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H. K. S., Geological Survey of Greenland, Copenhagen.

Geological setting of Precambrian supracrustal belts: a fundamental part of mineral resource evaluation in Greenland

Peter R. Dawes and Hans K. Schønwandt

In Precambrian shield areas the economic potential of supracrustal rocks is well documented, and some of the world's largest metal deposits are found within these sequences. The Black Angel lead-zinc stratabound mineralisation at Mârmorilik in central West Greenland (71° 10′N, Fig. 1), hosted in the Proterozoic Karrat Group, is one commercial enterprise that confirms that this potential can be realised in Greenland. In last year's volume of Report of Activities, Thomassen (1991a) gave a history of the geology and mineral exploration of the Black Angel deposit.

The closure of the Black Angel mine in 1990 determined that Greenland entered the last decade of this century without an operative large-scale mining project. (The Ivigtut cryolite mine in South-West Greenland ceased on-site extraction in 1987.) Thus there is mounting expectancy that the exploration programmes presently being undertaken by commercial companies and those in the planning stage will lead to a fairly prompt resumption of the exploitation of Greenland's mineral resources.

The relationship between the work areas of the commercial sector and the role of GGU with its wide range of short- and long-term scientific programmes has been outlined by Schønwandt (1992). More than ever before GGU's field programmes are designed at solving the geology of areas of economic importance, and GGU strives to assemble the sort of information that enables commercial enterprises to choose exploration targets.

This paper deals with one such programme: the mineral resource investigation of supracrustal belts of western Greenland.

Data on supracrustal belts

On GGU's geological maps of Greenland (sheets 1 to 5 at 1:500 000; see index map page 43 of this volume) supracrustal rocks in western Greenland are seen as patches and strips of green and brown within the very predominant red and orange colour of the gneiss complexes. The one exception is in the region between 71° and 75°N where vast areas of the early Proterozoic

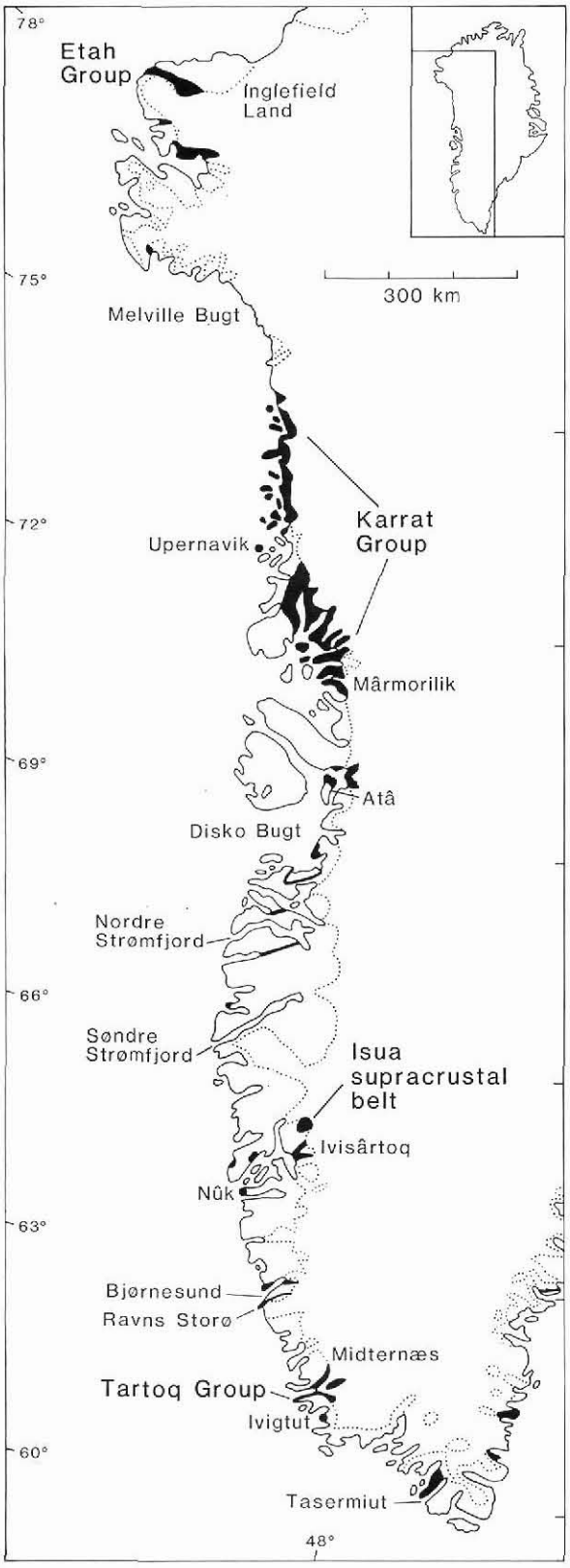

Fig. 1. Sketch map of western Greenland showing the main supracrustal belts.

Karrat Group and its equivalents dominate over infracrustal rocks (Fig. 1).

Map information in GGU archives on Precambrian supracrustal sequences varies from reconnaissance data to detailed field maps at 1:20 000. Much of the initial information pertaining to these sequences was obtained as part of regional systematic mapping programmes aimed specifically at production of the national map sheet coverage at 1:100 000 and 1:500 000. From time to time larger-scale maps covering supracrustal areas have been published by GGU and co-workers, for example at scales 1:20 000 and 1:40 000, and issued as part of detailed lithostratigraphic descriptions and regional appraisals (e.g. Bondesen, 1970; Higgins, 1970; Muller, 1974; Garde, 1978; Nutman, 1986; Fig. 2).

These maps have been the prerequisite for exploration work by commercial companies, as well as for later studies by GGU that have involved regional geochemical surveys (e.g. Armour-Brown *et al.*, 1982; Olesen, 1984; Steenfelt, 1987) and investigations of selected mineralisation targets (e.g. Appel & Secher, 1984; Secher & Kalvig, 1987). As part of the enacted policy of improving the information service to the mining community, GGU now publishes unedited reports summarising preliminary field data and analytical results stemming from relinquished concessions as well as from GGU's own investigations (e.g. Appel, 1989, 1990a, b, 1991; Thomassen, 1990, 1991b, 1992; Steenfelt, 1990; Erfurt, 1990; Erfurt & Lind, 1990). These data compilations form a main part of the Open File Series.

Modern geological appraisal

There is a growing consensus that the key to the understanding of the time-space distribution of metal deposits is to be found by reference to geologic and tectonic environments. It is now widely accepted that there is a demonstrable relationship between the type of ore deposit and global tectonic processes, and this has led to the first attempts at the classification of ore deposits with reference to plate tectonic scenarios (e.g. Guilbert, 1981). At the same time Precambrian shield regions are being explained in terms of 'terrane models' that many authors advocate show processes broadly analagous to Cenozoic plate tectonics. Such interpretations of Archaean and Proterozoic crystalline areas of the North Atlantic region, including Greenland, are now in vogue (e.g. Kalsbeek *et al.*, 1987; Friend *et al.*, 1988, 1990; Hoffman, 1988, 1989; Nutman *et al.*, 1989; Grocott & Pulvertaft, 1990; Windley, 1991).

While much of the plate tectonic activity ascribed to the Precambrian is obviously highly speculative, its application to Archaean and Proterozoic complexes pro-

Fig. 2. East-dipping Ketilidian supracrustal rocks in contact with Archaean gneisses. Grænseland, South-West Greenland. Photo: Peter Appel.

vides a practical model with which supracrustal, infracrustal and intrusive complexes can be classified. A long-term metallogenetic programme aimed at assessment of Greenland's mineral potential, with respect to primary environments and tectonic regimes, has been initiated at GGU. Determination of geological setting is a major step in the mineral resource evaluation of supracrustal belts.

Recent field work and planned projects

Central West Greenland. In the region between 69° and 72°N detailed work on Archaean and Proterozoic supracrustal rocks, including the widespread Karrat Group, commenced in 1989 and took place in part during the 'Disko Bugt Project' (1988–91, see Kalsbeek, 1989, 1990; Kalsbeek & Christiansen, 1992). The metallogenetic aspects of this programme have been reported on by Thomassen (1990, 1991b, 1992) and Schønwandt (1990, 1991).

Southern West Greenland. In 1991 field work was concentrated around latitude 63°N on the Ravns Storø and Bjørnesund supracrustal belts (Fig. 1), and carried out as part of the 'Bjørnesund Project' (see Appel, 1992).

South and South-East Greenland. The understanding of the Proterozoic Ketilidian mobile belt that crosses the southern tip of Greenland is very heterogeneous. The western part of the belt in South-West Greenland has been studied in detail (1:20 000 mapping); in contrast the eastern part extending as far as the south-east coast of Greenland is only cursorily known, and on the 1:500 000 map sheet (sheet 1: Sydgrønland) several inland areas are shown blank.

Project SupraSyd, planned to be run over several field seasons, is aimed at providing an economic assessment of the supracrustal rocks and intrusions of the Ketilidian mobile belt. The project will be initiated in 1992 with a reconnaissance of the relatively unknown eastern region, that is known to contain a variety of supracrustal sequences in which acid volcanic rocks and volcaniclastic sediments appear to play a prominent role. The geological setting of these rocks, and their relationship to the better known western part of the mobile belt, is unknown. The scattered information available from South-East Greenland (up to 62° 30'N) points to a potential economic target (Andrews *et al.*, 1971). The volcanic rocks and the appreciable thicknesses of gneissic lithologies derived from them are favourable hosts for sulphides, and in Andrews *et al.*

Fig. 3. Mafic supracrustal rocks containing banded iron formation within orthogneiss complex. Sidebriksfjord, Melville Bugt. Height of cliff about 450 m. Photo: P. R. Dawes.

(1971, p. 37) we find the tantalising comment that the region "is more likely to yield ore minerals than most of the gneissose terrains so far described from Greenland".

In the initial season, Project SupraSyd will investigate the economic potential of these poorly known supracrustal and gneiss complexes and relate their genesis to the previously mapped western part of the Ketilidian mobile belt. Subsequent field seasons will focus on selected supracrustal areas from an economic viewpoint and attempt classification of the different segments of the mobile belt within a modern geologic and tectonic terrane model. In this, the recent analysis of the Ketilidian belt by Windley (1991) will be a useful reference model, although this model is primarily based on field mapping by GGU more than 25 years ago.

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P. R. D. & H. K. S., Geological Survey of Greenland, Copenhagen.