28.

RECONNAISSANCE GEOLOGY OF THE PRECAMBRIAN SHIELD ON ELLESMERE AND COBURG ISLANDS, CANADIAN ARCTIC ARCHIPELAGO

Project 760023

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Abstract

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Reconnaissance geological mapping of the Precambrian Shield on Ellesmere and Coburg islands has been completed. The Shield area was metamorphosed entirely in the granulite facies. Detailed work on the unmetamorphosed Proterozoic sedimentary and igneous rocks of the Thule Basin has enabled correlations to be made both between the three main areas of outcrop and with the lower part of the Wolstenholme Formation on Greenland. Minor occurrences of Cu-Fe sulphides and malachite are common in metasedimentary basement rocks; malachite is also found in Thule Basin igneous rocks.

Introduction

The 1977 field season saw the initiation of airborne reconnaissance mapping of the northernmost part of the Canadian Shield. The Shield areas of eastern and southern Ellesmere Island and Coburg Island (Fig. 28.1) were mapped on a scale of 1:250 000 (NTS 39B, C and F, and parts of 39D, G and H; part of 48H; and parts of 49A, B, D, E and H). Mapping on Devon Island is planned for 1978 and that work should complete the geological reconnaissance of the Churchill Province of the Canadian Shield.

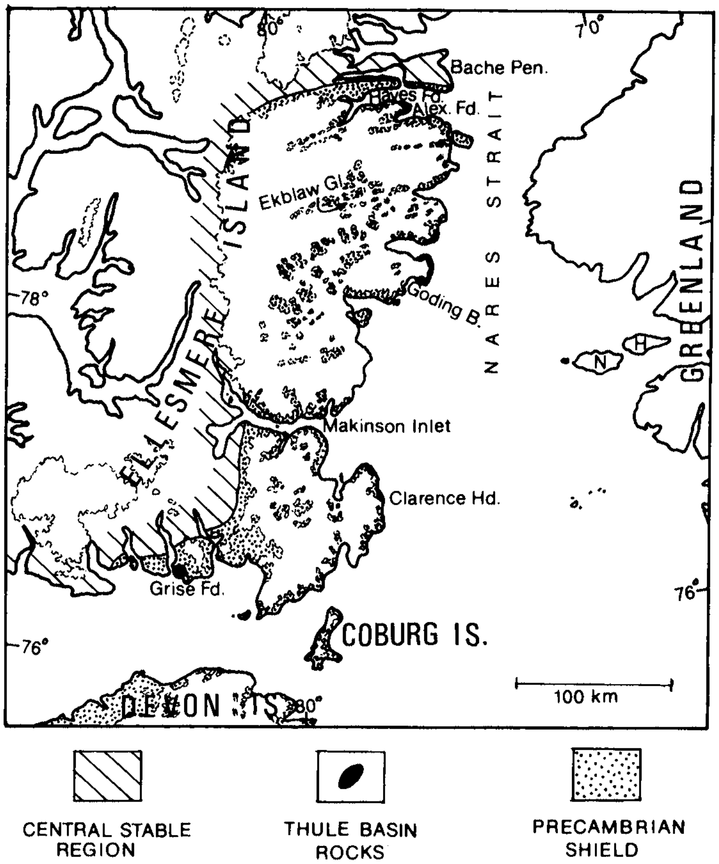

Figure 28.1 Locality map showing the extent of the Precambrian Shield on Ellesmere and Coburg islands. Only the major rock exposures in the area of heavy ice and snow cover are shown. Northumberland and Herbert islands in Greenland are marked "N" and "H".

Relief and permanent snow and ice cover in the map-area are considerable (Fig. 28.2). Coastal cliffs commonly rise to 500 m and nunataks to 1500 m a.s.l. The greatest relief - 2300 m - is found in the northwestern part of the area.

Prior knowledge of the Precambrian was based chiefly on the dog-sledge traverses of Christie (1962a,b), whose observations were of necessity confined largely to the coasts but included considerable detail on the Proterozoic Thule Basin rocks. A K-Ar date of 1760 m.y. on a gneiss from southeast Ellesmere Island is the only isotopic age available.

Crystalline Basement

The entire crystalline basement of Ellesmere and Coburg islands has been metamorphosed in the granulite facies. Rocks that in the field appear to be of amphibolite grade are interpreted as having been downgraded.

The basement rocks may be divided into the following broad groups:

(1) Massive to foliated quartzofeldspathic granulites. These rocks appear more or less homogeneous, are green on fresh, and brown or red on weathered surfaces, and commonly carry abundant feldspar porphyroblasts. They are the major rock-type in the Grise Fiord area.

(2) Metasediments. These include garnet-biotite gneisses, commonly with sillimanite and/or cordierite, well-banded hornblende ± pyroxene gneisses, diopside-bearing marble, and subordinate quartzite. Amphibolite is a common associate.

(3) Amphibolites, which generally carry at least one pyroxene.

(4) Granulite gneisses are distinct from the granulites of unit (1) in that they are heterogeneous and well banded pyroxene-bearing quartzofeldspathic rocks. Some have a metasedimentary aspect and indeed may be associated with, or even grade into, undoubted metasediments. Other varieties are of more uncertain origin. If an equilibrium one, the association hypersthene-sillimanite-quartz found in this unit suggests temperatures and pressures of metamorphism in the neighbourhood of 900°C and 10 kb.

(5) Granitic rocks. These are generally pink and weather red or brown, similar to the granulites, a fact which makes their distinction from the latter difficult at times, unless sampling is possible. The unit includes a diversity of types and, probably, ages of rock. In the Grise Fiord area and elsewhere, pink granite invaded and partly assimilated granulite. This major event was followed by severe

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Figure 28.2 Typical Shield terrain in gneisses and granulites north of Makinson Inlet. GSC 203055-Q

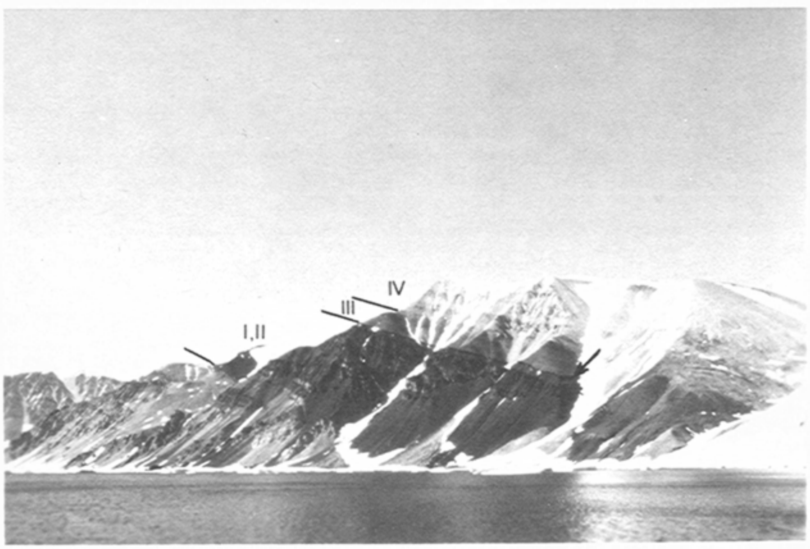

Figure 28.3 Unmetamorphosed Thule Basin rocks overlying steeply-dipping gneisses immediately south of Clarence Head. The Roman numerals refer to the units shown in Figure 28.4. At this locality, unit I is only 4 m thick. Arrow at right points to the thin, resistant stromatolitic carbonate bed at the base of unit III. GSC 203055-P

deformation, resulting locally in a granite-banded granulite gneiss. Garnet is common in both the granulite and granite. A medium- to coarse-grained, potassic granite outcrops extensively in the northwestern part of the area. While generally massive, this granite is foliated in places. In fact—discounting aplites and pegmatites — no undoubted post-tectonic granitic rocks were observed. A similar impression was gained by G.D. Jackson (pers. comm., 1977) in the spatially-related high-grade terrain of Bylot Island and northeastern Baffin Island.

Minor bodies of anorthosite were noted in the northern part of the area.

Relations between lithologic units of the basement have been largely obscured by intense deformation (or are frequently hidden under snow and ice). Generally, dips are steep to vertical and isoclinal folds are common. Recumbent folds were also recognized and, judging by frequent rapid changes in dip from shallow to steep, probably constitute a major fold type. A later phase of tectonism gave rise to broad, open folds. A northerly regional gneissic trend can be discerned but local variations are numerous and marked.

In lithology, grade of metamorphism and tectonic style, the crystalline basement of Ellesmere Island bears many similarities to that of northwestern Greenland (Dawes, 1976).

Proterozoic Thule Basin Rocks

Unmetamorphosed sedimentary and igneous rocks nonconformably overlie basement in several areas on the east coast of Ellesmere Island (Fig. 28.1). These beds belong to the Thule Basin sequence, the bulk of which is exposed on the Greenland side of Nares Strait (Christie, 1972). Figure 28.3 shows part of the southernmost outcrops, near Clarence Head; their variegated appearance and gentle dip are typical.

A schematic columnar section of the Thule Basin sequence on Ellesmere Island is presented in Figure 28.4. Nowhere is the entire section exposed nor are the successions in the various localities identical, yet the similarities suffice to permit correlations between them. Further analysis of the field data is necessary but the thickness of the entire section probably lies between 1000 and 1500 m, somewhat less than the 1800 m thickness estimated by Christie (1972).

The sediments clearly were deposited in a nearshore to subaerial environment. Orientations of cross-bedding commonly indicate westward-directed currents but bimodal transport patterns, strongly suggestive of tidal influence, predominate in many localities.

The Thule Basin sequence on Ellesmere Island can readily be correlated with the lower part of the Wolstenholme Formation of middle Proterozoic age (Dawes, 1976) in the Thule area of Greenland, in particular Herbert and Northumberland islands (Fig. 28.1).

Paleozoic Strata

The Precambrian Shield on Ellesmere Island is bordered on the west by Paleozoic rocks of the Central Stable Region (Christie, 1972). Evidence that the sedimentary cover once extended much farther over the Shield is provided by Paleozoic outliers in the interior of the Shield area.

The Paleozoic strata comprise carbonates and clastics ranging in age up to Devonian. Although structurally simple, the Paleozoic rocks form a succession that is unusually thick and complex, considering its proximity to the Precambrian Shield. Systematic mapping of these rocks has yet to be undertaken in much of the area.

The Precambrian-Paleozoic contact was mapped over the entire area and examined at a number of localities. The underlying granitic and granulitic basement rock is commonly a dusky red, a feature attributable to weathering, but no regolith was observed. The basal Paleozoic strata are quartz-pebble conglomerate, quartz sandstone and ripple-marked silty sandstone, some of which are ferruginous. No fossils have been found but these beds are probably lower Cambrian.

The striking contrast between the light-weathering Paleozoic and the darker basement greatly facilitates recognition of major block faulting. Faults with throws of several hundreds of metres are common.

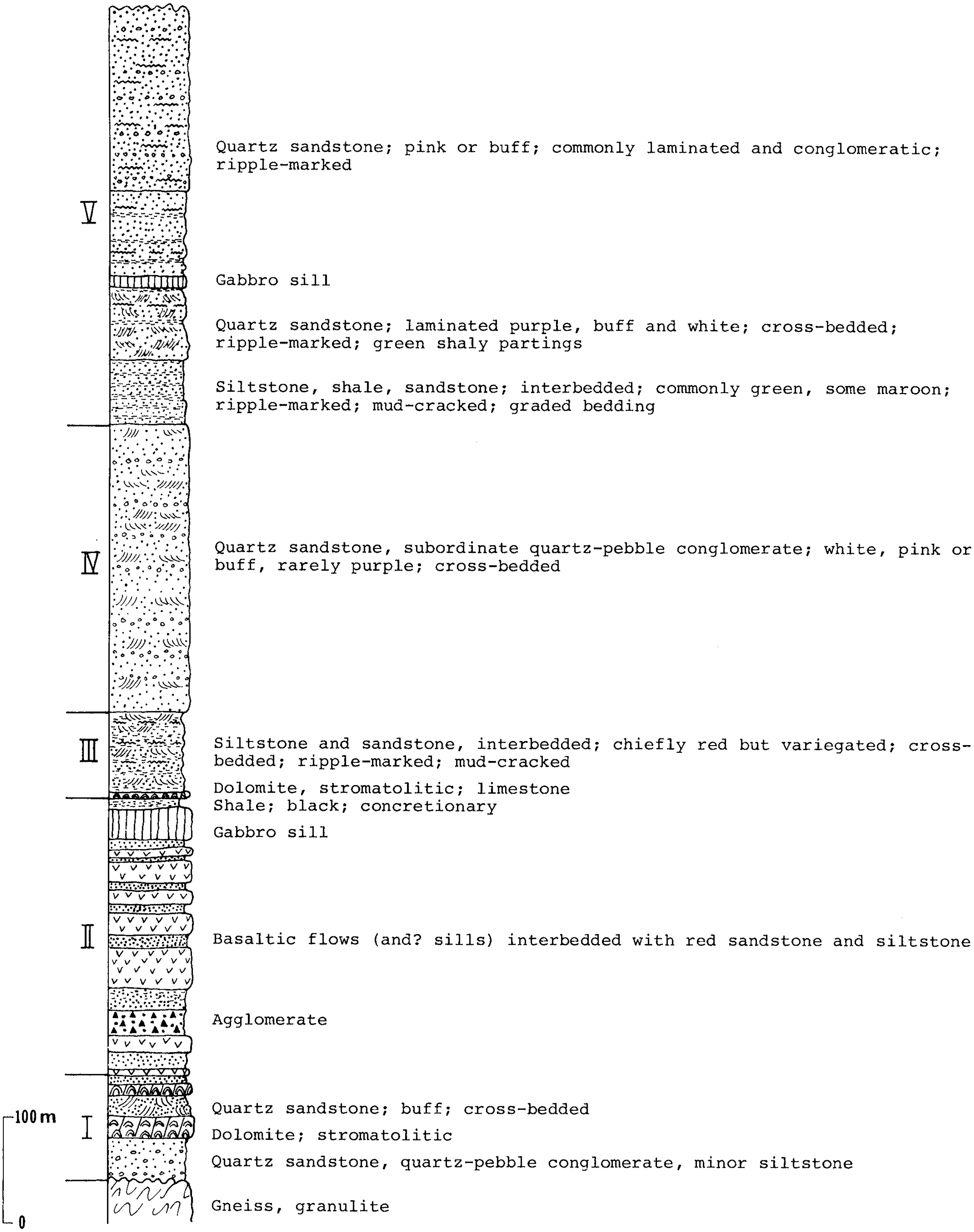

Figure 28.4 Composite, somewhat schematic columnar section of the Thule Basin sequence on Ellesmere Island. Compare this with section 8 (Herbert and Northumberland islands) of the sequence on Greenland in Dawes (1976, Fig. 232).

Diabase Dykes

Diabase dykes are distributed throughout the Precambrian terrane, generally trending northerly or northeasterly; they have not been seen cutting Paleozoic rocks. No major swarms were noted but dykes are numerous in the areas of Thule Basin strata, particularly Clarence Head and Goding Bay (Fig. 28.1).

Economic Geology

Minor occurrences of metallic minerals are common in the metasedimentary unit (2) of the crystalline basement. In the Alexandra Fiord area (Fig. 28.1), impressive gossans have developed over pyrrhotite ± chalcopyrite ± sphalerite-rich zones up to 8 m wide in the gneisses. Malachite staining was found in metasediments on the north shore of Makinson Inlet, along Ekblaw Glacier and on the south shores of Hayes Fiord and Bache Peninsula (Fig. 28.1); it was also seen on the cliffs formed by unit II of the Thule Basin sequence near Clarence Head (Fig. 28.3).

Seams of low-grade coal are abundant in sediments of the Eureka Sound Group of Cretaceous-Tertiary age, which outcrop in the Central Stable Region near the western edge of the ice cap.

Acknowledgments

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