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WEATHERING STAGE AS A RELATIVE AGE OF TILL IN THE CENTRAL SØR-RONDANE

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Abstract: The Sør-Rondane Mountains are, in places, covered with variously weathered tills that form lateral moraines and/or moraine fields on the flanks of the mountains or supraglacial moraine fields around the mountains. Surface gravels of forty-seven tills were examined for determining the degree of weathering, and those tills were classified into five weathering stages (1a, 1b, 2, 3 and 4). The measurement and classification methods are very simple but useful for understanding the outline of the glacial history of the region, especially the younger part.

1. Introduction

The degree of weathering of surface materials of the ground is an important indicator, because it shows the relative exposure age of formerly ice-covered ground without a radiometric or biostratigraphic age. Moraines, especially lateral ones, indicate past glacial fluctuations. MORIWAKI *et al.* (1991, 1992) have already constructed the glacial history of the Sør-Rondane Mountains region since the Pliocene, based on the degree of weathering of tills, cosmogenic exposure ages (NISHIIZUMI *et al.*, 1991) and glacial landforms. We obtained additional data on the degree of weathering of surface gravels from twenty-five moraines in the central Sør-Rondane, which clarify the more detailed glacial history. This paper presents a preliminary result of the analysis.

2. Investigated Moraines and Classification of Weathering Stages of Tills

The degree of weathering of tills was investigated in Brattnipene (Bn1-14), Lunckeryggen (Jb1-7), Deromfjellet (Dm1-2), Mefjell (Mf1-17) and Bergersenfjella (Bg1-7) in the

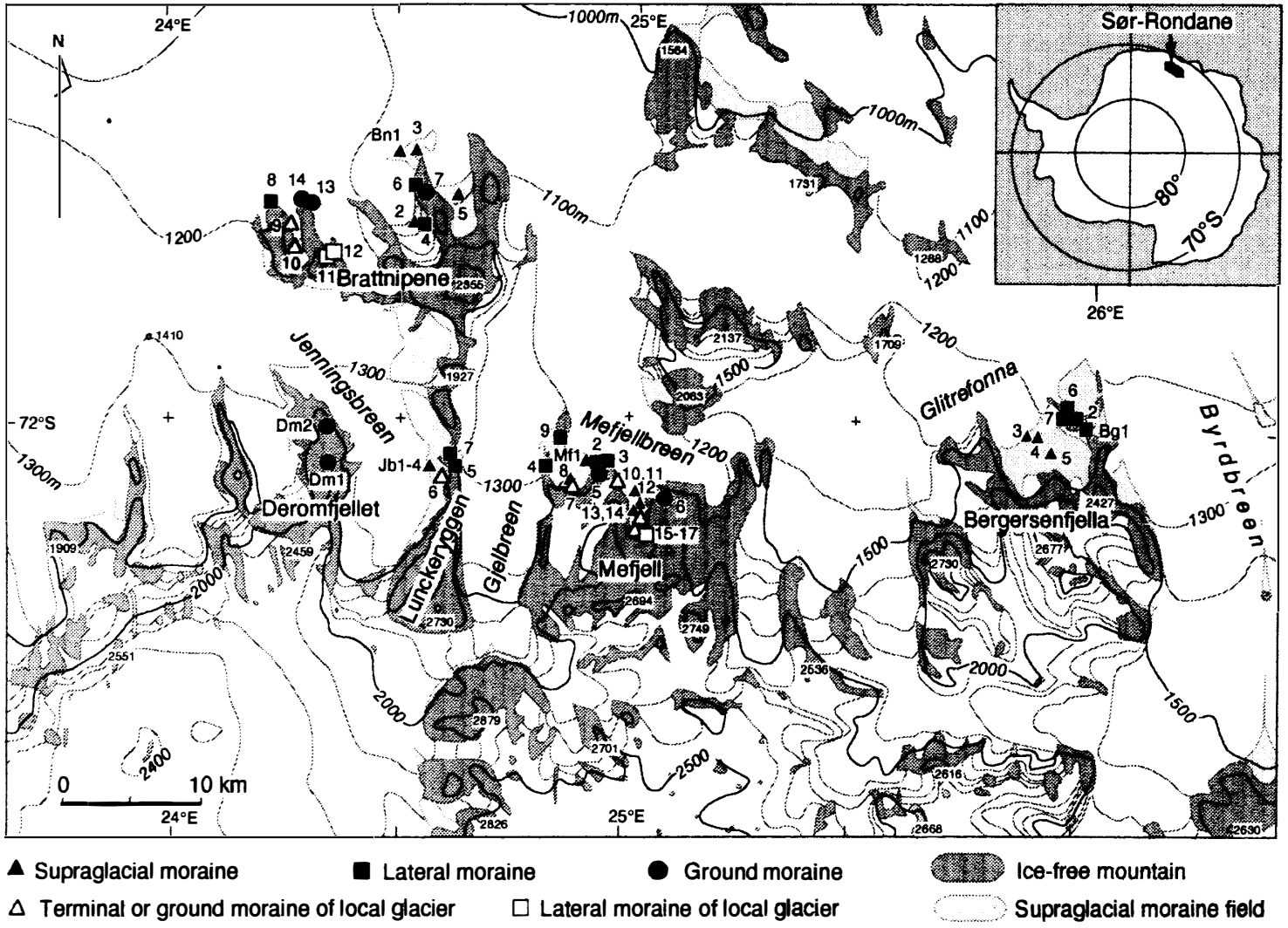

Fig. 1. Location map of the investigated tills in the central Sør-Rondane.

Table 1. The degree of weathering of individual gravel.

DW0	a fresh gravel
DW1	a stained gravel without cavernous weathering, ventifact and crumbing
DW2	a stained, cavernously weathered and/or windfacetted, not crumbled gravel
DW3	a distincky stained and somewhat crumled gravel
DW4	a strongly stained and crumbled gravel

Table 2. Weathering stages of tills.

Stage 1a till	consists almost of DW0 and a few of DW1 gravels
Stage 1b till	consists mainly of DW0 and up to 40 percent of DW 1, 2 and 3 gravels
Stage 2 till	consists mainly of DW1 and some of DW0, 2 and 3 gravels
Stage 3 till	consists mainly of gravels with the degree of weathering higher than DW2, seldom contains DW0 gravels
Stage 4 till	consists mainly of DW3 gravels, contains DW4 ones

central Sør-Rondane (Fig. 1), and on Nils Larsenfjellet (NLf: 22°40′E, 72°14′S) in the western Sør-Rondane. Supraglacial tills showing flow patterns of the underlying ice form thin moraine fields, fringing the mountains or occupying embayments (Bn1-3 and 5, Jb1-4, Mf1 and 12-13, and Bg3-5). Lateral moraines on mountain flanks indicate a former level of a stable ice sheet (Bn4, 6 and 8, Jb5 and 7, Mf2-4 and 9, and Bg1-2 and 6-7). Bn7, Dm1-2, Mf5-6, and NLf are ground moraines situated on flat-top mountains or in ice-free valleys at high elevations. Bn9-12, Mf7-8, 10-11 and 14-17 seem to be tills deposited by local alpine glaciers. Bn1-7, Jb1-7, Mf1-6 and NLf have been reported by MORIWAKI *et al.* (1991).

Measurement was done for the largest 100 gravels in a 10×10 m quadrangle on the surface of each till. Classifications of the degree of weathering of individual gravels (DW) and of weathering stages of tills follow MORIWAKI *et al.* (1991 ; Table 1, 2).

If all the gravels examined show the same degree of weathering, the degree of weathering of till is the same as the degree of weathering of gravels (DW). However, tills consist substantially of gravels of different DW. MORIWAKI *et al.* (1991) introduced the weathering index (*Wi*) indicating the degree of weathering of till, but the weathering index was a misleading and incorrect term in this case. We use the degree of weathering of till (*Wt*) instead of *Wi* (Figs. 2, 3).

$$Wt=0\times N_0+1\times N_1+2\times N_2+3\times N_3+4\times N_4,$$

where the subscripts denote the degree of weathering of individual gravel (DW values), and N_0, N_1, N_2, N_3 and N_4 denote the number (percentage) of gravels of DW 0–4, respectively.

3. Results of Classification and Estimated Changes of the Ice Sheet Surface

Classification of weathering stages of tills, and relations between the weathering stages of tills and their relative heights from the present ice surface, are shown in Figs. 2 and 3. All data are plotted in Fig. 3A ; then, to illustrate changes in the height of the ice sheet surface, we removed data points of the tills originating from local alpine glaciers and

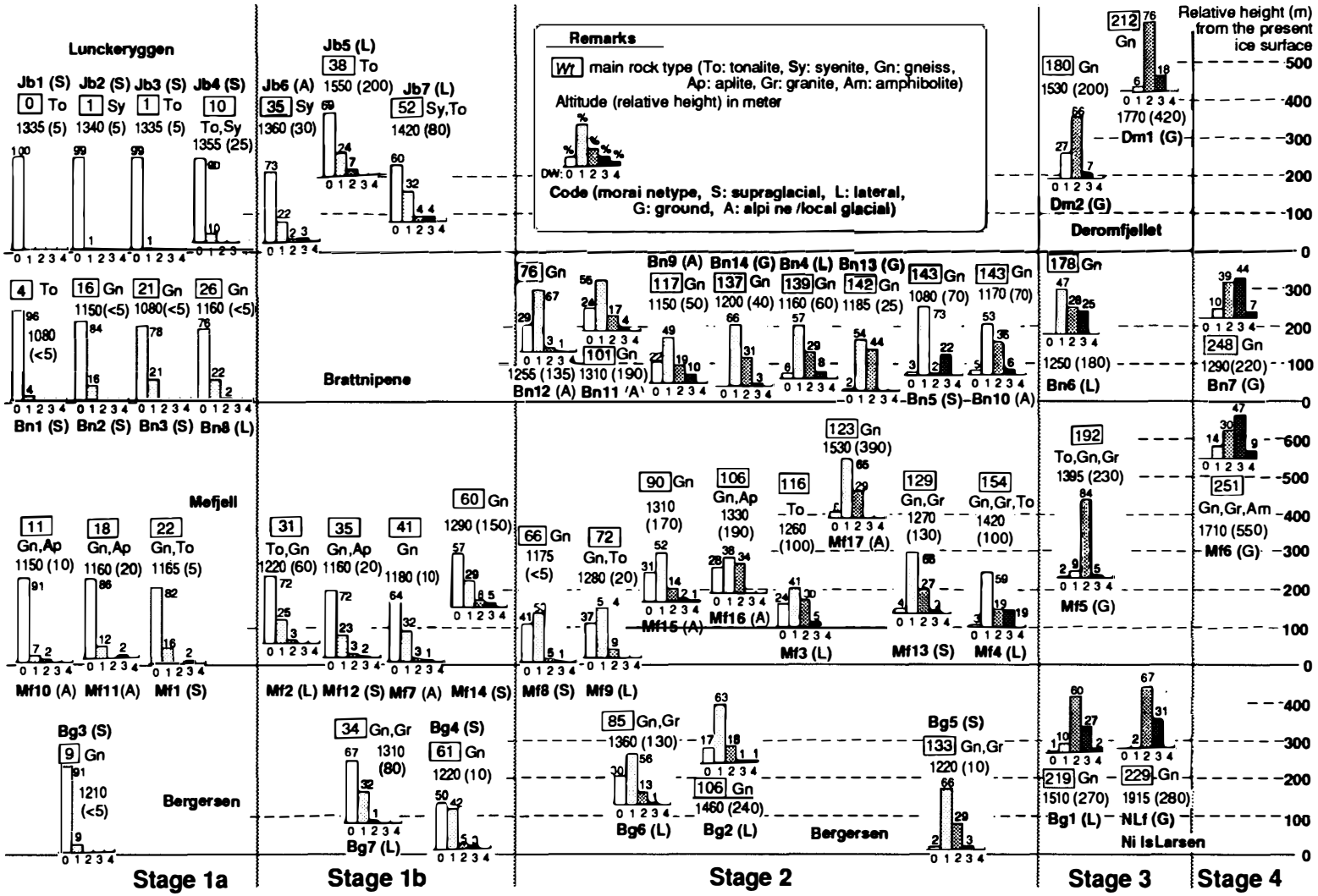

Fig. 2. Classification of weathering stages, and relative height of the investigated position from the present ice surface. DW : degree of weathering of gravel. Wt : degree of weathering of till. Height (figure) of each column shows percentage.

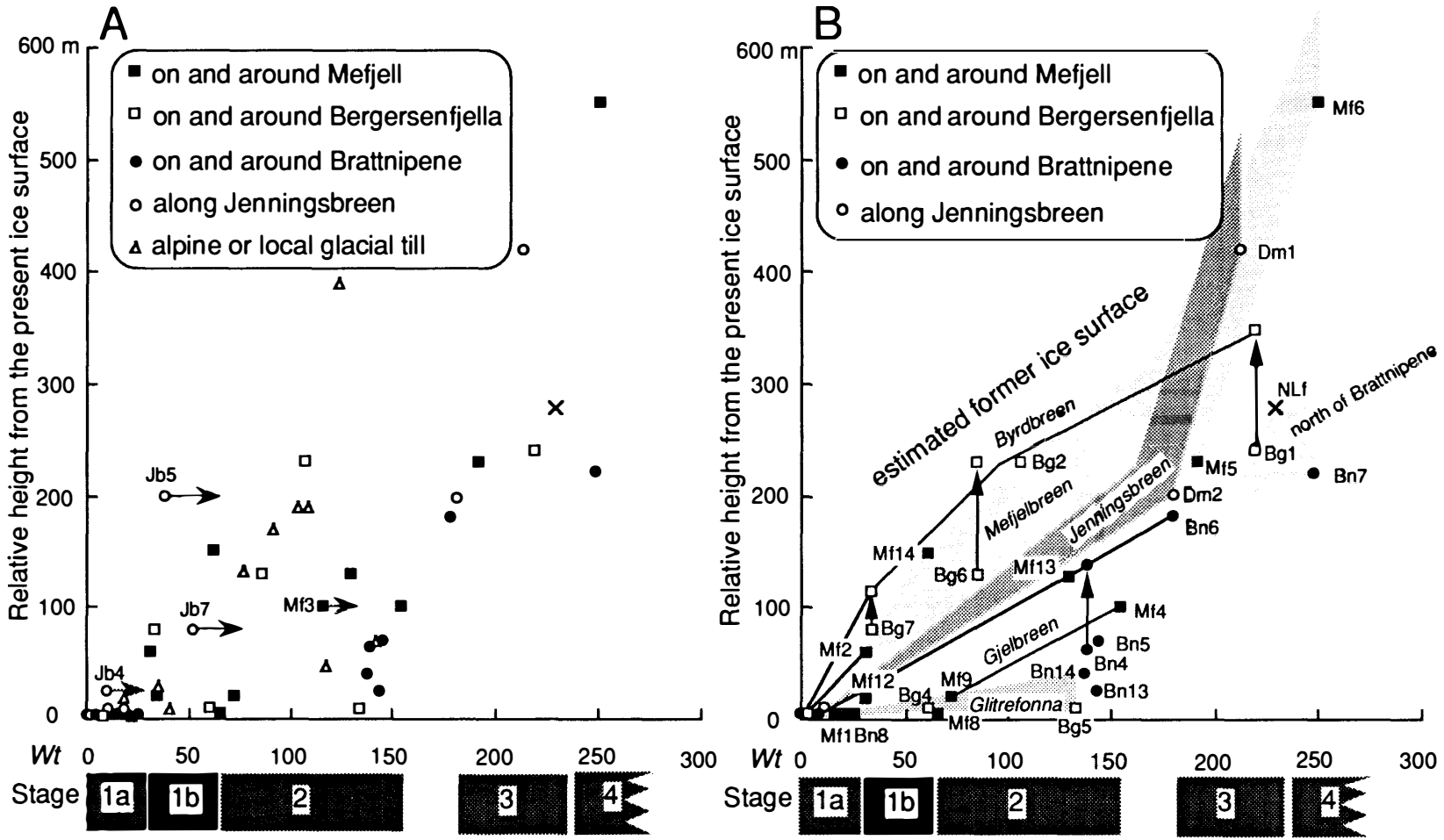

Fig. 3. Graphs showing the relation between weathering stages of tills and their relative heights from the present ice surface. A : All measured tills are presented. Relative height represents investigated height of till above the present ice surface. Tills with arrow consist mainly of tonalite or syenite gravels which weather relatively slowly, therefore they are probably older than the present estimates. B : Tills other than those formed by a local glacier or consisted of tonalite and syenite gravels. An arrow shows the highest position of an individual lateral moraine that probably represents a former ice surface. A shaded area based on ground moraines represents the lowest position of a former ice surface.

consisting of rocks that tend to be not susceptible to weathering (tonalite and syenite; MORIWAKI *et al.*, 1991), then adopted the highest position instead of the measured position as a relative height of individual lateral moraine, as in Fig. 3B. Fig. 3B shows that the relative height of tills decreases toward the present, and probably indicates that ice surface changes were somewhat different locally in the central Sør-Rondane.

Our classification method, measuring only surface gravels, is a simple and easy way for determination of the weathering stages (relative ages), and it enables us to collect data from many places in short field-time. This method is useful for construction of glacial history, especially of younger ages. However, the boundary between Stages 3 and 4 (see Fig. 2) is not yet definitive, because of scarcity of data. Analyses of salt and soil properties in tills (CAMPBELL and CLARIDGE, 1987; MATSUOKA, 1991) will make it possible to subdivide the old tills into several stages.

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