

Additional evidence of pre-Silurian high-pressure metamorphic rocks in Spitsbergen

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It has been previously suggested that the high-pressure metamorphic rock complex of Motalafjella, central-western Spitsbergen, is older than Lower Silurian. An unconformity has been discovered at the base of a limestone which contains fossils similar to those reported as Lower Silurian from the same massif. This proves that the high-pressure metamorphics represent an older rock complex. The unconformity surface is inverted in the area, and large recumbent folds involving the Silurian Bulltinden Formation have been mapped. These folds are considered to be pre-Carboniferous.

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Introduction

A blueschist-eclogite complex has been reported from Motalafjella, central-western Spitsbergen (Horsfield 1972; Ohta 1978; Manby 1978; Ohta 1979). K/Ar ages have been obtained from the rocks in the range 402–475 Ma and at 621 Ma (Horsfield 1972). A Flyshoid succession, the Bulltinden Formation (Horsfield 1972; Hjelle et al. 1979; Harland et al. 1979), is closely connected with the complex, and fossils from the formation are considered to be Lower Silurian in age (Scrutton et al. 1976). Some pebbles of altered schists similar to the glaucophane schists were found in boulder conglomerates of the Bulltinden Formation, and a pre-Silurian age for the high-pressure metamorphic rocks has been suggested (Horsfield 1972).

During the 1983 field survey an unconformity was discovered at the base of the limestone member of the Bulltinden Formation, and this provides concrete evidence that the high-pressure metamorphism is pre-Silurian. In this paper field observations of the unconformity are described and a preliminary re-interpretation of the geological structure of the area is presented.

Geological outline of Motalafjella (Fig. 1)

The Bulltinden Formation makes up roughly 2/3 of the north-eastern Motalafjella, and consists mainly of boulder conglomerate, black shale, grey sandstone alternations, and limestone. The remainder of the massif includes phyllitic rocks and the high-pressure metamorphic rocks of the Vestgötåbreen Formation. All planar structures, both bedding and schistosity, show a monoclinical structure with a gentle curve of strikes. The mean dip is moderate to the west and southwest.

A 10–20 m thick limestone member of the Bulltinden Formation crosses the massif from NW to SE. The boulder conglomerate changes greatly in thickness, and the shale contains several limestone lenses, most of which are fossiliferous.

The Vestgötåbreen Formation consists of two units: a lower

unit of mainly green and black phyllites with subordinate amounts of meta-basic rocks (partly showing pillow structure), quartzite, dolomitic rocks and serpentinite, and an upper unit of mainly high-pressure metamorphic rocks and schistose limestone with a small amount of chert. The phyllites of the lower unit and the micaceous schists of the upper unit have very strong diaphoritic cleavages.

Description of the unconformity

The unconformity has been observed clearly at two localities (A and B in Fig. 1) and supporting evidence has been found at several other localities (C–G in Fig. 1).

Locality A. (Fig. 2)

An about 20 m thick, dark grey limestone bed of the Bulltinden Formation forms a vertical cliff here and is overlain by a dolomitic layer with a characteristic brown, weathered colour. The lower surface of the dolomitic layer has a strongly weathered appearance and is brecciated into angular-subangular blocks, the interstices of which are filled with conglomeratic grey limestone. The limestone is conglomeratic for 3–5 m from its structural upper surface. The clast population includes subangular-rounded blocks and pebbles, up to 20 cm, of mainly dolomitic rocks and subordinate numbers of quartzite, green phyllite, schistose limestone and serpentinite, all components derived from the Vestgötåbreen Formation. The matrix is dense, grey limestone and contains gastropods similar to those reported by Scrutton et al. (1976). Fossil-bearing limestone pebbles are often found in the boulder conglomerate structurally underlying the limestone. A large recumbent syncline crest can be clearly seen on the eastern cliff in the conglomerate. These observations imply that the limestone has an unconformity at its stratigraphic base, although the whole succession is now overturned.

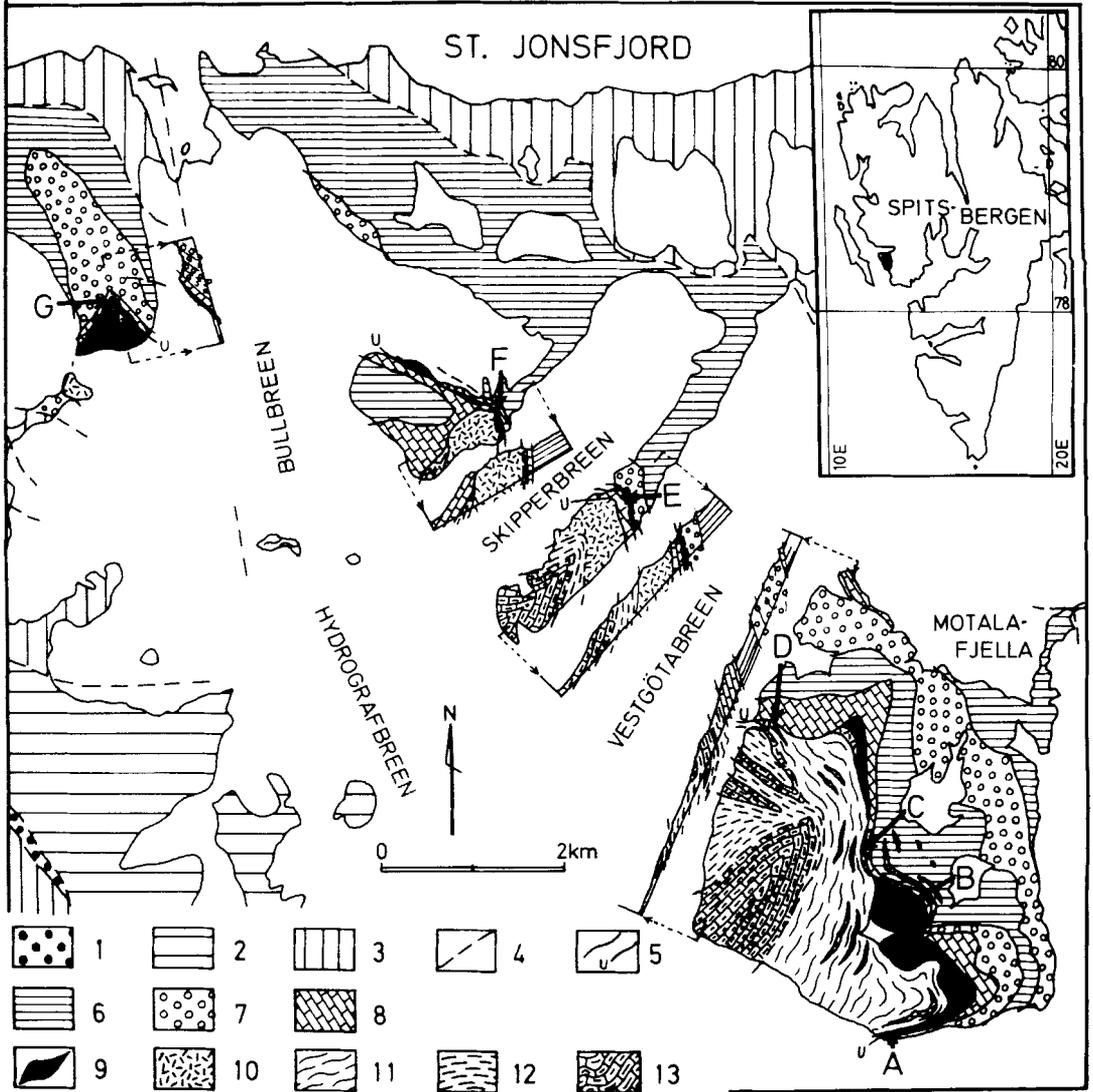


Fig. 1. Geological map of Motalafjella and adjacent area with schematic profiles. 1. Carboniferous. 2. Upper Hecla Hoek rocks, excluding the Bulltinden Formation. 3. Middle Hecla Hoek rocks. 4. fault. 5. lithologic boundaries. u = unconformity. *Bulltinden Formation*: 6. shale-sandstone alternation. 7. boulder conglomerate. 8. limestone. *Vestgötabreen formation, lower unit*: 9. dolomitic rocks. 10. epidote-actinolite greenstone. 11. green and black phyllites. *The upper unit*: 12. high-pressure metamorphic rocks. 13. schistose limestone

Locality B

The contact between the limestone and the dolomitic rock is exposed discontinuously; the contact surface dips 10–20° to the west. The limestone is conglomeratic for 2–3 m from the contact and has subangular to well rounded blocks and pebbles of dolomitic rocks which structurally overlie the limestone. Gastropods have been found within the conglomeratic rocks in the northern part and some cross-laminated beds are totally composed of fragments of gastropods, cephalopods, and trilobites

in the southern part. Thin films of grey limestone penetrate along joint planes of the dolomitic rock.

Other localities

The grey limestone underlies a meta-basic rock of the Vestgötabreen formation at Locality C. The limestone contains some sandy and conglomeratic layers near the contact, and the contact surface does not show any trace of slip. The precise

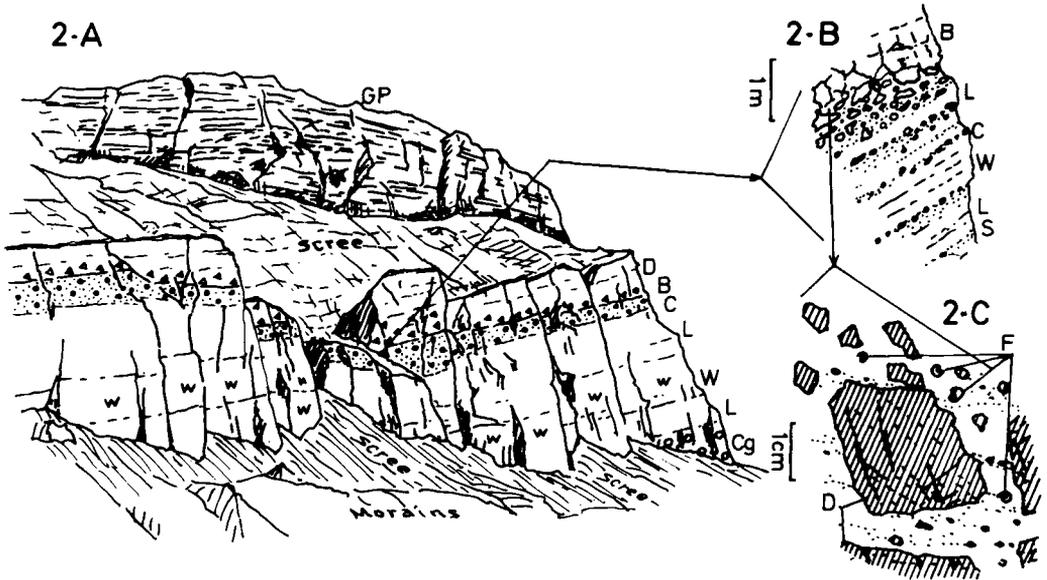


Fig. 2. Sketches of the unconformity at Locality A (after photographs). A: GP—green phyllite, D—massive dolomitic rock, B—brecciated and brown-weathered dolomitic rock, C—conglomeratic grey limestone, L—grey limestone, W—white limestone, Cg—boulder conglomerate. B: Contact between the brecciated dolomitic rock and the conglomeratic limestone, S—sandy limestone. C: Fossils occurring in the brecciated dolomitic rock, F—gastropods, D—dolomitic rock block.

contact is not exposed at Locality D, but many scree blocks of grey limestone contain subangular blocks and rounded pebbles of quartzite, green phyllite and dolomitic rock.

On the ridge south of Skipperbreen (Locality E), the grey limestone underlies an epidote-actinolite greenstone of the Vestgötåbreen Formation without any slip plane. Thin layers of green and white limestone, each layer less than 10 cm thick, form a banded structure near the contact for less than 5 m. A stock-like epidote-actinolite greenstone is enclosed by the grey limestone on the northern ridge of Skipperbreen (Locality F). The limestone overlies the greenstones and high-pressure metamorphic rocks in the central and western part, showing banded structure as in Locality E, while a fault cuts the eastern part and the limestone is in contact with a dolomitic rock without signs of movement. Thus, an overturned anticline is exposed here, although being cut by the fault. The grey limestone underlies a brown dolomitic layer and greenstones on the southern slope of Bulltinden (Locality G), without slip. The conglomerate layers structurally below the limestone show overturned cross-bedding and grading.

Summary

All observations described above, despite the complexity of the folding, prove that the grey limestone member of the Bulltinden Formation formerly rested unconformably on various rocks of the Vestgötåbreen Formation. This is direct evidence that the high-pressure metamorphic rocks of the Vestgötåbreen Formation are older than the Silurian Bulltinden Formation.

Large recumbent folds involving the Bulltinden Formation

are obvious. The Hecla Hoek rocks contain nearly isoclinal folds with sub-vertical axial planes, and are unconformably covered by Lower Carboniferous sandstone on both northern and southern sides of Eidembukta, about 5 km west and southwest of the present area. Isoclinal folds with similar style and axial direction occur in the Carboniferous rocks along the eastern margin of the Tertiary graben of Forlandsudet, 5 km northwest of the present area, but they have different dimensions from the above mentioned ones. Accordingly, these large recumbent folds developed in the Hecla Hoek rocks are most likely older than Carboniferous.

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