

## Quaternary of the Hornsund Region (Spitsbergen) in research of the Institute of Geology, Warsaw University, in 1981—85

### 1. Introduction

Studies of the Quaternary sediments of the Hornsund Region were carried through in the Institute of Geology, Warsaw University, in 1981—85 within the institute project IGP-4 “Studies of lithology, origin and stratigraphy of the Quaternary sediments of Poland and some polar and tropical areas” supervised by Docent L. Lindner and the project IGP-1 “Sedimentologic studies of clastic ancient and recent deposits” supervised by Professor P. Roniewicz. They also entered the Interdisciplinary Project MR.I.29 “Studies of sea and land polar regions as a basic for rational exploitation of natural resources and the protection of their environment”, coordinated by the Institute of Geophysics, Polish Academy of Sciences, and the Quaternary Research Institute, A. Mickiewicz University of Poznań. Investigations were based on data collected in the field by the scientists of the Institute of Geology who took part in expeditions to the Hornsund Region, organized by the Institute of Geophysics, Polish Academy of Sciences in 1979 (L. Marks) and 1980 (J. Giżejowski, L. Lindner and W. Roszczyńko), University of Gdańsk in 1980 and 1981 (C. Filipowicz), Jagiellonian University in 1984 (C. Filipowicz) and 1985 (R. Szcęsny). This investigated area was enlarged in 1984 by the expedition to the Isfjorden Region in Central Spitsbergen, organized together with the Institute of Hydrogeology and Engineering Geology, Warsaw University, and the Quaternary Research Institute, A. Mickiewicz University of Poznań (L. Lindner and L. Marks).

Studies of the Quaternary of the Hornsund Region that were undertaken in the Institute of Geology, Warsaw University, in 1981—1985 continued the earlier investigations of 1979—1980 (*cf.* A. Wierzbowski 1983), connected with a geomorphologic mapping of this area (Karczewski, Kostrzewski and Marks 1979, 1983a; Andrzejewski et al. 1980, 1981, 1983). These studies were possible as we could use the Norwegian air photos of 1960—1961 of this area, lend us by the Institute of Land-Surveying and Cartography, Head Office of Land-Surveying and Cartography (Warszawa). We could also friendly cooperate with treams of Professor A. Karczewski (Quaternary

Research Institute, A. Mickiewicz University of Poznań) and of Docent K. Pękala (Institute of the Earth Sciences, M. Curie-Skłodowska University of Lublin).

As a result, the Quaternary sediments of the Hornsund Region could be investigated in many aspects. They comprised a preparation of numerous maps of Quaternary landforms and sediments, studies of their origin and age as well as of the Quaternary tectonic processes.

## 2. Maps of Quaternary landforms and sediments

The methodology prepared in the Institute of Geology, Warsaw University (Lindner, Marks, Ostaficzuk, Pękala and Szczęsny 1984, 1985, 1986a, b, c; Lindner, Marks, Ostaficzuk, Szczęsny and Pękala 1984) allowed to present up to now four sheets of photogeologic maps in a scale of 1:10.000, showing the Quaternary landforms and sediments of the Hornsund Region (Fig. 1). These maps, based on the own contour lines, enclosed Quaternary landforms and sediments grouped in four sets of varying origin. The first set comprised landforms and sediments located at mountain slopes. The second one was formed of glacial and nival features. The third set dealt with marine landforms and sediments (mainly associated with raised marine terraces) and the fourth one contained lake, fluvial and aeolian landforms and sediments.

The photogeologic map of the interlobal zone of Torellbreen (Szczęsny et al. 1985) shows extents and genetic variety of Quaternary deposits. It presents a changeable retreat of glacial lobes of the Vestre Torell and the Austre Torell glaciers. Besides, extents of sediments of ice-dam lakes are marked. These lakes have been active a short time ago at the foot of the Krakken and Raudfjellet mountain massifs.

The photogeologic map of the forefield of Nann, Tone and Austre Torell glaciers (Ostaficzuk, Marks and Lindner 1980) documents firstly extents of outer and inner ice-cored moraines in the forefield of the Austre Torell Glacier, outwash trains in the forefield of the Nann Glacier as well as the hardly accessible tongue of the Tone Glacier, being gradually transformed into a rock glacier.

The photogeologic map of the Slaklidalen Region (Ostaficzuk, Lindner and Marks 1986) presents Quaternary landforms and sediments within the Slakli Valley, the Lid Valley as well as in their forefields (Breinesflaya) and in the upstream part of the Lisbet Valley. This area has landforms and sediments that are typical for the valleys, almost non-glaciated at present. Due to that, evidence of glacial erosion and accumulation of earlier glaciations was noted there, together with still existing relic cirque glaciers

with morainic rock glaciers in their forefields. Besides, a rich collection of slope landforms and sediments was noted, almost complete (for this part of Spitsbergen) set of marine terraces and glacial landforms and sediments in the upstream Lisbet Valley.

The photogeologic map of the Bunge Glacier forefield (Ostaficzuk, Lindner and Marks 1982) is the example of detailed analysis of extramorphainal and intramorphainal landforms and sediments of the Bunge Glacier, preserved marine terraces in its forefield as well as slope landforms and sediments. But the present glacial sediments there are also patches of older tills, preserved at mountain slopes of Stupryggen and tops of Kulmrabben.

The analysis of air photos was also helpful for preparation of geologic-geomorphologic maps in smaller scales of the Rev Valley (Karczewski, Kostrzewski and Marks 1981a), the Trekelen Peninsula (Marks 1981, 1983) and the Wieder Valley (Szczęsny 1986).

All these photogeologic maps present in detail a varying relief and Quaternary deposits of the Hornsund Region. Besides, they show their mutual spatial relations and therefore, allow to reconstruct a palaeogeographic evolution of this area during the Quaternary. They form also the excellent initial data for reconstructions of the Pleistocene glacial relief of Poland, in its lowland and upland areas as well as for the ones that have been occupied by mountain glaciers.

### 3. Origin of the Quaternary landforms and sediments

The subject of origin of the Quaternary landforms and sediments of the Hornsund Region is present in almost every paper on the Quaternary of this area. But the mentioned photogeologic maps, it was described in papers on raised marine beaches of the northern seashore of Hornsund (Karczewski, Kostrzewski and Marks 1980c, 1981c, 1983c) and the Kulmstranda area (Kłysz and Lindner 1981c), on glacial deposits of the downstream Lisbet Valley (Kłysz and Lindner 1981a), the Slakli Valley (Kłysz and Lindner 1981b, 1983; Lindner, Marks and Ostaficzuk 1986), forefields of the Bunge Glacier (Kłysz and Lindner 1982; Lindner, Marks and Ostaficzuk 1984), of the Torell, Nann and Tone glaciers (Lindner, Marks and Ostaficzuk 1980, 1982), the Treskelen Peninsula (Marks 1981, 1983) and the interlobal zone of the Torell Glacier (Pękala et al. in press). Schematic geologic sections (*cf.* Fig. 1; Lindner, Marks and Pękala in press a) present a synthesis on the Quaternary sediments and landforms of the mentioned areas.

Besides, much attention was paid to a development of some debris slope accumulations and rock glaciers, and proposals of their morphologic

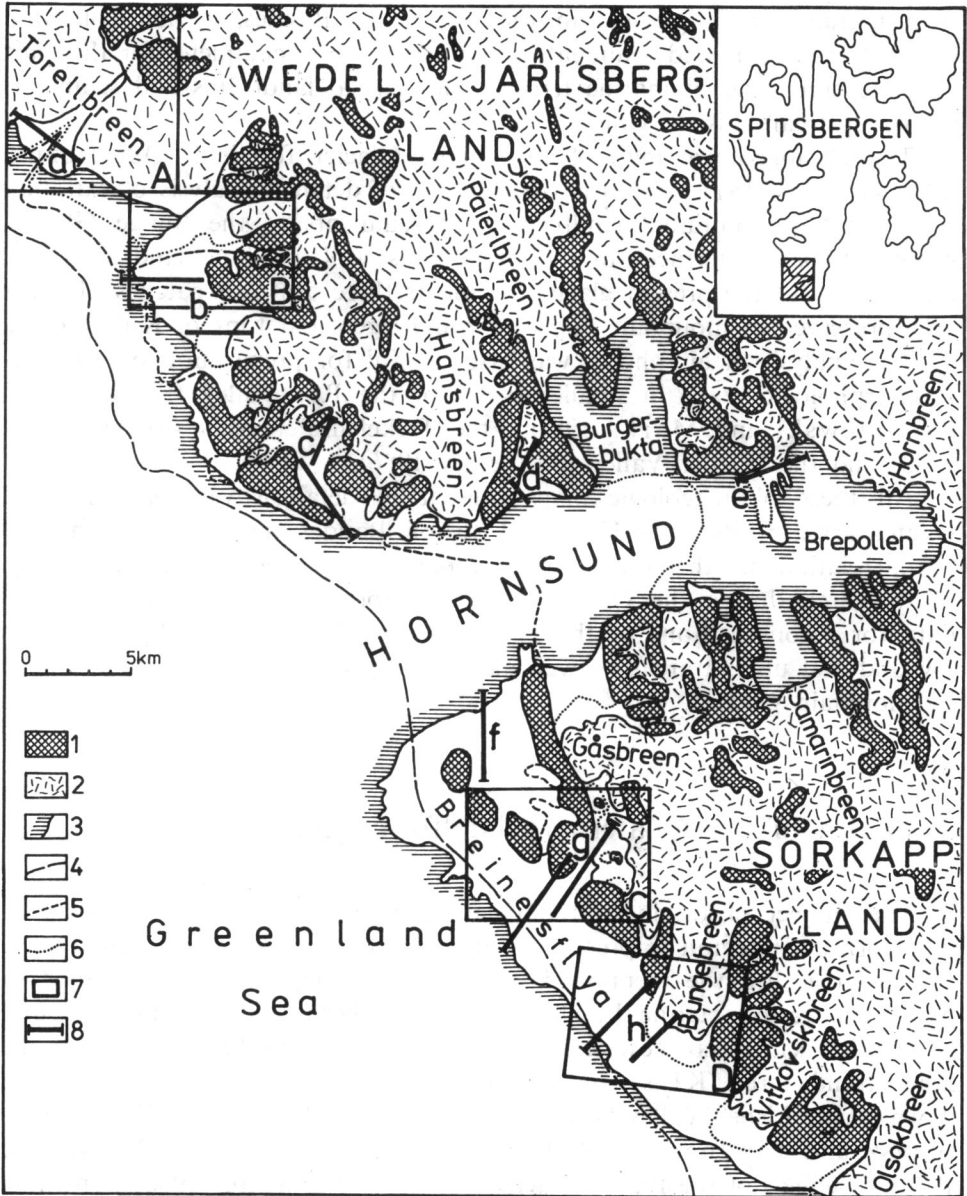


Fig. 1. Location sketch of the Hornsund Region 1 — mountains, 2 — glaciers, 3 — shoreline, 4 — maximum extent of glaciers during the Sörkapp Land Glaciation, 5 — maximum extent of glaciers during the Holocene, 6 — maximum extent of glaciers during the Little Ice Age, 7 — photogeologic maps in a scale of 1:10,000 prepared in the Institute of Geology of the Warsaw University: A — of the interlobal zone of the Torell Glacier (Szczęsny et al. 1985), B — of the forefield of the Nann and Torell glaciers (Ostaficzuk, Marks and Lindner 1980), C — of the Slakli Valley region (Ostaficzuk, Lindner and Marks 1986), D — of the forefield of the Bunge Glacier (Ostaficzuk, Lindner and Marks 1982); 8 — schematic geologic sections (Lindner, Marks and Pękala in press); a — of the Torellkjegla region, b — of the

classification (Karczewski, Kostrzewski and Marks 1980b, 1981b, 1983b) and genetic classification (Lindner and Marks 1985a, 1985b) were presented.

A development of the Late Quaternary karst features was also noted. On southern slopes of the Stupryggen massif there are patterns of karrens and a large karst canyon (Lindner and Kłysz 1986).

Sedimentology of the Quaternary marine sediments of the Hornsund Region formed another field of research of the scientists from the Institute of Geology of the Warsaw University. Basing on submarine explorations, collected samples of bottom sediments and echo sounding sections, the present sedimentary processes in the off-shore zone were investigated in the Hyttevika Bay (Giżejewski and Roszczyńko 1982), the Skodde Bay (Filipowicz and Giżejewski 1984, 1986) and the Nottingham Bay (Giżejewski 1986). An attempt was also undertaken to define a glaciomarine sedimentation in the Brepollen Bay (Filipowicz 1986). The general conclusion of these papers says that melting out of debris from sea and glacial ice blocks plays the principal role in a development of sediments in the off-shore zone of Hornsund.

#### 4. Quaternary tectonic processes

The photogeologic interpretation and fieldworks allowed to say a word on the Late Quaternary tectonic movements in the forefield and the neighbouring area of the Bunge Glacier and southern Breinesfløy (Lindner, Marks and Szczęsny 1985, 1986). These movements are marked among others by glacioisostatically restored dislocation zones of the pre-Quaternary bedrock, used by meltwater trains in Breinesfløya, the outwash track of Vinda and gorges within the ice-cored moraines of the Bunge Glacier. Some of these zones are also distinct on southern slopes of Stupryggen and in the vicinity of Kulmrabben.

#### 5. Paleogeography and chronostratigraphy of the Quaternary sediments

This subject is present in most papers on the Quaternary of the Hornsund Region, mainly being the aim of these works. It comprises

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Elvefløya region, c — of the Revdalen and Fuglebergsletta region, d — of the Bogstranda region, e — of the Treskelodden region, f — of the Lisbetdalen and Kulmstranda region, g — of the Slaklidalen region, h — of the Bungeleira region

conclusions on presence of glaciers of the last glaciation (Lindner and Marks 1983) based on investigations in the northwestern Sörkapp Land of the southern seashore of Hornsund (Kłysz and Lindner 1981a): the Würm and the Holocene glaciations of the Slakli Valley (Kłysz and Lindner 1981b, 1983a, 1983b), and the southwestern Wedel Jarlsberg Land of the northern seashore of Hornsund: the last deglaciation of the Treskelen Peninsula (Marks 1981, 1983), and the Holocene glaciations of the Rev Valley (Karczewski, Kostrzewski and Marks 1980a, 1981a, 1983d) as well as the evolution of the interlobal zone of the Torell Glacier (Pękala et al. in press).

These papers together with absolute datings of sediments in the Hornsund Region by radiocarbon and thermoluminescence methods, formed the basis for the first proposal of a chronostratigraphic subdivision of the Late Quaternary of this area (Lindner, Marks and Pękala 1983, 1984, in press a, in press b; Marks and Pękala 1986, Pękala et al. in press). Two interglacials: Torellkjegla (= Masovian, Holstein) and Bogstranda (= Eemian), and two glaciations: Wedel Jarlsberg Land (= Saale, Odra + Warta) and Sörkapp Land (= Vistulian) were distinguished, accompanied by 2—3 glacial episodes during the Holocene (Fig. 2).

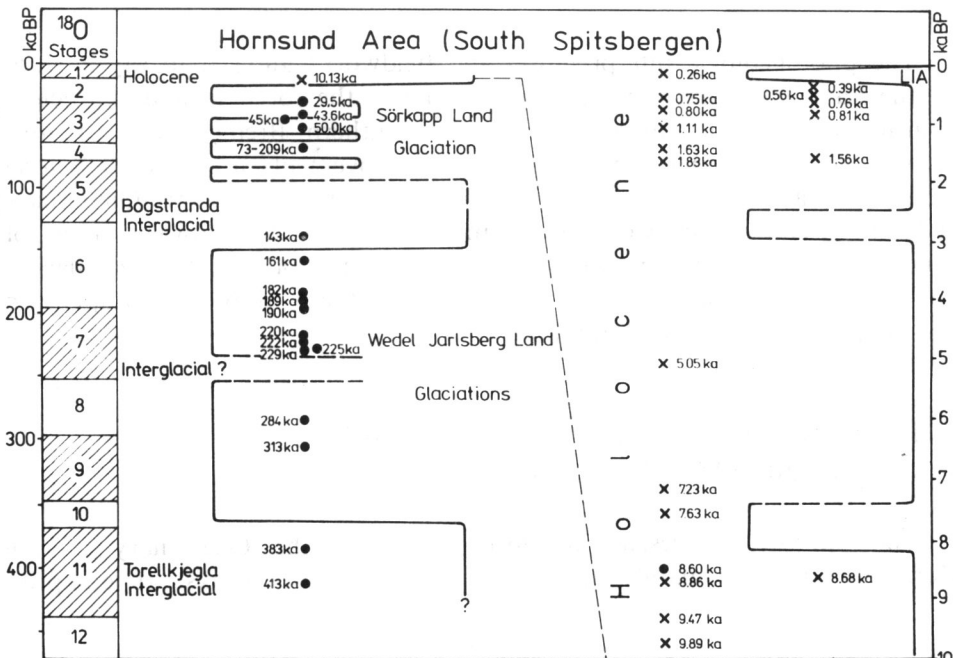


Fig. 2. Chronostratigraphic subdivision of the Quaternary of the Hornsund Region (after Lindner, Marks and Pękala in press b) black dots mark thermoluminescence datings, crosses mark radiocarbon datings; LIA — Little Ice Age

Studies in this area of first interest were widened by the attempt of probable correlations with the Isfjorden Region in Central Spitsbergen. Such work is represented by the preliminary paper on morphogenesis of the Petuniabukta at the end of the Pleistocene and in the Holocene (Kasprzak et al. 1985).

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