicular or oblique (generally the direction EW, NE-SW) to the left-oriented Recherchebreen and Antoniabreen strike-slip faults;

5) Block Reinodden distributed unit Tertiary tectonic Maria-Theresiatoppen Faults of an strike-slip character and direction of ENE-WSW (Dallmann 1989; Dallmann *et al.* 1990). A small block of rock formed post Caledonian rocks (from the Carboniferous to the lower Cretaceous).

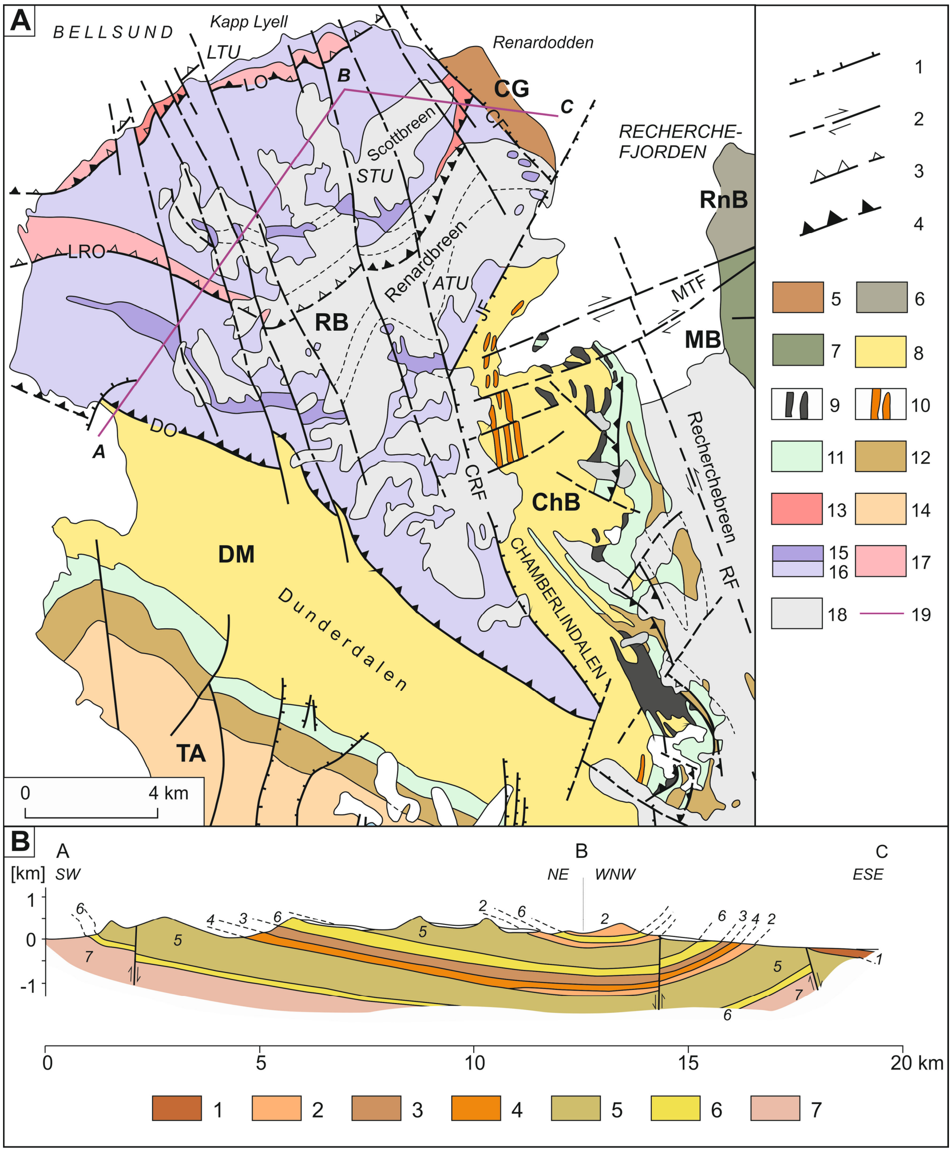

Fig. 2.1.2. A- selected tectonic/structural elements in the Renardbreen and Chamberlindalen blocks. Based on reinterpretation of geological map 1:100,000, sheet Van Keulenfjorden (Dallmann *et al.* 1990, supplemented by Birkenmajer 2004): 1- Tertiary dip-slip faults, 2- Tertiary strike-slip faults, 3- minor Caledonian overthrusts, 4- major Caledonian overthrusts, 5- Tertiary deposits (Calypsostranda Graben), 6- Reinodden Block (Carboniferous-Mesozoic platform cover), 7- Martinfjella Block (Late Proterozoic-Early Ordovician rocks), 8- Gåshamna Fm. (phyllites and chlorite schists), 9- selected stratabound mafic rocks (and ?Mesozoic dolerites) within the Gåshamna Fm., 10- intercalations within the Gåshamna Fm. (quartzite, limestone, dolostone), 11- Höferpynten Fm., 12- Slyngfjellet Fm., 13- ?Bergskardet Fm. (Deilegga Gp., Middle Proterozoic), 14- rocks of the Thiisfjellet anticlinorium (Middle Proterozoic), 15- Kapp Lyell diamictite – upper: *green*, 16- Kapp Lyell diamictite – lower: *yellow*, 17- Bergskardet Fm. (Deilegga Gp., Middle Proterozoic), 18- glaciers, 19- line of geological section. Major tectonic elements: ChB- Chamberlindalen Block (mainly Late Proterozoic rocks), CG- Calypsostranda Graben (Tertiary coal – bearing deposits), DM- Dunderdalen Monocline (Late Proterozoic metasediments), MB- Martinfjella Block (Late Proterozoic-Early Ordovician metasediments), RB- Renardbreen Block (Middle-Late Proterozoic metasediments), RnB- Reinodden Block (Late Palaeozoic-Mesozoic deposits), TA- Thiisfjellet Anticlinorium (Middle Proterozoic). Overthrusts (Caledonian) and faults (mainly

The **Renardbreen Block (RB)** consists of Proterozoic rocks of Deilegga (Bergskardet Fm.) and Sofiebogen (Kapp Lyell Fm.) Groups (Fig. 2.1.2AB). Within the Renardbreen block, three overthrust tectonic units, controlled by the Caledonian orogenic activity, were distinguished (Birkenmajer 2002, 2004, 2010). The lowest unit, Activekammen, is a form of an anticline made of diamictite rocks that are greenish at the core and yellow at their external strata (Figs. 2.1.2B and 2.1.3). Diamictites are mostly represented by metamorphic glacigenic sediments, connected with Precambrian glacial episode Varanger (Photo 2.1.1AB). These sediments are estimated to have the thickness of more than 2,000 m (Dallmann *et al.* 1990; Birkenmajer 2004, 2010). From the south, the unit is enclosed by the Dunderdalen overthrust and from the north – by the Lognedalen-Renardbreen overthrust. A higher-lying tectonic group is the Scottbreen unit. Both units were formed as an anticline, inclined to the south-east. The Scottbreen unit is also made up of diamictites: green at the core and yellow in their external strata, and finally turning into dark grey, as well as of tectonically active phyllites of the Logne Fm. (Harland 1997) or Bergskardet Fm. (Birkenmajer 2004, 2010).

Tectonic units of the Renardbreen Block lie on the monocline quartz (phyllite) and carbonate schists of the Gåshamna formation, revealed in the Dunderdalen (Birkenmajer 2004)(Photo 2.1.1C).

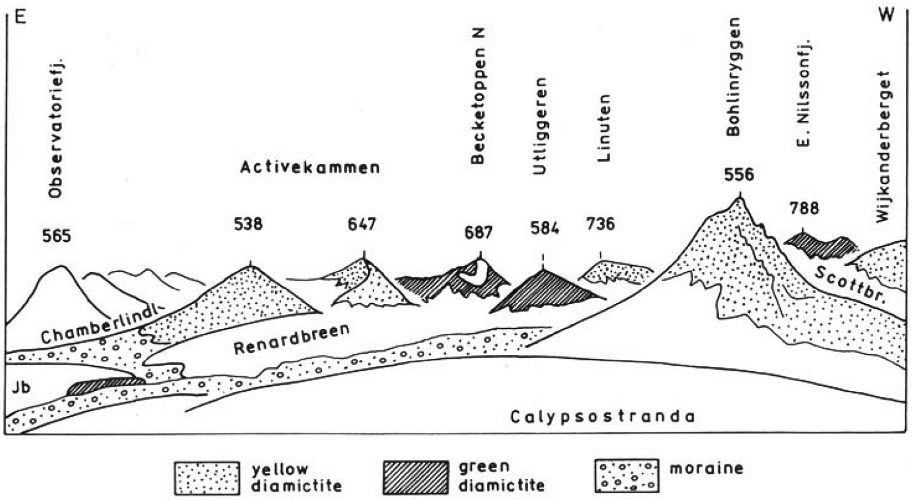

Fig. 2.1.3. Perspective view from Calypsostranda over mountain area around Renardbreen and Scottbreen, showing distribution of yellow and green diamictite units, Kapp Lyell Fm. (Birkenmajer 2004, 2010).

Tertiary): DO- Dunderfjellet Overthrust, LO- Lyellstranda Overthrust, LRO- Lognedalen-Renardbreen Overthrust, CF- Calypsostranda Fault, CrF- Crammerbreane Fault, MTF- Maria-Theresiatoppen Faults.
B- geological cross-section A-B-C of the Renardbreen syncline (Dallmann *et al.* 1990): Van Mijenfjorden Gp. (Paleogene): Calypsostranda Gp.: 1- Renardodden Fm. (Late Palaeogene); Kapp Lyell Gp. (Upper Proterozoic): 2- diamictites, mainly with dolomite clasts, 3- phyllites, 4- diamictites, mainly with limestone clasts, 5- diamictites, mainly with quartzite clasts, 6- diamictites, mainly with dolomite and quartzite clasts, 7- phyllites.

Photo 2.1.1. A- erratic on the Renardbreen forefield built with diamictite of Kapp Lyell Fm. (Photo Ł. Franczak 2011), B- diamictite Kapp Lyell Fm. near Klokkefjellshytta (Photo G. Gajek 2011), C- phyllite and carbonate schists of the Gåshamna Fm. – Dunderbukta (Photo P. Zagórski 2012).

The Scottbreen unit is closed from the north by the Lyellstranda overthrust. To the north of the overthrust, a separate, highest unit of the Renardbreen block can be distinguished. The unit, called Lyellstranda, is made up of polygenic metamorphosed glacial sediments. The above units represent large-scale Caledonian tectonic movements in the form of horizontal displacement of solid rock masses from the north-western direction. The area of Caledonian thrusts of the Renardbreen Block is enclosed on the east by Tertiary Calypsostranda fault zones.

Apart from Caledonian tectonic activity, the Renardbreen Block has a series of secondary tectonic discontinuities of longitudinal character (parallel to the Recherchebreen fault – RF). Birkenmajer (2004, 2006, 2010) distinguishes at least five discontinuities. Although these faults should not be connected with the bulge area of Recherchebreen, their age can certainly be attributed to the Tertiary tectonic transformations (Fig. 2.1.2AB).

The **Chamberlindalen Block** (ChB) is yet another tectonic unit in the analysed area, which is made up entirely of Upper Proterozoic rocks of the Sofiebogen Group (Fig. 2.1.2A, Photos 2.1.2AB and 2.1.3A). According to Birkenmajer (2002), these rocks make an anticline or a fold dip that is inclined to the east, i.e. the so-called Chamberlindalen fold (CRF) (Bjørnerud 1990; Dallmann *et al.* 1990, 1993; Birkenmajer 2004). The core of the anticline is made up of Slyngfjellet Fm. metaconglomerates turning into Höferpynten Fm. dolomites in their dips, and enriched with interstratified Gåshamna effusive rocks. The diverse character of the Chamberlindalen block is definitely a result of the Caledonian orogenic activity. It might have also been affected by the Tertiary tectonic activity, visible in the arrangement of quartzes of the Gåshamna Fm. in the north-western block margin (Dallmann *et al.* 1990; Birkenmajer 2004, 2006), which indicates a dextrorotary movement of the unit by ca. 45° (from NNW-SSE to ca. NE-SW) at the crossing of the Josephbukta and Crammerbreane discontinuities. The Caledonian units are sheared from the east by the Recherchebreen zone that was active also in the Palaeogene.

Photo 2.1.2. Structural elements in relief of Chamberlindalen (Chamberlindalen Block) (Photo P. Zagórski 2006).

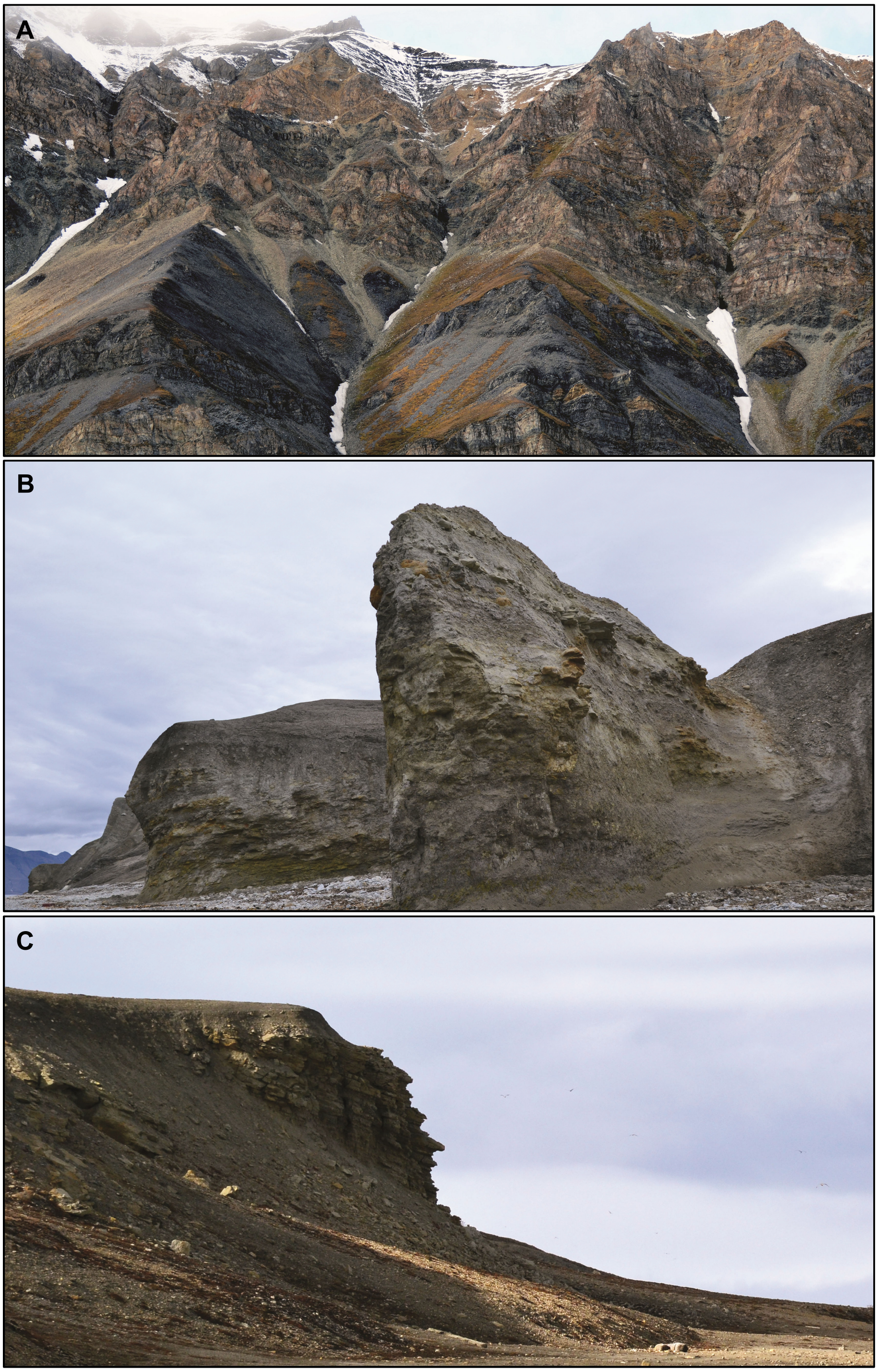

Photo 2.1.3. A- Höferpynten Fm. dolomites build Observatoriefjellet (Photo P. Zagórski 2011), B- Tertiary clastic deposits filling the Calypsostranda Graben – cliff in Skilvika (Photo G. Gajek 2011), C- dead cliff of Calypsostranda composed of Tertiary clastic sediments filling the Calypsostrandy Graben (Photo G. Gajek 2011).

One of the most interesting tectonic units of the north-western part of the Wedel Jarlsberg Land is the **Calypsostranda Graben** (CG) (Fig. 2.1.2AB) The 1.5 km wide and 6 km long graben is filled with clastic Tertiary sediments of the minimum thickness of 250 m and is enclosed from the west by the dip-slip Calypsostranda fault (CF) and a group of gravity NW-SE faults, and by the Josephbukta fault (JF) from the south (Birkenmajer & Gmur 2010). Its northern and north-eastern borders have not been marked precisely, as they run on the Bellsund and Recherchefjorden bed (Fig. 2.1.2A).

The sediments of the Calypsostranda Graben consist of three formations. The Rochesterpynten Fm. is constituted by a tectonic and sedimentary mixture, with big blocks of metadiamictites of the metamorphic Kapp Lyell Fm. as the main element. The mixture was formed as a result of mass movements of weathered material that occurred during the Tertiary tectonic activity. The formation is complemented by sandstone-type rocks that might be a result of intensive erosion of Precambrian rocks in the fault zone along the Skilvika-Josephbukta line (Dallmann 1989; Birkenmajer 2006; Birkenmajer & Gmur 2010). The Skilvika Fm. is made up of silicites with numerous Tertiary fossils (mainly shells) and loose (low-compacted) sandstones with hard coal banks and pebbles and plant remains (Photo 2.1.3BC). The thickness of this rock sequence is ca. 110-120 m. The highest unit of the Tertiary Calypsostranda Group is the Renardodden Fm., investigated to the greatest extent. The formation is represented by (ca. 220 m) thick, mainly grey and light yellow, sandstones with hard coal remains and few local sandstone pebbles, sometimes reaching greater dimensions (diameter of ca. 2 m, field observation). The sandstone banks are often separated by layers of ferruginous concretions.

The Tertiary sediments of Calypsostranda were the subject of interest of an English mining firm, The Northern Exploration Company Ltd. (NEC), that conducted hard coal mining works at the beginning of the 20th century. Harsh climate and low profitability of the investment contributed to the fast demise of the Calypsobyen mine.

The age of the Calypsostranda Group sediments cannot be clearly defined. Livshits (1974) assesses the age of Skilvika and Renardodden Fms. as Upper Eocene/ Lower Oligocene, whereas Birkenmajer & Gmur (2010) date the sediments to the Upper Palaeogene.

The plant remains in the clastic sediments and hard coal strata (Schweitzer 1974; Lehmann *et al.* 1978; Thiedig *et al.* 1979; Birkenmajer & Gmur 2010) indicate the Upper Eocene or Lower Oligocene age of the graben sedimentation. The age of the form can thus be attributed to the Tertiary tectonic deformations within the bedrock, yet the precise mechanism of graben formation has not so far been discovered. The formation of the Calypsostranda Graben may be connected with the evolution of the Bellsund-Forlandsundet Grabens zone. Seismic testing (Blinova *et al.* 2009) conducted in the region suggests that the grabens may be of similar age as the Calypsostranda Graben. Accumulation that started within the grabens dates back to the Eocene, and the forms are considered to be pull-apart basins, created along the fault zone in the Upper Eocene during local dextrorotary compression and later elongation of the seabed in the area of Hornsund discontinuities, as well as during evolution of thrust-and-fold belt in the western Spitsbergen.

Late Proterozoic rocks build up **Martinfjella Block** (MB) located east from Recherchefjorden, bounded by Recherchebreen fault (RF) and Antoniabreen fault (AF) (Dallmann *et al.* 1990; Birkenmajer 2004) (Figs. 2.1.2A and 2.1.4). Rocks cropping out on Martinfjella range are classified by few researchers to the Middle Proterozoic Magnethøgda Sequence and are cut by numerous W-E striking fault zones and thrust-fronts (Flood *et al.* 1971; Dallmann *et al.* 1990). In the study area several formations can be distinguish: Gåshamna Fm. (phyllites with quartzite intercalations), Höferpynten Fm. (dolostones), Gnålberget Fm. (bluish to whitish, grey-yellow weathered, usually strongly foliated limestone/marble Wiederfjellet (dolomitic quartzites), Jarnbekken (reddish and yellow-red weathered ore-bearing dolostones), Luciapynten – massive greenish to bluish dolostones) (Birkenmajer 2002, 2004) (Photo 2.1.4AB).

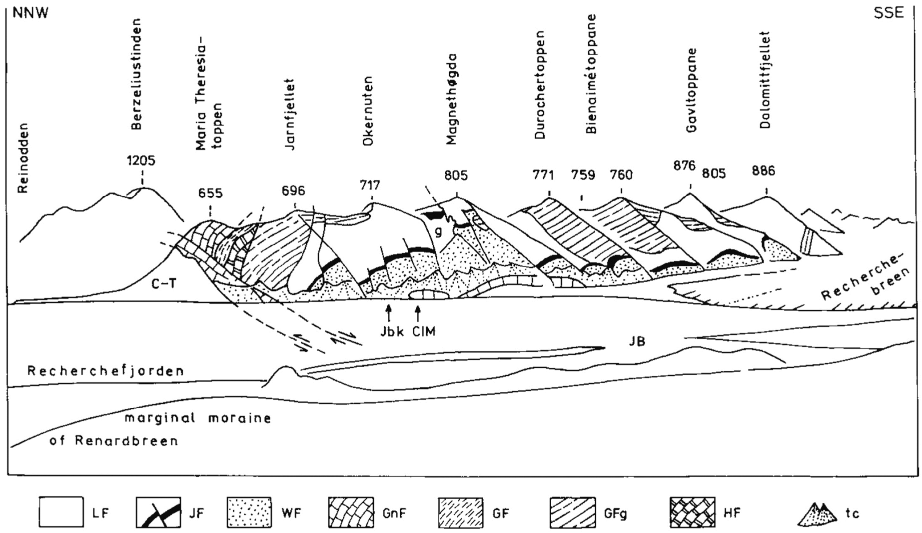

Fig. 2.1.4. Geological panorama of Martinfjella, as seen from left marginal moraine of Renardbreen (after: Birkenmajer 2002, 2004). Martinfjella Block: LF- Luciapynten Fm., JF- Jarnbekken Fm., WF- Wiederfjellet Fm., GnF- Gnålberget Fm., GF- Gåshamna Fm., GFg- Gåshamna Fm., Aldegondaberget Mbr (= migmatite-bearing Gåshamna Fm. in Birkenmajer 2002); HF- Höferpynten Fm., tc- talus cones, C-T- Carboniferous through Triassic strata, Jbk- Jarnbekken (type locality of the Jarnbekken Fm.), CIM- 'Camp Iron Mountain' (see Dallmann *et al.* 1990), JB- Josephbukta, main Tertiary strike-slip faults marked.

The boundary between two tectonics units: Martinfjella Block to the south and **Reinodden Block** (RnB) to the North is formed by two Tertiary Maria-Theresiatoppen Faults (striking ENE-WSW) (Figs. 2.1.2A and 2.1.4). The Reinodden Block is consist of by continuous sequence of rock from Lower Carboniferous to Lower Cretaceous comprising the Orustdalen Fm. (conglomerates, sandstones, quartzites with intercalations of intrusives) as well as representatives of all major geological units of Svalbard including: Gipsdalen Grup (marine shelf carbonates with evaporite intercalations), Tempelfjorden Grup (siliceous (spiculitic) shales, siltstones and cherts with intercalated minor sandstones and limestones), Sassendalen Grup (Mesozoic, shales and siltstones with subordinate sandstones passing upwards into very organic-rich and phosphatic strata), Kapp Toscana Grup (shales, siltstones and sandstones) i Adventdalen Grup (shales, siltstones and sandstones of Late Jurassic to Early Cretaceous age) (Dallmann *et al.* 1990).

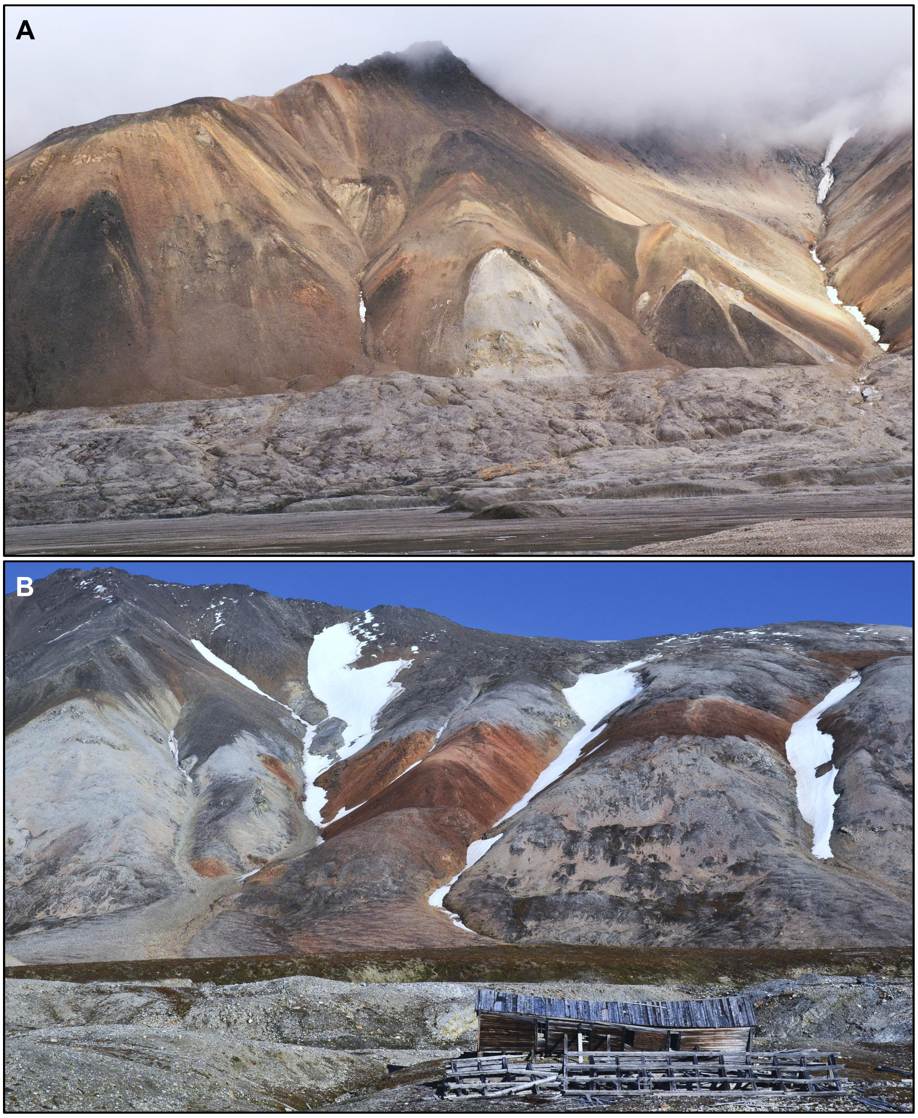

Photo 2.1.4. A- lithological variation of Martinfjella Block – Magnethøgda slope (Photo G. Gajek 2011), B- lithological variations Martinfjella Block, seen on the Jarnfjellet slopes – 'Camp Iron Mountain' (Photo: G. Gajek 2011).

Streszczenie

Tektonika i litologia

Archipelag Svalbard, z jego największą wyspą Spitsbergenem, położony jest w północno-zachodnim narożu szelfu Morza Barentsa. Rozwój geotektoniczny Svalbardu obejmuje szereg etapów, wyrazem których są główne piętra strukturalne:

1) etap tworzenia się podłoża paleoproterozoiczno-wczesnosylurskiego Svalbardu – tzw. sukcesję Hecla Hoek,
2) etap w miarę stabilnego rozwoju platformy karbońsko-mezozoicznej,
3) etap powstania późnomezozoiczno-kenozoicznego, zachodniospitsbergeńskiego pasa fałdowego oraz towarzyszących mu rowów tektonicznych.

Rozwój geologiczny prekambryjsko-staropaleozoicznej serii Hecla Hoek był bardzo skomplikowany. Wynika to z długotrwałej i wielofazowej historii orogenezy kaledońskiej.

Początek kaledońskim ruchom górotwórczym dała w tym obszarze kolizja Laurentii i Baltiki. Nastąpiło zamykanie się tektonicznego szwu Oceanu Iapetus. Ruchom tym towarzyszyły nasilające się zjawiska metamorficzne, wulkaniczne oraz plutoniczne, (plutonizm granitowy, magmatyzm, metamorfizm gnejsowy). Kolejne intensywne zjawiska tektoniczne nawiedziły Spitsbergen dopiero po względnie stabilnym geologicznie okresie trwającym od karbonu po kredę.

W późnym paleocenie północny kierunek przemieszczania się Grenlandii powoduje kolizję ze Spitsbergenem oraz „zrzucenie" go na południowy-wschód. Efektem tych ruchów jest powstanie zachodniospitsbergeńskiego pasa fałdowego datowanego od późnego paleocenu po późny eocen. Ten długi na 300 i szeroki na 100 km orogen o kierunku NNW-SSE jest wyjątkowy, gdyż powstał poza głównymi strefami orogenicznymi świata. Wraz z rozwojem północnej części Oceanu Atlantyckiego w późnym trzeciorzędzie nastąpiło dźwiganie północno-zachodniego rogu szelfu europejskiego. Trzeciorzędowa aktywność tektoniczna w północno-zachodniej części Ziemi Wedela Jarlsberga doprowadziła do powstania grabenów (m.in. Calypsostrandy) oraz szeregu nieciągłości tektonicznych w obrębie jednostek podłoża kaledońskiego.

Zdecydowana większość obszaru objętego opracowaniem pozostaje w obrębie starych, kaledońskich formacji tektonicznych, odnowionych i remodelowanych w czasie trzeciorzędowej aktywności tektonicznej.

Największą jednostkę tektoniczną w obrębie opisywanego obszaru – Blok Renardbreen – budują głównie częściowo zmetamorfizowane diamiktyty wieku proterozicznego, które od wschodu, w obrębie Calypsostrandy, graniczą z trzeciorzędowymi osadami klastycznymi wypełniającymi rów tektoniczny. Na wschód od nieciągłości Recherchebreen wychodnie masywnych kwarcytów i dolomitów oraz skały węglanowe i fyllity tworzą blok Martinfjella. Na północ, w obrębie niewielkiego bloku Reinodden, rejestrowane są wychodnie osadów postkaledońskich (od karbonu po dolną kredę).

Objaśnienia

Ryciny

Ryc. 2.1.1. Uproszczona mapa geologiczna Svalbardu (Birkenmajer, Zastawniak 2005): C- Calypsostranda (Bellsund), WJL- Wedel Jarlsberg Land.

Ryc. 2.1.2. A: Wybrane tektoniczno-strukturalne elementy bloków Renardbreen i Chamberlindalen, w oparciu o interpretację mapy geologicznej 1:100000, arkusz Van Keulenfjorden

(Dallmann *et al.* 1990, uzupełnione przez Birkenmajera 2004, zmieniony przez Bartoszewskiego i in. 2004): 1- trzeciorzędowe uskoki zrzutowe, 2- trzeciorzędowe uskoki przesuwcze, 3- podrzędne nasunięcia kaledońskie, 4- główne nasunięcia kaledońskie, 5- osady trzeciorzędowe (rów Calypsostrandy), 6- blok Reinodden (pokrywy karbońsko-mezozoiczne), 7- blok Martinfjella (skały późnego proterozoiku i wczesnego ordowiku), 8- formacja Gåshamna (fyllity, chlorytowe łupki), 9- intruzje skał magmowych (i mezozoicznych (?) dolerytów) wewnątrz formacji Gåshamna, 10- wtrącenia kwarcytowe, wapienne i dolomitowe wewnątrz formacji Gåshamna, 11- formacja Höferpynten, 12- formacja Slyngfjellet, 13- formacja Bergskardet (?), (grupa Deilegga, środkowy proterozoik), 14- skały antyklinorium Thiisfjellet (środkowy proterozoik), 15- diamiktyty górne – zielone formacji Kapp Lyell, 16- diamiktyty dolne – żółte formacji Kapp Lyell, 17- formacja Bergskardet (grupa Deilegga, środkowy proterozoik), 18- lodowce, 19- linia przekroju geologicznego. Główne elementy tektoniki: ChB- blok Chamberlindalen (głównie skały późnego protrerozoiku), CG- rów Calypsostrandy (trzeciorzędowy osady węglonośne), DM- monoklina Dunderdalen (skały metaosadowe późnego proterozoiku), MB- blok Martinfjella (skały metaosadowe późnego proterozoiku i wczesnego ordowiku), RB- blok Renardbreen (skały metaosadowe środkowego i późnego proterozoiku, RnB- blok Reinodden (osady późnego paleozoiku i mezozoiku), TA- antyklinorium Thiisfjellet (skały środkowego proterozoiku). Nasunięcia (kaledońskie) i uskoki (głównie trzeciorzędowe): DO- nasunięcie Dunderfjellet, LO- nasunięcie Lyellstrandy, LRO- nasunięcie Lognedalen-Renardbreen, CF- uskok Calypsostrandy, CrF- uskok Crammerbreane, JF- uskok Josephbukty, MTF- uskoki Maria Theresiatoppen.

B: Przekrój geologiczny (A-B-C) przez synklinę Renardbreen (Dallman et al. 1990): Grupa Van Mijenfjorden (paleogen): grupa Calypsostrandy: 1- formacja Renardodden (późny paleogen); Grupa Kapp Lyell (górny proterozoik): 2- diamiktyty, głównie z klastami dolomitowymi, 3- fyllity, 4- diamiktyty, głównie z klastami wapiennymi, 5- diamiktyty, głównie z klastami kwarcowymi, 6- diamiktyty, głównie z klastami dolomitowymi i kwarcowymi; Grupa Dunderbukta i Recherchefjorden (górny proterozoik): 7- fyllity.

Ryc. 2.1.3. Widok perspektywiczny z Calypsostrandy na grzbiety otaczające Renardbreen i Scottbreen pokazujący rozmieszczenie żółtych i zielonych diamiktytów formacji Kapp Kyell (Birkenmajer 2004).

Ryc. 2.1.4. Panorama geologiczna Martinfjella widoczna z lewej moreny marginalnej Renardbreen (Birkenmajer 2002, 2004). Blok Martinfjella: LF- formacja Luciapynten, JF- formacja Jarnbekken, WF- formacja Wiederfjellet, GnF- formacja Gnålberget, GF- formacja Gåshamna, GFg- formacja Gåshamna, jednostka Aldegondaberget z migmatytami, formacja Gåshamna, wg Birkenmajera 2002); HF- formacja Höferpynten, tc- stożki usypiskowe, C-T- warstwy karbonu z triasowymi, Jbk- Jarnbekken (stanowisko formacji Jarnbekken), CIM- „Camp Iron Mountain" (Dallmann i in. 1990), JB- Josephbukta, zaznaczono główne trzeciorzędowe uskoki przesuwcze.

Fotografie

Fot. 2.1.1. A- głaz narzutowy na przedpolu Renardbreen zbudowany z diamiktytów formacji Kapp Lyell (fot. Ł. Franczak 2011), B- diamiktyty formacji Kapp Lyell w okolicach Klokkefjellshytta (fot. G. Gajek 2011), C- fyllity i łupki węglanowe formacji Gåshamna – Dunderbukta (fot. P. Zagórski 2012).

Fot. 2.1.2. Elementy rzeźby strukturalnej w Chamberlindalen – blok Chamberlindalen (Photo P. Zagórski 2006).

Fot. 2.1.3. A- dolomity formacji Höferpynten budujące zbocza Observatoriefjellet (fot. P. Zagórski 2011), B- trzeciorzędowe osady klastyczne wypełniające rów Calypsostrandy – klif w Skilvika (Photo G. Gajek 2011), C- martwy klif Calypsostrandy, zbudowany z trzeciorzędowych osadów klastycznych wypełniających rów Calypsostrandy (fot. G. Gajek 2011).

Fot. 2.1.4. A- zróżnicowanie litologiczne bloku Martinfjella – zbocza Magnethøgda (fot. G. Gajek 2011), B- zróżnicowanie litologiczne bloku Martinfjella widoczne na stokach Jarnfjellet – „Camp Iron Mountain" (fot. G. Gajek 2011).