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A. L. WASHBURN*
MINZE STUIVER†

*Department of Geology, Yale University
†Yale Geochronometric Laboratory, New Haven, Conn., U.S.A.

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GLACIAL GEOLOGY AND GEOMORPHOLOGY OF THE SORTEHJORNE AREA, EAST GREENLAND

The 1961 field season was the second and final season of a two-year program to study glacial geology and geomorphology in the Sortehjorne Area, East Greenland. The program was initiated in 1959, when the author, his wife, and Mr. Guntram A. Jarre, University of Wyoming, spent from July 8 to September 9 in the field. In April 1961, the author returned to the Sortehjorne area with Mr. Norman P. Lasca, University of Michigan, and completed the field program on September 1, 1961.

Access to the Sortehjorne area is available from Reykjavik, Iceland through charter flights of Nordisk Mineselskab A/S which operates a lead and zinc mine in the Mesters Vig region. Supplies and logistical support were obtained from the mine.

The area studied includes the main Mesters Vig valley, Storedal, and three major tributary valleys, Fundal and Nidsdal on the northwest side of Storedal, and Oksedal on the southeast side. Traverses were made on foot to the divides at the valley heads and the ridge crests, as well as along the valley floors and lower slopes. Aerial photo coverage and topographic maps on a scale of 1:15000 were obtained from the Geodetic Institute, Copenhagen. Altitudes were measured by aneroid type altimeters. The maximum altitude in the

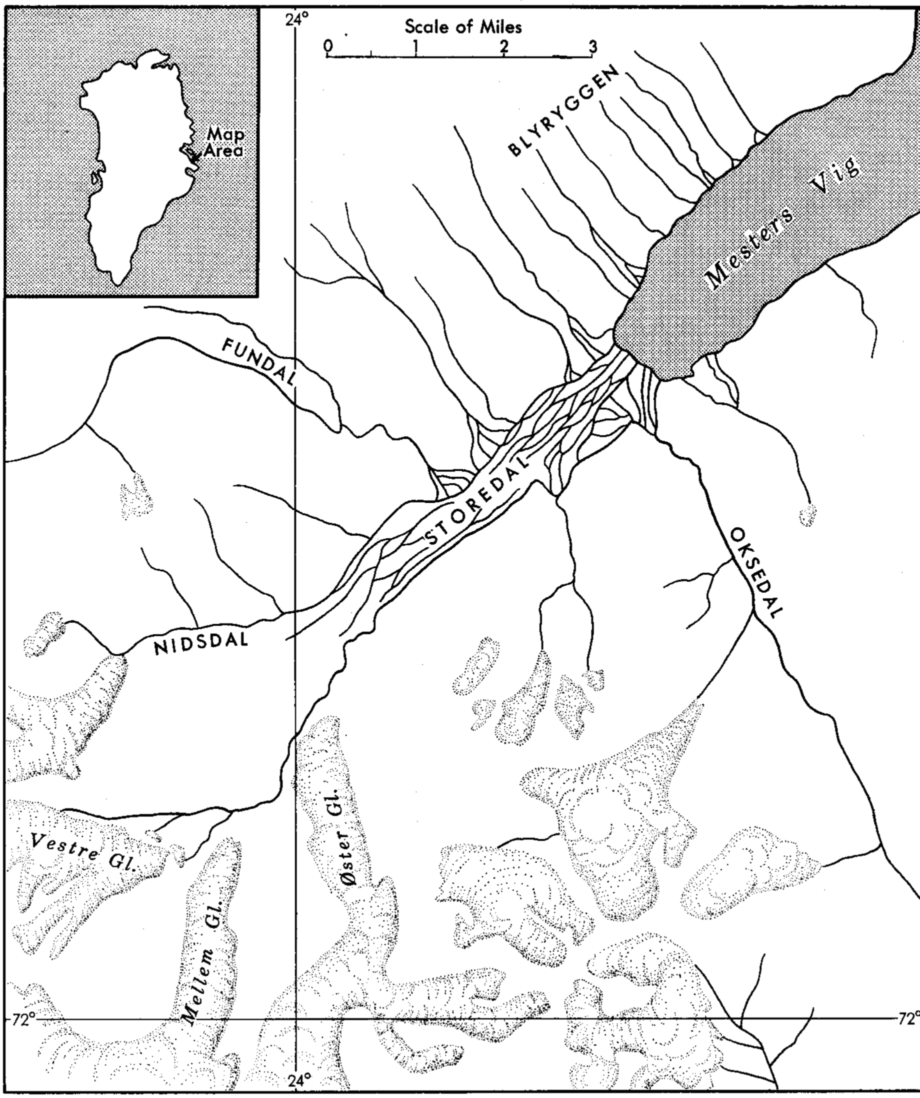

Fig. 1. Sortehjorne area, East Greenland.

area is 1290 metres at the head of Pingsdal, a tributary of Fundal. The minimum altitude is sea-level at the mouth of Mesters Vig.

The Sortehjorne area lies within the coastal fringe of Paleozoic sediments and is bounded on the south and southwest by Tertiary plutonic rocks of the Werner Mountains. To the west a major north-south trending valley, Skeldal, separates the highly deformed metamorphic complex of the Staunings Alps from the gently dipping coastal sediments. Kong Oscar Fjord forms the north and northeast boundary. Basaltic dikes and sills intrude the sediments throughout the coastal fringe, forming important topographic controls where they occur as resistant caps overlying the less resistant sediments and as sharp ridges on the faces of the steeper slopes.

In general the area represents glacially eroded alpine topography in which small remnants of once larger valley glaciers occupy most of the cirques. At the head of Mesters Vig an extensive outwash plain is developed by the melt waters of the Mellem, Øster, and Vestre Glaciers and extends into the tidal flats of Mesters Vig. From the outwash plain, slopes covered with glacial and glacial-fluvial deposits and locally derived weathering products, rise gently to a prominent break in slope at the base of the highly dissected sedimentary mountains. Glacial meltwater streams occupy most of the valleys within these mountains. Near their mouths, the streams have cut deep, narrow gorges in the exposed bedrock, frequently forming waterfalls where resistant horizons are encountered.

Surficial deposits of the Sortehjorne area are limited to late-Pleistocene glacial and glacial-fluvial deposits, and deltaic, landslide, and marine beach deposits. The glacial deposits include older lateral moraine remnants found along the valley walls of the tributary valleys and the main valley, and younger recessional moraines usually located within 1 kilometre of the present ice fronts.

The younger moraines are steep-faced, ice-cored, composed of fresh materials, and lack a vegetative cover. They are found near the margin of all glaciers in the Sortehjorne area. That these moraines may represent a minor readvance of the glaciers is demonstrated by the terminal moraine of a small tributary glacier on the northwest side of Nidsdal. This moraine, overlying landslide debris deposited along the southwest slope of the tributary valley, represents a later stage in a general, although short-term, deterioration of the climate during recent time.

Lateral moraine remnants are preserved along the valley walls of the Fundal at altitudes of 350 metres on the northeast side and 260 metres on the southwest side. Based on the following criteria: extent of vegetative cover, presence of active talus fans, degree of topographic expression, the lateral moraine remnants on the northeast side of Fundal are considered older than those on the southwest side. Pockets of well-sorted fluvial sands are associated with the moraine on the southwest side and, in some places, this moraine appears to overlie fluvial sands and discontinuous clay horizons. The lateral moraine remnants of the Fundal are interpreted to represent successively lower stages in the downwasting of the Fundal Glacier.

That the lateral moraine remnants are older than the recessional moraines is attested by their higher topographic position, discontinuous nature, well-vegetated surfaces, and more subdued topography.

The distribution of granite and syenite erratic boulders derived from the plutonic rocks of the Werner Mountains indicates the extent of glaciation in the area. Erratics were observed at 525 metres on the southwest slope of Storedal in the vicinity of Vestre Glacier, and at 420 metres along the southeast slope of Blyryggen. The lack of erratics and other evidence of glacial erosion on the high peaks and ridges suggests that the Sortehjorne area was a region of nunataks during maximum glaciation.

Erratics deposited near the mouth of Mesters Vig by ice flowing southeasterly down Kong Oscar Fjord indicate that fiord ice covered this area. Striae trending parallel to Mesters Vig, related to ice flowing northeasterly down Storedal, are well preserved on basalt knobs in the same vicinity as the Kong Oscar Fjord erratics, although usually at lower altitudes. No striae parallel to Kong Oscar Fjord were found associated with the northeasterly trending striae. Thus it appears that the striae were produced during a time when fiord ice had receded from the mouth of Mesters Vig.

Southeasterly sloping kame terraces occur most extensively along the northwest side of Storedal at altitudes of 70 to 80 metres above sea-level. These terraces indicate higher levels of the ice during deglaciation.

Landslide deposits, concentrated at the foot of steep, northeast-facing cliffs, are well developed in many tributary valleys. The coarse, angular debris, with little or no vegetative cover represents accumulation during a stage of climatic deterioration that culminated in the prolonged standstill of the ice fronts represented by the recessional moraines.

Emerged marine deltas are best preserved on the southeast side of Storedal, at the mouth of the tributary valley, Oksedal. Here are three distinct levels at 77, 66, and 35 metres above sea-level. A fourth level is represented on the northwest side of Storedal, where marine shells occur at 46 metres above sea-level in deltaic sands overlain by coarse gravels. Marine shells, whalebone, and baleen collected from the emerged deltas and beaches are expected to give dates for these higher sea-levels.

Drainage patterns of the streams tributary to the Storedal outwash plain illustrate the combined effects of glacial and structural control. In the Fundal two streams developed a parallel drainage pattern along the margins of a central bedrock ridge. The parallelism of the drainage is interpreted as the result of incision of ice-marginal streams during a time when the central part of the Fundal was occupied by a single glacier. The junction of the streams is in an area of ponded meltwater deposits and stagnant ice features that were deposited during the recession of the Fundal Glacier. Thus the confluence of the streams occurred during or after the Fundal Glacier retreated up valley and was no longer tributary to the Mesters Vig Glacier.

During isostatic adjustment of the land, following recession of the glaciers, rejuvenation of the streams resulted in extensive downcutting and a deep canyon was formed near the mouth of the Fundal. Joints in coarse, conglomeratic sandstone controlled the stream pattern during this canyon cutting period. Two dominant joint sets, one trending N.20°W. and the other N.80°E., are present in the bedrock of the Fundal. This structural control has resulted in the development of a stream pattern in the lower reaches of the Fundal characterized by closely spaced, sharp bends, with the stream's course following first one trend of the joints and then the other. The stream is thus adjusting the original glacially controlled drainage pattern to the bedrock structure. Three kilometres from the confluence a waterfall in each stream marks the present limit of headward erosion. Upstream of the waterfalls both streams have braided channels choked with glacial-fluvial debris.

Joints play a similar role in the structural control of the drainage pattern in Oksedal. Here the dominant sets of joints trend N.25° E. and N. 80° W. Glacial control of the stream pattern differs from that in the Fundal. Tributary glaciers flowing into the main valley have caused lateral displacements of the Okse River around the ice and morainal debris. Thus the main drainage in the upper reaches of the Oksedal is asymmetrical relative to the valley axis.

The stream canyons have nearly vertical walls because the joints usually dip more steeply than 80°.

Conclusions

During maximum glaciation the major peaks of the Sortehjorne area were exposed above the ice as nunataks well inland from the ice margin, which extended a considerable distance beyond the present coastline.

Deglaciation was accomplished primarily by lateral thinning and downwasting, with little development of recessional end moraines. Isolated blocks of stagnant ice were common during deglaciation.

Ice in Kong Oscar Fjord thinned so that it no longer covered the mouth of Mesters Vig at a time when ice in Storedal was actively abrading the bedrock at the mouth of Mesters Vig.

Emerged marine features indicate sea-level at least 75 metres above present sea-level.

Terminal moraines of the valley glaciers indicate a minor readvance of the ice fronts during recent time.

Isostatic adjustment of the land caused rejuvenation of the streams, resulting in extensive canyon cutting.

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FRED PESSL JR.