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Field report on combined Anglo–Bulgarian geological studies in northern Alexander Island

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Introduction

The structural basement of Alexander Island consists of a wide belt of accretionary complex rocks, the LeMay Group (Burn 1984). This is overlain by ?Cretaceous–Tertiary calc-alkaline volcanic rocks (Burn 1981), and intruded by several slightly younger, but related, plutons (Care 1983). The Rouen Mountains batholith is a large group of these plutons which occurs in the northern part of the island.

All of these rocks were studied by a joint British Antarctic Survey (BAS)/Sofia University geological project (Fig. 1) during the 1987–1988 season supported by BAS Twin Otter aircraft from Rothera. The combined aims of the project were to collect samples for petrological, geochemical, and isotopic study from the Rouen Mountains (B.K.K.), and to undertake detailed sedimentological (C.T.P.) and structural (P.A.R.N.) observations in the LeMay Group, as well as to provide Antarctic experience for the Bulgarian members of the party at the start of their Antarctic programme.

LeMay Group

At Cape Vostok (Fig. 1), thin beds of limestone, with thin chert laminae, occur in a strongly disrupted sequence of greywackes and shales with some beds of red bedded chert. This is the first known significant occurrence of limestone in the LeMay Group. These lithologies are otherwise identical to those seen at Debussy Heights (Fig. 1), and appear to represent their northward, along-strike continuation. The Cape Vostok area shows a similar structural style to Debussy Heights, with a complex history of soft-sediment deformation, cleavage formation and later north-easterly-directed thrusting, as well as a large number of major westerly-dipping normal faults.

In the Douglas Range (Fig. 1) a major westerly-directed thrust-belt, which post-dated the cleavage-related folds in the area, was found during a previous season (1985/86) in the course of a 9 km long traverse, eastwards from the foot to the summit of the Douglas Range. An imbricate stack of easterly-dipping thrust sheets is exposed which become increasingly steeply-dipping and eventually overturn towards the eastern end of the section. A reconnaissance of other parts of the Douglas Range by the authors, traced similar structures 27 km along-strike from the vicinity of Tufts Pass to locality 5 (Fig. 1). This out-of-sequence thrust-belt is an important structural feature of the northern part of the island. A sole thrust to the thrust-belt runs nearly north-south along the east bank of Hampton Glacier at the foot of the Douglas Range, and a possible roof thrust may exist in the Toynbee Glacier area.

Six detailed sedimentological logs were measured through turbidite sequences at localities distributed across northern Alexander Island. Lithofacies similar to Burn's (1984) medium- and thinly-bedded lithofacies and his massive ungraded lithofacies were recognized. The former consisted of packets of turbidites, which alternate with units of the latter facies comprising thick beds of massive, ungraded, medium- to very coarse-grained sandstones, separated by

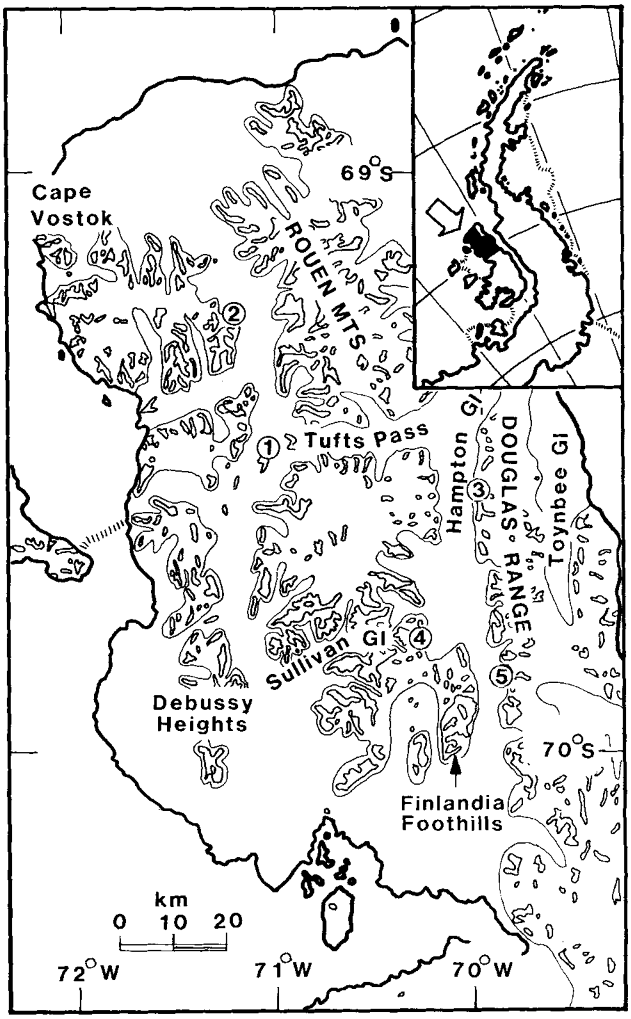

Fig. 1. Map of northern Alexander Island, showing the numbered and named localities mentioned in the text.

thin beds of mudstones; an association typical of flysch-type sequences. In these massive units, some sandstone beds are amalgamated. Five sections (Fig. 1, localities 1–5) showed clear thickening- and coarsening-upward trends. Preliminary sedimentological results indicate that these rocks may represent deposition in a progradational system (cf. Macdonald 1986).

Some samples from LeMay Group turbidite sequences in northern Alexander Island yielded several foraminifera, confirming their Mesozoic age (see review, Tranter 1987), which it is hoped further work should refine.

A rich assemblage of trace fossils was collected from locality 3 in the Douglas Range. They belong to several ichnogenerae: *Helminthoida*, *Palaeomeandron*, *Muensteria*, *Chondrites*, *Zoophycos*? This ichnocoenosis is commonly assigned to the deepwater *Nereites* ichnofacies.

Tertiary calc-alkaline volcanic rocks.

Basaltic flows from Finlandia Foothills were sampled for geochemical work. These rocks are basalts, andesitic basalts and andesites (Burn 1981, recent unpublished analyses B.K.K.). The basalts and andesitic basalts contain phenocrysts of orthopyroxene and clinopyroxene, whereas the andesites are hornblende-phyric. Minor strike-slip faults are present, confirming that some strike-slip deformation has occurred since 60 Ma ago.

Tertiary Rouen Mountains batholith

Many localities in western Rouen Mountains (Fig. 1), which Care (1983) visited during his reconnaissance of the area, were sites from which more detailed sampling for geochemistry was undertaken. An examination was made of the field relationships of the plutonic phases.

Gabbro was found as inclusions in the granite of north-west Rouen Mountains, extending the range of magmatic evolution in the area, from that described by Care (1983). Cross-cutting relationships showed the following sequence:

a. gabbro,
b. diorites and quartz diorites,
c. quartz-monzodiorites, monzodiorites and granodiorites,
d. granites,
e. granite porphyry,
f. aplites.

From field relations, the first three phases (a–c, above) can be distinguished as separate magmatic pulses in what had formerly been regarded as a homogenous granodioritic batholith (Care 1983). All these three contain biotite and hornblende as mafic minerals. However, Care distinguished separate plutons of granite and adamellite in south-west Rouen Mountains. This distinction now appears to be less significant than formerly thought, and may be the result of local fluid interactions during the crystallization of a common granitic phase (d above).

Aligned xenolithic inclusions and biotite flakes define a fabric near the margins of the plutons. The orientations of these marginal fabrics allow the shape of the batholith to be reconstructed as a north-south oval cupola-like form. The Rouen Mountains show variations in erosion levels, from near the batholith-roof in the south, to slightly deeper levels in the north. Some minor faults are present in the batholith. These faults are most frequently parallel to the main, sub-vertical, joint-orientation in the batholith, which strikes NE–SW. The faults show shallowly-pitching slickensides, and were the locus for the intrusion of later intermediate dykes. These features may be related to a period of Tertiary strike-slip deformation (Storey & Nell 1988). The weak internal deformation of the batholith contrasts with the transposed fabrics of the aureole, which were developed by temperature-related softening during the intrusion of the batholith.

Conclusions

The results of this project have advanced our understanding of the geological development of northern Alexander Island. These include the identification of Tertiary strike-slip deformation, the recognition of the importance of major out-of-sequence thrusting, and a better understanding of the relationships between the intrusive phases in the Rouen Mountains batholith. More is now known of the sedimentology of the LeMay Group, and new constraints have been put on its age.

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