Landform Analysis, Vol. 5: 102–106 (2007)

The conditioning of the evolution of NW part of the coast of Wedel Jarlsberg Land (Spitsbergen) during the last century

Piotr Zagórski*

Department of Geomorphology, Institute of Earth Sciences, Maria Curie-Skłodowska University, Lublin, Poland

In the area of NW part of Wedel Jarlsberg Land (southern Bellsund, Spitsbergen) the studies of formation of coastal zone began during the 1st Polar Expedition of Maria Curie-Skłodowska University to Spitsbergen in 1986 and continued the following years. They covered about 70 km long coast from Dunderdalen to the eastern coast of Rrecherchefjorden (Harasimiuk 1987, Harasimiuk, Jezierski 1991, Zagórski 2002, 2004). It is characterized by alternate abrasive and accumulative parts. Their spatial location and development depend mainly on geological structure of background as well as exposition to waving.

In this article, in reference to the last century, a special attention was paid to the evolution of a coast in the section from Skilvika to Josephbukta. In the Skilvika region the coast is in the form of cliff developed within the Proterozoic rocks (western part) and Tertiary rocks with the additional series of Quaternary sediments (eastern part) (Dallmann et al. 1990, Birkenmajer 2004, Landvik et al. 1992, Pękala, Repelewska-Pękalowa 1990). In the vicinity of Renardodden, due to the intensive accumulation, there were a few storm ridges formed, at present – fossil, on the surface of which numerous stations of XVII and XIX centuries settlements are located (Krawczyk, Reder 1989). In the section between Renardodden and Josephbukta, the coast is of accumulative character with a full profile beach. It is formed by the marine terrace, 2–8 m a.s.l. (terrace I) and 40-180 m wide, separated with a section of cliff shore in the zone of marginal moraine of Renardbreen (Harasimiuk 1987, Zagórski 2002). The terrace is built of sands and gravels transported to the shore zone by streams from the tundra area and a river flowing from the Scott and Renard Glaciers (Fig. 1).

During the last century the coast of NW part of Wedel Jarlsberg Land was and is still affected by various morphogenetic factors including littoral, glacial, fluvioglacial and fluvial processes. They reflect internal dynamics, feedbacks of atmosphere, cryosphere and hydrosphere. The Little Ice Age was a remarkable glacial episode in this area. Its end is dated on XIXth and XXth centuries (Isaksson et al. 2005). Large glaciers getting into the sea like Renardbreen and Rrecherchebreen largely affected coast transformation. Their marginal zones invaded partly the terrace I level (Fig. 1). There, among others, exarative redeposition of sediments and fossil flora took place, e.g. in the case of Renardbreen forefield – fossil flora dated with the radiocarbon method as 660±80, 1040±80 and 1130±80 BP (Dzierżek et al. 1990). Additional finding is enriched with an occupation layer (Renardbreen 1) glacially remodelled (Jasinski, Starkov 1993). Based on the archaeological-geomorphological work, there were found small changes of sea level that were probably due to glacio-isostasy (Jasinski et al. 1997). Another effect could be also caused by intensification of abrasion processes.

During the last century the most important factors that affect transformation of coasts were marine processes (waving, tides, longshore current). Within the coast zone their actions are intensified by fluvial, glacial and mass movement processes. Destructive effect of waving is particularly evident in the case of cliff shores (Fig. 1). The example can be the Skilvika region where the cliff evolution is additionally predisposed by occurrence of Tertiary carbonaceous

* e-mail: pzagorsk@biotop.umcs.lublin.pl

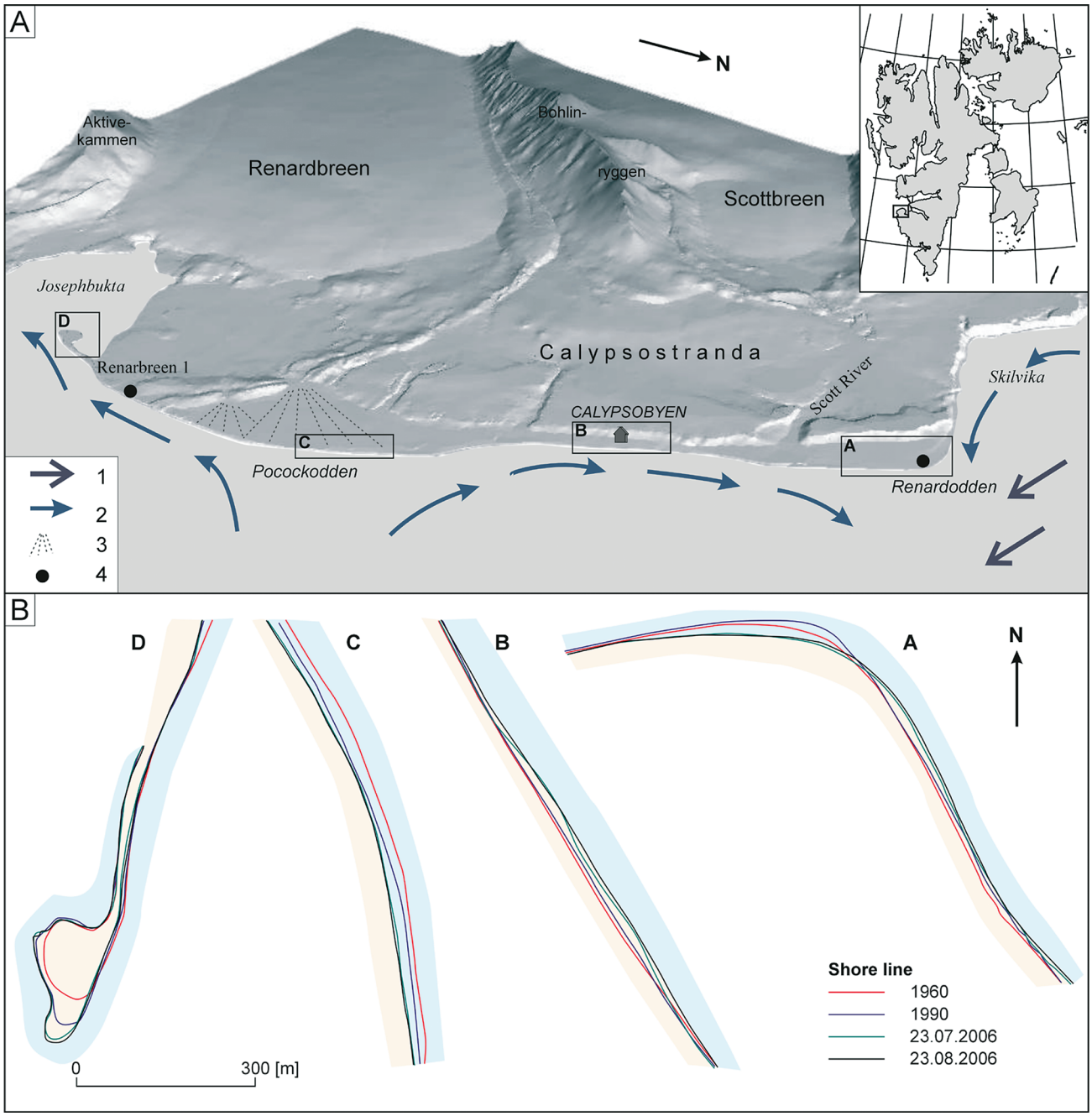

Fig. 1. A: 3D model of study area: 1 – oceanic drift (high wave energy), 2 – longshore current (after: Harasimiuk, Jezierski 1991), 3 – sandur cones, 4 – location of archaeological sites. B: Changes of shoreline

formation filling up the tectonic graben (Birkenmajer 2004). However, at the cliff foot there is formed an abrasive platform, cleared out of sediments by waving and broadening with cliff recession (Harasimiuk 1987, Zagórski 2004).

The delivery of material increased during the glacier recession (mainly: Scottbreen and Renardbreen) when the Little Ice Age was over and the zone of longshore currents convergence diminished the abrasion rate in the Calypsostranda region and made accumulation predominant e.g. in the vicinity of Renardodden. The archaeological date and geomorphological works carried out in this region indicate intensive evolution of Renardodden from the XVIIth century (Jasinski, Zagórski 1996). The closest to the present coastal zone (about 60 m from the coastal line) is the site Renardodden 1 which is the survival of the Russian station of walrus hunter from the first half of the XIXth century (Jasinski, Zavyalov 1995). Originally the hunter station building was out of the reach of storm waving. However, due to increase of abrasive processes activity, the old storm ridge was destroyed and the waves dragged pieces of brick and organic remains over the tidal zone (Fig. 1, 2). This condition was still maintained up to the beginning of the 60s i.e. when quick reces-

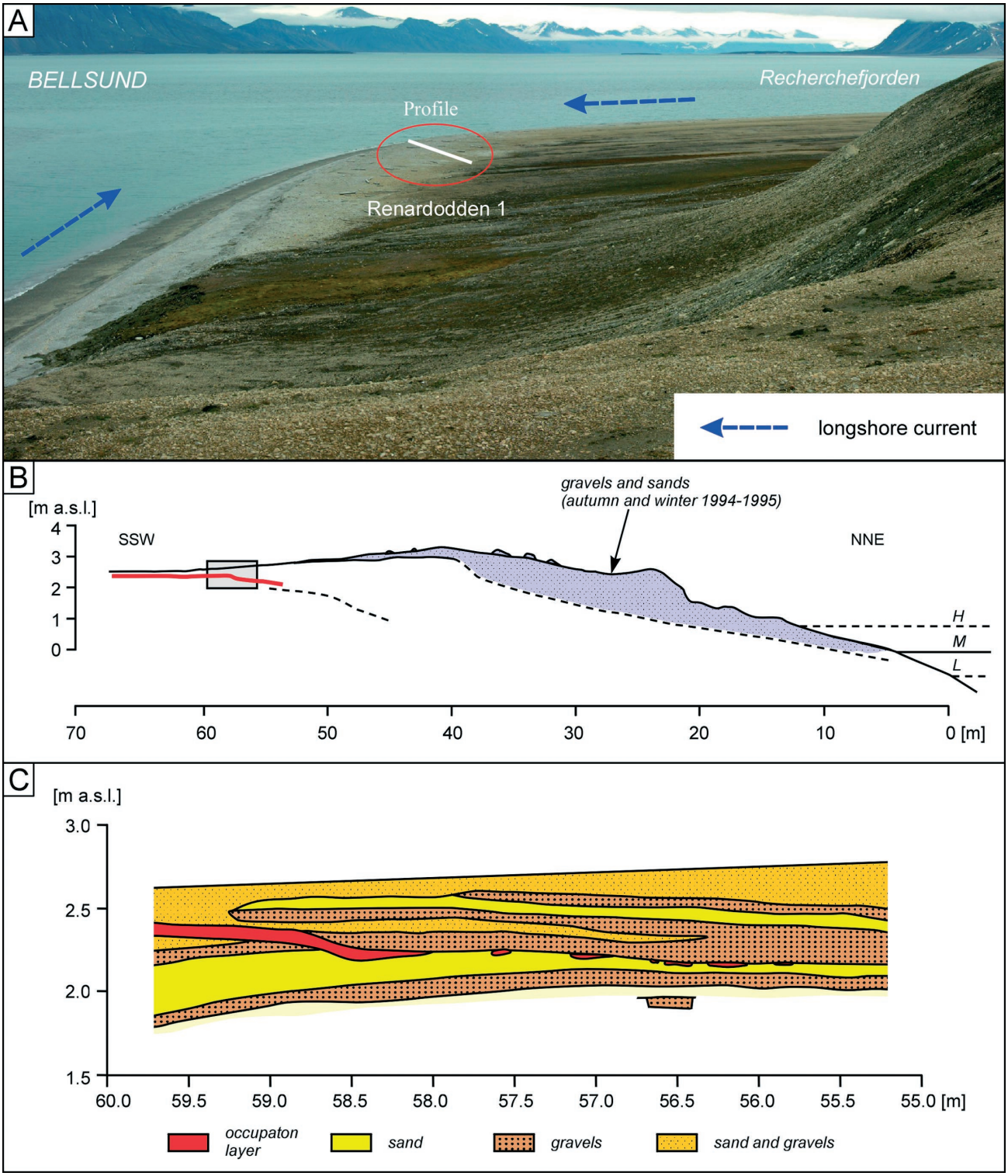

Fig. 2. Archaeological site Renardodden 1
A: General view, B: Geological profile across the storm ridge, C: Geological profile across the fragment of storm ridge with dragged occupation layer (after Jasinski, Zagórski 1996)

sion of the Scottbreen began (Reder 1996, Zagórski, Bartoszewski 2004). Till 1990 intensification of material supply resulted in the extension of the cape by almost 20 m (Fig. 1). However, lately there some developing changes of cape geometry has been observed due to poorer material supply from the marginal zone of the Scottbreen to the coastal zone and increasing role of marine processes (waving, longshore current). The part from Skilvika was largely sheared and that towards the Scott River estuary was aggradated (Harasimiuk 1987, Zagórski 2004).

From the works carried out in the 80s of the last century the area of accumulative coast situated be-

tween the Scott River and Pocockodden is considered to be relatively stable where the north-west coastal current is of saturated character and its whole energy makes dislocation of sediments along the shore (Harasimiuk 1987) (Fig. 1). Observations and measurements of coastal line changes performed using the GPS receiver during the polar expeditions in 2000, 2005 and 2006 under quiet meteorological conditions indicate gradual building up of a new gravelly ridge. However, strong storm conditions caused removal of the coast by a few meters and return to the previous state. Comparison of many years' observations of the coastal line was based on benchmark point and GPS measurements point to gradual change of coast geometry (Zagórski 2002, 2004). The autumn-winter storms of extreme sizes contribute largely to these changes (particularly in 1992/1993) (Rodzik, Wiktorowicz 1996, Zagórski 1996). Over ten metre removal of coastal line and addition of gravelly, gravelly-sandy and vegetable covers on the storm ridge area took place at that time in the vicinity of the station in Calypsobyen (Zagórski 1996). In successive years such rapid changes were not observed but gradual reconstruction of the devastated area took place.

At the beginning of the XXth century up to the sixties fluvial and fluvioglacial processes combined with marine ones had a significant effect on the coast shape. Their role was to deliver terrigenous material to the coastal zone (Harasimiuk, Król 1992). Such situation was observed, among others, in the case of vast sandur cones on the distal side of moraine ridges of Renardbreen (Fig. 1, 2). Slightly oblique area of semicircular shape was formed. At present due to Renardbreen recession and fluvioglacial supply disappearance they have become dead forms. Disappearance of land material supply resulted in increase of marine processes activity which, turn in, caused formation of a gravelly ridge inhibiting cone destruction (Harasimiuk 1987, Zagórski 2004). However, local longshore currents of which one flows towards north-west and the other south are of significant importance for evolution (Harasimiuk, Jezierski 1991). The latter supplied with the material from destruction of fluvioglacial cones of the Renardbreen affected the formation of sand spit bordering Josephbukta in the east and at present plays an important role in its transformation. Its evolution was also predisposed by occurrence of glacial sediments of Renardbreen marginal zone (Harasimiuk 1987, Zagórski 2004).

Occurrence of coastal ice is also an essential factor (for example: Jahn 1977, Jezierski 1992, Rodzik, Wiktorowicz 1996). Its quick accumulation provides effective protection of the shore against destructive activity of waving. Similarly, its long existence in the spring-summer season inhibits transformation of the coastal zone (Zagórski 1996, 2004).

Acknowledgment

The paper was prepared within the ordered research project PBZ-KBN/P04/2004.

Literature

Birkenmajer, K., 2004. Caledonian basement in NW Wedel Jarlsberg Land south of Bellsund, Spitsbergen. Polish Polar Research, 25(1): 3–26.

Dallmann, W.K., Hjelle, A., Ohta, Y., Salvigsen, O., Bjørnerud, M.G., Hauser, E.C., Maher, H.D., Craddock, C., 1990. Geological Map Svalbard, 1:100,000: B11G Van Keulenfjorden. Norsk Polarinstitutt, Temakart, 15.

Dzierżek, J., Nitychoruk, J., Rzętkowska, A., 1990. Geological-geomorphological analisis and 14C dating of submarine organogenic deposits within the Renardbreen outer margin, Wedel Jarlsberg Land, Spitsbergen. Polar Research, 8: 275–281.

Harasimiuk, M., 1987. Współczesny rozwój wybrzeży południowego Bellsundu i fiordu Recherche (Zachodni Spitsbergen). XIV Sympozjum Polarne, Lublin: 99–102.

Harasimiuk, M., Jezierski, W., 1991. Types of coasts of south Bellsund (West Spitsbergen) and tendency of their evolution. Wyprawy Geograficzne na Spitsbergen, UMCS, Lublin: 17–22.

Harasimiuk, M., Król, T., 1992. The dynamics of morphogenetic and sedimentary processes in the estuary segments of river valleys in the Recherche Fiord (Western Spitsbergen). Wyprawy Geograficzne na Spitsbergen, Lublin: 59–66.

Isaksson, E., Kohler, J., Pohjola, V., Moore, J., Igarashi, M., Karlo, L., Martma, T., Meijer, H., Motoyama, H., Vaikma, R., van de Wal, R.S.W., 2005: Two ice-core ?18O records from Svalbard illustrating climate and sea-ice variability over the last 400 years. The Holocene, 15(4): 501–509.

Jahn A., 1977: Periglacial forms produced by shore ice at Hornsund (Spitsbergen). Acta Univ. Wratisl., Spitsbergen Expeditions II, Wrocław, 19–29.

Jasinski M.E., Repelewska-Pękalowa J., Pękala K., 1997: The role of archaeological localities in the estimation of geodynamic processes of Recherche Fjord coastal zone (Bellsund, Spitsbergen--Svalbard). Wyprawy Geograficzne na Spitsbergen, UMCS, Lublin, 101–106.

Jasinski, M.E., Starkov, V.F., 1993. Archaeological investigations of a cultural layer in moraine deposits of Renard Glacier, Recherchefjorden, Svalbard. Field season 1992. XX Sympozjum Polarne, Lublin: 55–72.

Jasinski, M.E., Zagórski, P., 1996. Significance of archaeological sites for estimating coastal plain development in the Renardodden area, Bellsund,

Spitsbergen. Wyprawy Geograficzne na Spitsbergen, UMCS, Lublin: 35–41.
Jasinski, M.E., Zavyalov, V.I., 1995. Archaeological excavations of a Russian hunting station at the Renardodden 1 site, Recherche Fjord, Spitsbergen. Field Work 1995. Wyprawy Geograficzne na Spitsbergen, UMCS, Lublin: 43–53.
Jezierski W., 1992: Spatial changeability of dynamics of marine sediment pro-cesses in Calypsostranda region (Recherche Fjord, Western Spitsbergen). Wyprawy Geograficzne na Spitsbergen, Lublin, 67–72.
Krawczyk, A., Reder, J., 1989. Pozostałości osadnictwa sezonowego w północno-zachodniej części Ziemi Wedela Jarlsberga. Wyprawy Geograficzne na Spitsbergen, UMCS, Lublin: 131–146.
Landvik, J.Y., Bolstad, M., Lycke, A.K., Mangerud, J., Sejrup, H.P., 1992. Weichselian stratigraphy and paleoenvironments at Bellsund, western Svalbard. Boreas, 21: 335–358.
Pękala, K., Repelewska-Pękalowa, J., 1990. Relief and stratigraphy of Quaternary deposits in the region of Recherche Fiord and southern Bellsund (Western Spitsbergen). Wyprawy Geograficzne na Spitsbergen, UMCS, Lublin: 9–20.
Reder, J., 1996. Evolution of marginal zones during a continued glacial retreat in northwestern Wedel Jarlsberg Land, Spitsbergen. Polish Polar Research, 17(1–2): 61–84.
Rodzik, J., Wiktorowicz, S., 1996. Shore ice of Hornsund Fiord in the area of the Polish Polar Station in Spitsbergen during the 1992/1993 winter. Wyprawy Geograficzne na Spitsbergen, Lublin: 191–195.
Zagórski, P., 1996. Effect of sea activity and the role of snow banks in the deve-lopment of Calypsostranda coastal zone (Bellsund, Spitsbergen). Wyprawy Geograficzne na Spitsbergen, Lublin: 201–211.
Zagórski, P., 2002. Rozwój rzeźby litoralnej północno-zachodniej części Ziemi Wedela Jarlsberga (Spitsbergen). Ms., Zakład Geomorfologii, Instytut Nauk o Ziemi UMCS, Lublin.
Zagórski, P., 2004. Czynniki morfogenetyczne kształtujące strefę brzegową w okolicach Calypsobyen (Bellsund, Spitsbergen). Annales UMCS, sec. B, 59, 63–82.
Zagórski, P., Bartoszewski, S., 2004. Próba oceny recesji lodowca Scotta w oparciu o materiały archiwalne i pomiary GPS. Polish Polar Studies. XXX MSP, Gdynia: 415–424.