Research Note

Some notes on glacial geomorphology in the inner part of St. Jonsfjorden, Svalbard

ARNT-IVAR KVERNDAL

Kverndal, A.-I. 1991: Some notes on glacial geomorphology in the inner part of St. Jonsfjorden, Svalbard. *Polar Research 9(2)*, 215–217.

Working as a field assistant for Dr. Harmon Maher during the Norwegian Polar Research Institute's Svalbard Expedition 1991, A.-I. Kverndal had the opportunity to do a large-scale study on the glacial geology in the St. Jonsfjorden area. This note emphasises the glacial geomorphology connected to the Konowbreen/Osbornebreen glacier system; it also comments on the possibilities for further research in this area.

Arnt-Ivar Kverndal, University of Tromsø, Department of Geology, Tromsø Museum, N-9000 Tromsø, Norway.

St. Jonsfjorden (78°30′N, 12°30′E) is situated on the western coast of Spitsbergen, Svalbard (Fig. 1). The area is characterised by jagged peaks, nunataks, and the many glaciers draining down to the fjord. The bedrock geology is dominated by a complex composition of metamorphic rocks, the oldest of which comprise the Hecla Hoek basement rocks that were deformed and metamorphised during the Caledonian and older events. Overlying the Hecla Hoek we find the Upper Paleozoic and Mesozoic rocks, deformed and metamorphised during the Early Tertiary opening of the Norwegian–Greenland and Arctic oceanic basins (Maher 1989).

The glaciers in the St. Jonsfjorden area are of the typical Spitsbergen type: topographically influenced ice-masses draining down to the fjord from composite accumulation areas.

Supraglacial meltwater drainage, the observation of icings, and the significance of ice-cored moraines in the frontal areas indicate a sub-polar temperature regime of the St. Jonsfjorden glaciers. A recorded surge on Osbornebreen and the estimation that 90% of the glaciers on Svalbard are of the surging type (Hagen & Liestøl 1990) suggest that most of the glaciers around St. Jonsfjorden are influenced by this special periodic behaviour. the phenomenon makes it difficult to establish a relationship between climatic and glacier front variations in the region.

Glacial geology

According to Liestøl (1988), the advance of the glacier fronts on western Spitsbergen in the second half of the last century represents the maximum extension of ice cover in the Holocene. Maps, aerial photographs, and mass-balance investigations in the Kongsfjorden area show that the glaciers' ice-mass volume change has been negative since the beginning of this century (Hagen & Liestøl 1990; Lefauconnier & Hagen 1990). This continuous deficit in mass-balance can be explained by higher summer temperatures (Hagen & Liestøl 1990), or by the low precipitation rate (Liestøl 1988).

In the inner part of St. Jonsfjorden, the two glaciers Konowbreen and Osbornebreen compose the most dominant glacier system in the area (Fig. 1). Distally to today's glacier fronts, lateral moraines along both sides of the fjord give an indication of the system's extensions during the Holocene. Even though the moraines have a very complex morphology, it is possible to interprete different glacial stages. The marginal and oldest moraine, possibly deposited in the second half of the last century, gives a picture of the system's maximum Holocene extension (Fig. 1). The moraines indicate a low-gradient ice profile, extending to the Piriepynten and Konowfjellet area, where push-moraines containing marine sediments and shell fragments were discovered (Fig. 2). The ridges are located 2–7 m a.s.l., and both the situation and morphology connect them to the Konowbreen/Osbornebreen glacier system. The marine sediments and the content of shells indicate that the glacier front was grounded during this advance.

Glacial erratics are found in the same area as the push-moraines (Fig. 1). In fact, at Konowfjellet erratics are found on top of the ridges. They are conglomerates of Carboniferous age and limestones of Permian age, belonging respectively to the Tornkanten and Kapp Starostin formations. The latter formation is only to be found in the Osbornebreen drainage area, documenting the origin of the morainic material.

Between 1987 and 1989 Osbornebreen surged, and the glacier front advanced about 2 km (Fig. 1). A 40 to 50 m lowering of the ice-profile in the accumulation area shows how ice-mass surplus has been transported from this area down to the frontal part of the glacier. Today the front displays a typical post-surge situation: a heavily crevassed frontal area, steep lateral sides, and a high calving rate. The present glacier flow is not sufficient

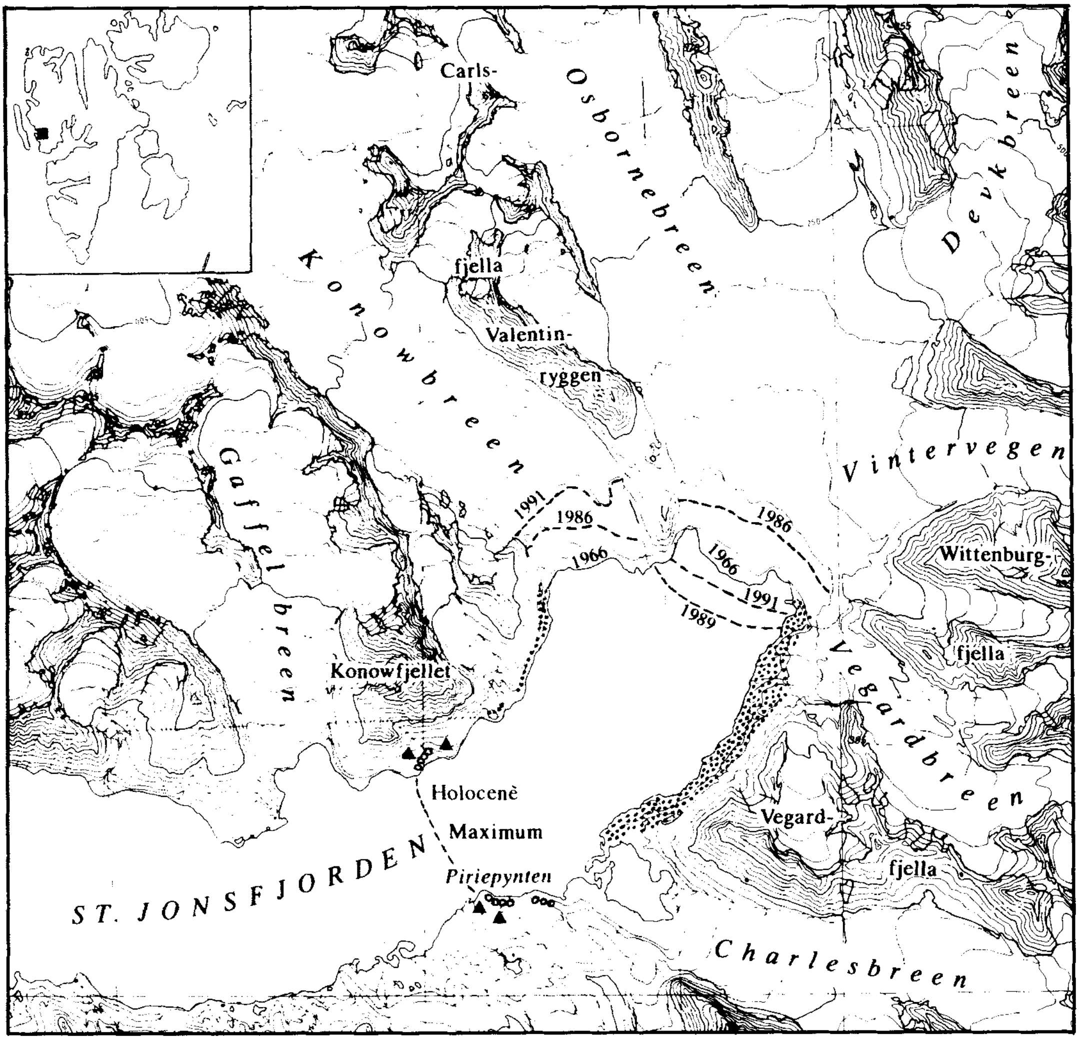

Fig. 1. Large-scale interpretation of the glacial geology and glacier limits connected to the Konowbreen/Osbornebreen glacier system. (---- = glacier limits, ▲ = glacial erratics, ○ = push-moraine, ∵ = lateral moraine).

to compensate for the large calving rate; thus the front has retreated almost 200 m since 1989.

Considering that the Konowbreen/Osbornebreen maximum extension was initiated by a surge, it is possible to estimate the system's large-scale ice-mass deficit during the last century. In such an estimate, however, it is important to take into consideration the fact that glacier surges behave differently from time to time.

Investigations in front of Osbornebreen show that the last surge had very little effect on the morphology. Both field observations and studies of aerial photographs indicate that the glacier front has been sliding over the old ice-cored lateral moraines, leaving them almost undisturbed. Due to the effect of calving, a vertical section in the frontal area of Osbornebreen has been uncovered. The section clearly shows the process where glacier ice is sliding over an old ice-cored moraine, leaving it without any glacitectonical disturbances (Fig. 3).

Investigations inside the deglaciated zone show that during the surge very little morainic material has been deposited. This observation is important in explaining the formation of the marginal moraines situated on both sides of St. Jonsfjorden. One hypothesis is that the moraines are not directly initiated by the surge, but are rather a result of the transportation of morainic material to the frontal areas during the period after the surge. The thickness and size of the morainic deposits are therefore closely related to the length of the period the area has been glaciated. As mentioned above, Osbornebreen has retreated about 200 m since 1989; this relatively rapid retreat would explain then why so little morainic material has been detected in the deglaciated zone.

Fig. 2. Push-moraine at Piriepynten. Dr. Maher as scale.

Fig. 3. Vertical section at the front of Osbornebreen documenting that the glacier has been sliding over the old ice-cored moraine, leaving it almost undisturbed.

Further research

The complex geology and geomorphology, the different types of glaciers draining down to the fjord, and the fact that Osbornebreen surged between 1987 and 1989 all make the St. Jonsfjorden area very interesting for further and more detailed research. However, there have been few investigations in the St. Jonsfjorden area, probably because of its inaccessibility. Only one paper published by Forman (1989) is known to the author.

One of the most challenging topics in glacial geological research today is achieving better understanding of the geomorphological processes associated with glacier front oscillations. In St. Jonsfjorden the glaciers are easily accessible by boat, making it possible to investigate many different types of glaciers. The Osbornebreen surge also makes it possible to carry out detailed studies on the formation of marginal moraines in front of a surging glacier.

Because of the complex geology in the St. Jonsfjorden area, a detailed petrographical mapping of morainic material and glacial erratics can provide valuable information about glacier limits. A 1 : 100 000 scale bedrock map is in preparation at the Norwegian Polar Research Institute.

References

Forman, S. L. 1989: Late Weichselian glaciation and deglaciation of Forlandsundet area, western Spitsbergen. *Boreas 18*, 51–60.

Hagen, J. O. & Liestøl, O. 1990: Long-term glacier mass-balance investigations in Svalbard 1950–1988. *Ann. Glaciol. 14*, 148–152.

Lefauconnier, B. & Hagen, J. O. 1990: Glaciers and Climate in Svalbard, statistical analysis of the Brøgger glacier mass balance for the last 77 years. *Ann. Glaciol. 14*, 102–106.

Liestøl, O. 1988: The Glaciers in the Kongsfjorden area, Svalbard. *Nor. Geogr. Tidsskr. 42*, 231–238.

Maher, H. D., Jr. 1989: Photointerpretation of Tertiary structures in platform cover strata of interior Oscar II Land, Spitsbergen. *Polar Research 6*, 155–172.