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TILL STRATIGRAPHICAL STUDIES IN THE PULJU AREA IN NORTHERN FINLAND

by
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Introduction

Nonorientated, morphologically annular or curved moraine hummocks are called Pulju moraines. In aerial photographs they appear worm-like and winding, forming areas of hummocky moraine on valley bottoms and hollows. They are abundant north of the Late Weichselian

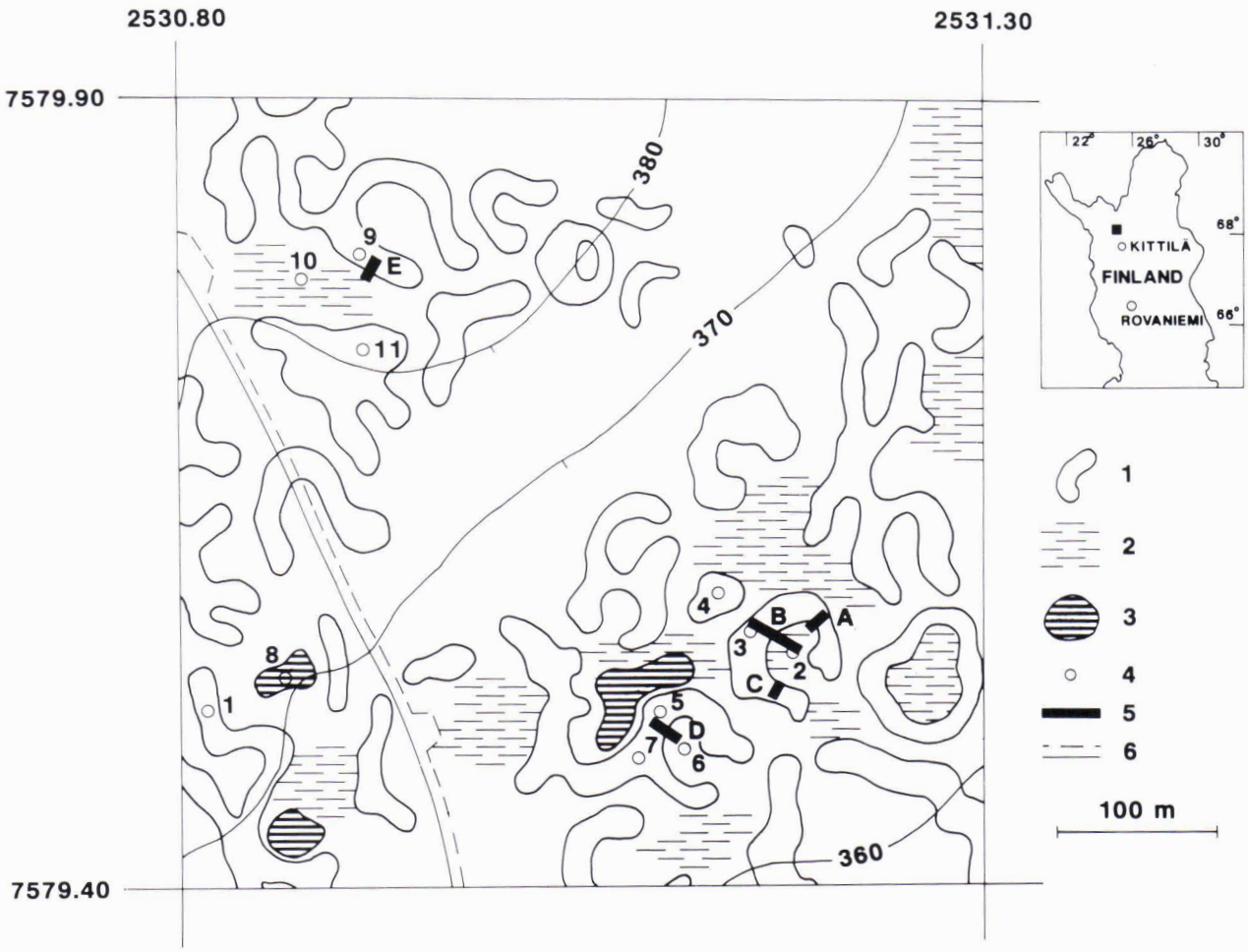

Fig. 1. Investigation region and the work carried out there. 1 = Pulju moraine ridge, 2 = bog, 3 = pool, 4 = drilling site, 5 = test pit, 6 = road.

Fig. 2. Test pit B dug across a Pulju moraine ridge and central hollow.

ice-divide zone, in Inari, in Enontekiö, and in the northern part of Kittilä (Aartolahti 1974). The largest and most well-known area of occurrence is around the village of Pulju, hence the name of this moraine type (Kujansuu 1967).

Field work

The field work was carried out during 1989 to investigate the genesis of Pulju moraines, and the depositional mechanisms of the till material. The area chosen for the study consisted of a group of different types of hummocks and ridges situated north of the Pulju village in Kittilä. The structure and till stratigraphy of individual hummocks and their relation to the ice-flow directions were investigated using air photo interpretation, hydraulic drilling, and by digging test-pits with an excavator (Fig. 1). Drilling and test pit sites were chosen from different parts of the moraine ridges: on crests of the ring ridges, on proximal and distal slopes, in hollows inside the ring ridges, and between the moraine ridges. Stratigraphical interpretation, sampling, and stone orientation measurements of the test pit walls were carried out (Fig 2).

Results

The Pulju moraine ridges of the study area are seldom full circles. Instead, they are mostly open on one side and interconnected (Fig. 3). Their diameter varies from 20 to 150 m. The height of the ridges varies between one and four meters. The hollow of a ring ridge lies two to five meters below the crest. It has often become peaty, and the thickness of the peat varies between one and two meters. There are considerable height differences in the water level of the bog pools between adjacent hollows indicating poor water permeability in the ridge till material.

Three distinct till units were distinguished in the Pulju moraine ridges (Fig. 4). Texturally, they are sandy till. The upper unit is light brown in colour, loose, and sandy with thin sandy lenses and layers. In the lower parts of the slopes and the central hollows the upper unit consists almost solely of sand with structures caused by flowage. Generally, there is a thin layer of sand under the stones. On the crests, the upper unit is from 0.8 to 1.2 m in thickness, and in the hollows about 0.5 m.

The middle unit is denser than the upper one, and grey brown in colour. Sandy lenses are absent, but streaks caused by precipitation can be observed between stones. The thickness varies between two to five meters, being thickest in the ridges and thinnest in the central hollows.

The lowest till unit is coloured dark-grey and is dense in structure. The material contains more stones and larger stones than the two upper units. The upper contact is even and has not been influenced by the overlying till units or their thickness.

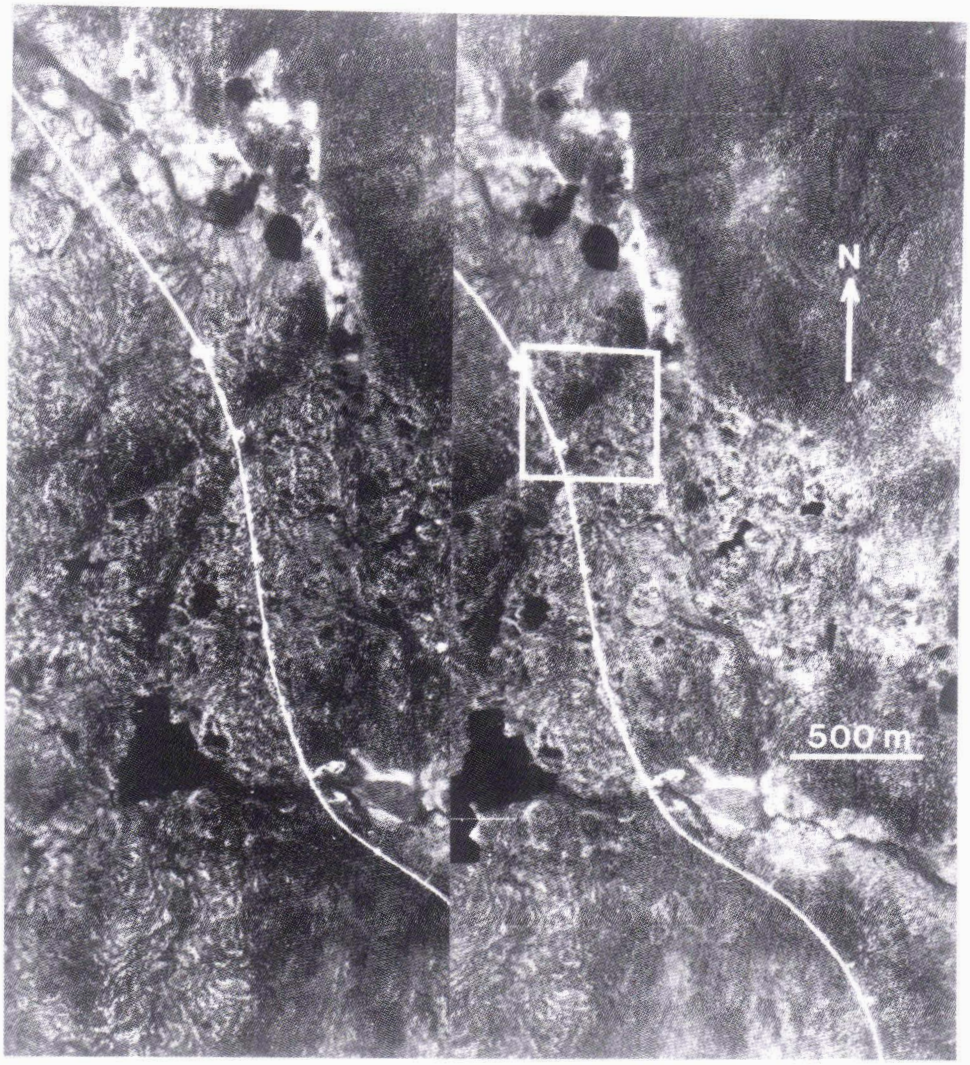

Fig. 3. Stereographic aerial photograph from the Pulju moraine area. Published by permission of the General Survey Office.

The orientation of the stones in the till varies in the various units. The upper unit shows no orientation or ambiguous orientation, and does not correspond to the direction of the ice movement. In the middle unit, clear orientation is distinguished which, however, parallel with the crest orientation. The orientation of the stones in the lowest till unit varies from 170 to 190 degrees. It is equal to the younger direction of flow in the area and it is consistent throughout the test pits.

Conclusions

The lowest stratigraphic unit consists of lodgement till, which has been interpreted while having been formed during the Middle or Late Weichselian stage in the ice sheet base as it was flowing actively northwards from the Central Lapland ice divide zone (Fig. 5A). This is implied by both the physical properties of the till material and the

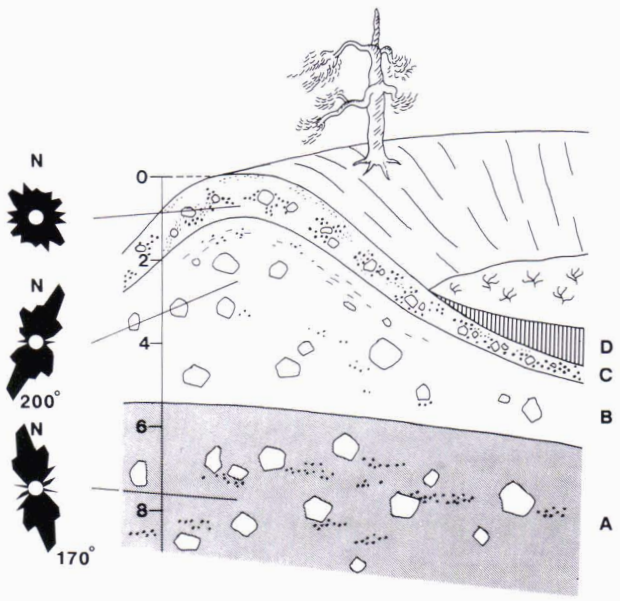

Fig. 4. Stratigraphy of a Pulju moraine ridge: A = lodgement till, B = basal melt-out till, C = supraglacial till, D = postglacial peat.

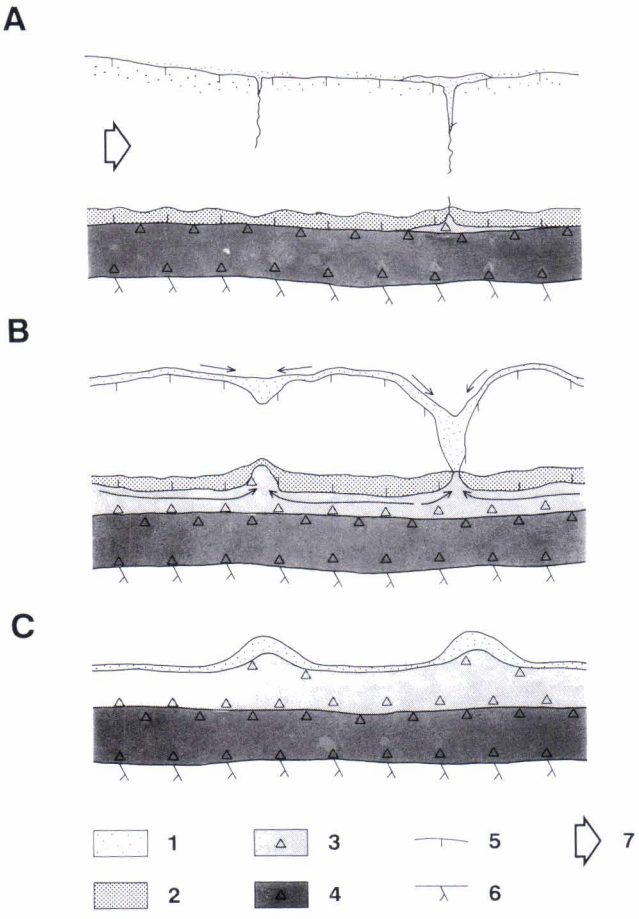

Fig. 5. Graphic presentation of the genesis of Pulju moraine ridges (see p. 2—3). 1 = supraglacial debris and till, 2 = subglacial debris, 3 = basal melt-out till, 4 = lodgement till, 5 = ice, 6 = bedrock surface, 7 = ice-flow direction).

results from the stone orientation measurements. The lowest moraine unit corresponds to till bed II of northern Finlands till stratigraphy (Hirvas et al. 1977). Its upper contact forms a gently undulating even surface, upon which the younger till units were deposited.

The middle unit is basal till interpreted as having been formed as basal melt out till near the margin of the continuous ice sheet, in its basal part. It forms the core of the Pulju moraine ridges which was formed during the deglaciation stage when the ice margin had broken up into blocks and the weight of the ice blocks forced the water-saturated till upwards into the crevasses and fractures of the ice sheet base (Fig. 5B). The stones of the till were oriented transversely with respect to the direction of the squeezing and movement of the till. The orientation of the stones in the middle unit correspond to the results obtained by Aartolahti (1974) from the so called lower till unit. In the Kaaresuvanto area the stone orientation follows the direction of the active ice movement (Aario 1990).

The upper unit is formed from supraglacial material accumulated on the ridges in the weak areas and in the ice fractures. The varying topography of the area, especially the Pulju fell in the south, contributed to the breaking up of the ice sheet margin. The basal parts of the ice margin which retreated to the south stagnated, and a large area of melting dead ice remained on the northern side of the fell. Later, the ice margin broke down into blocks, which were deposited on the ridges, and the supraglacial material fell in between these blocks (Fig. 5C). As the ice blocks left in the hollows melted *in situ,* they released large amounts of meltwater which as it streamed down to the valleys, made openings in the ridges. This is why most Pulju moraine rings are not closed downslope.

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