35.

A DETAILED CROSS-SECTION THROUGH THE SOUTHERN MARGIN OF THE FOXE FOLD BELT IN THE VICINITY OF DEWAR LAKES, BAFFIN ISLAND, DISTRICT OF FRANKLIN

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Abstract

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The Aphebian Piling Group along the southern margin of the Baffin Island Foxe Fold Belt mantles an Archean basement terrane and consists of a basal quartzite and schist overlain by a thick metagreywacke-phyllite section which contains a variable assemblage of amphibolites and ultramafics near its base. Early isoclinal interfolding of basement and cover during the peak of metamorphism was followed by compressional folding which dominated deformation at upper levels while initiating and localizing along antiformal hinges the active gravitational gneiss remobilization which superceded it at depth. The present outcrop pattern is dominated by elongate domes surrounded by complex fabrics resulting from the superimposition of upright folding and gneiss doming on an older subhorizontal schistosity.

The 1977 field season involved two months 1:50 000 scale mapping of a detailed structural and stratigraphic cross-section through part of the southern margin of the Foxe Fold Belt near Dewar Lakes, Baffin Island (DEW line site FOX 3, Fig. 35.1). Foot traversing, aided by canova boat transportation, was undertaken chiefly within sheets 27B/5 and 27B/12 (Fig. 35.2). This work will form part of a doctoral thesis at Queen's University and is sponsored by the Geological Survey of Canada under the supervision of Dr. W.C. Morgan. It is part of a continuing study of the Baffin Island Foxe Fold Belt (Morgan et al., 1975, 1976).

Regional Geology

The extent of the metamorphosed supracrustal Piling Group on central Baffin Island was reported by Jackson (1969, 1971) who named the group and proposed a correlation with the Penrhyn Group on Melville Peninsula to form part of the Foxe Fold Belt (Jackson and Taylor, 1972). Subsequent detailed work has expanded our knowledge of the belt on Baffin Island (Chernis, 1976; Morgan et al., 1975, 1976).

Regional considerations and geochronological studies have indicated that the supracrustal rocks are Aphebian in age and overlie an Archean granitoid basement complex. These basement rocks outcrop in a series of domal culminations along the northern and southern margins of the east-west trending Piling belt. They are overlain by a miogeoclinal sequence that is predominantly carbonates to the north and impure quartzites to the south. Above the southern quartzites an assemblage of amphibolitic to ultramafic rocks occupies a restricted stratigraphic interval in the lower part of the overlying greywacke-siltstone unit and may be a facies equivalent of the extensive sulphide facies iron-formation and rusty schists which occupy the same interval to the north. A eugeoclinal flysch assemblage blankets the miogeoclinal sequence and dominates the central part of the synformal belt.

Stratigraphy

The Piling Group has a stratigraphy which, although complicated by metamorphic transformations and thickness variations, is constant throughout the study area. The granitoid basement complex is overlain sequentially by an impure basal quartzite with interlayered schists, an amphibolite to hornblendite interlayered with metasediments and calc-silicate gneisses and a thick sequence of greywacke-siltstone or its metamorphic equivalent – migmatitic paragneiss. The previously reported basal metaconglomerate (Morgan et al., 1976) is now interpreted as boudinaged quartz veins in a highly deformed schistose matrix. Carbonate-bearing rocks form only thin calcsilicate gneisses associated with some of the thicker amphibolites.

1. Basement Complex

Granitoid basement rocks ranging from granite to granodiorite averaging quartz monzonite in composition are exposed in a series of domes across the area. As named geographical features are rare, these domal culminations have been numbered to facilitate reference to them (Fig. 35.2). The presence of relict layering, amphibolite and biotite schist boudins and sheets, pods of ultramafic rocks (Dome 4) and augen suggesting a coarser parent, all support the concept that a heterogeneous gneiss terrane formed a basement to the supracrustals and was subsequently remobilized.

The gneisses are pink, orange or grey on fresh surfaces with a distinctive yellowish white weathered surface. They are generally mafic-poor and although minor muscovite or sillimanite may occur marginal to the metasediments, the actual basement-cover contact is usually sharp and distinctive. A penetrative biotite and local ribbon quartz

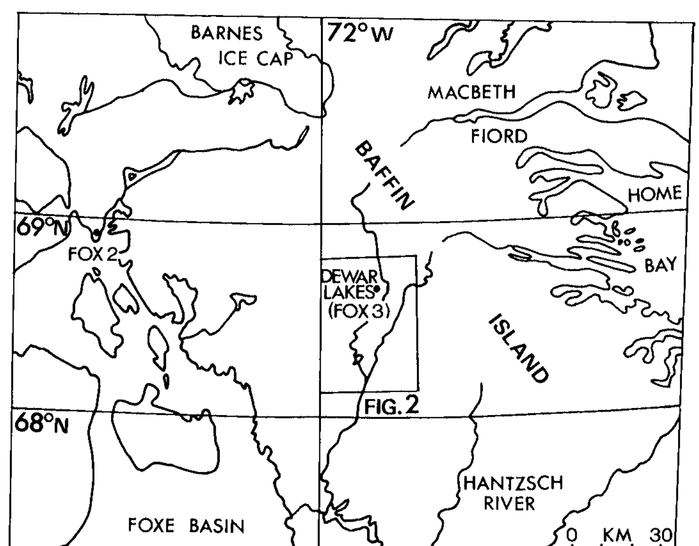

Figure 35.1. Location map.

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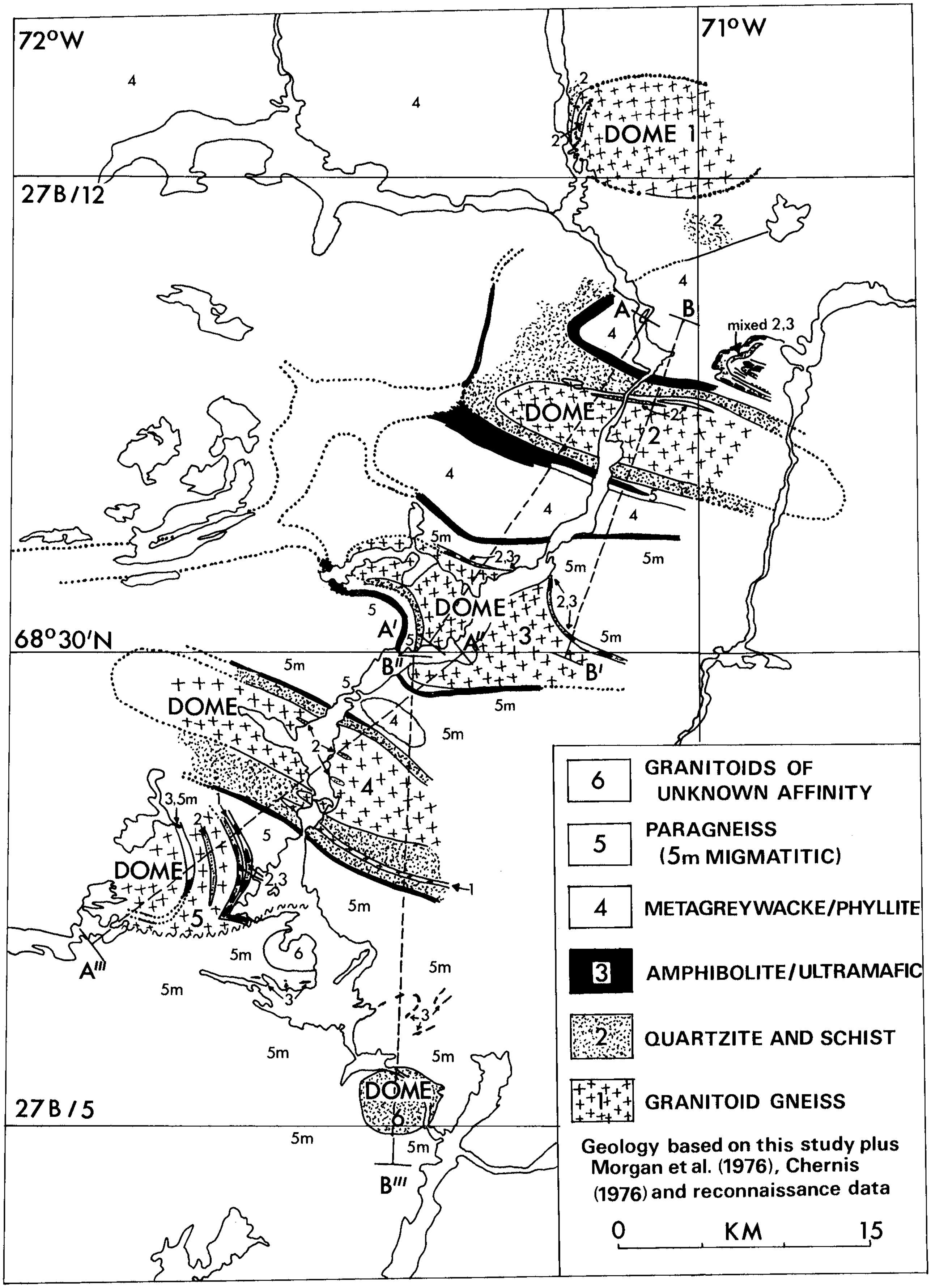

Figure 35.2. Geological map of the study area excluding diabase dykes.

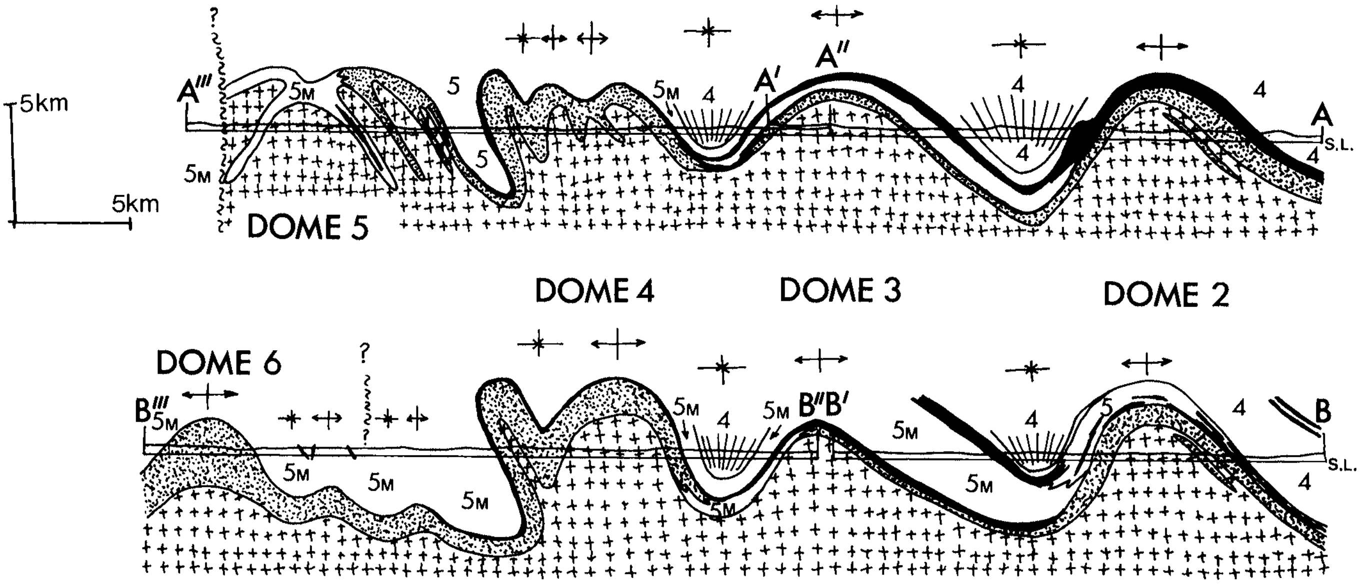

Figure 35.3. Schematic and interpretive cross-sections through the study area showing D3 closures only. See Figure 35.2 for legend.

schistosity arches across the domes and is concordant with the contacts. Only along the northern margin of Dome 2 is there a marked divergence between this schistosity and the older layering. Elsewhere all layering, as well as early pegmatites and quartz veins, has been isoclinally folded and transposed parallel to the schistosity. Nowhere is layering observed to be truncated by the basement-cover contact. The degree of heterogeneity and the strength of layering increase towards the margins of the domes although poorly developed laminations on various scales occur throughout.

Gneisses in the north are finer grained and contain elongate mm- to cm-sized augen of quartz and feldspar and a strong biotite mineral streaking, both parallel to the long axis of the domes. Cross-cutting pegmatites 1-15 m thick and up to 2 km long make up 5-20 per cent of Dome 2 and form distinctive sets whose orientations may be related to late stresses within the dome. They locally cross the basement-cover contact and spread out as sills in the overlying quartzite, producing an apparent truncation which was initially thought to identify the dykes as a presedimentary feature. Farther south the pegmatites are smaller and more evenly distributed. Weak to moderate folding and locally developed marginal schistosity characterize these late syntectonic intrusives.

2. Impure Quartzite and Schist unit

Flaggy to blocky, greyish white quartzites of the basal metasedimentary unit generally contain 90-95 per cent fine to medium grained quartz with various combinations of muscovite, biotite and feldspar. These impurities are concentrated in thin layers producing a pronounced colour lamination and fissility on the millimetre and centimetre scale. On the scale of metres, the quartzite is interlayered with more dominantly schistose rocks containing up to 80 per cent combined muscovite and biotite with some sillimanite and garnet. The high grade equivalent of the unit is a distinctive quartzofeldspathic rock with mm to cm sized pods of sillimanite, feldspar and quartz. Biotite schist and amphibolite sheets and boudins are locally present near the base of the quartzite but their relationship to amphibolites in the basement gneiss and in the overlying metasediments is not known. The quartzite-schist sequence does not seem to contain any internal markers such that although poorly preserved cross-beds marginal to Dome 2 are right way up, rare minor folds suggest at least limited transposition of sedimentary layering and the extent to which the original bedding has been disrupted or overturned remains unknown.

Whereas the lower contact with the basement is generally sharp, the upper contact may be gradational with interlayered quartzite and paragneiss over a transition zone of some tens of metres. Thicknesses vary without an apparent regular pattern with Domes 1, 2, 4 and 6 being flanked or cored by substantial thicknesses of quartzite while Domes 3 and 5 have very thin mantles.

3. Amphibolite and Ultramafic rock unit

Mafic-rich rocks which overlie the quartzite unit possess a complex, irregular, internal stratigraphy. Compositionally they range, both overall and along strike, from speckled amphibolites with subequal hornblende and plagioclase, through black to dark green hornblendites and into ultramafic rocks with partially serpentinized porphyroblasts of olivine. Although locally massive, they are predominantly strongly foliated and internally well layered on the scale of mm to cm. South of Dome 2, highly deformed, possibly metavolcanic pillow-like shapes were observed whereas north of Dome 2, cm-thick bands of amphibolite in siltstone suggest a metasedimentary origin. The close association with banded calcsilicate gneisses supports the latter suggestion while the presence of massive sulphides (see Economic Geology) seems to favour the former. Possibly both metasedimentary and metavolcanic amphibolites are present.

A variable thickness of paragneiss commonly separates the mafic rocks from the quartzite while north of both Domes 2 and 3 there appears to be upper and lower amphibolite sequences within the metagreywacke. As a general rule, however, there is simply a single amphibolite or hornblendite, usually along the upper contact of the quartzite. These distinctive units pinch out to the east and south with the hornblendite north of Dome 4 passing gradationally into a finely laminated transitional metasediment and Dome 6 lacking a mantling amphibolite.

4. Metagreywacke-Metasiltstone unit

The metamorphosed flysch of the central eugeoclinal zone extends out over the quartzite and contains the amphibolite-ultramafic unit in its lower levels, in which association it is locally sulphide-bearing and rusty. A series of transitions occur from north to south and similarily from high to low stratigraphic levels changing a fine grained, recognizably sedimentary rock into a strongly deformed and highly metamorphosed migmatitic paragneiss. In neither state are internal marker horizons recognizable.

At low grade sedimentary bedding and laminations are preserved. Other sedimentary features, with the exception of concordant, compositionally zoned calcsilicate nodules, were not recognized. The flysch is composed of 0.1-3 m layers of metagreywacke, rarely containing monocrystalline grains of quartz and feldspar several mm in diameter, alternating with 1-20 cm layers of siltstone or phyllite. Both are poor in K-feldspar. Lateral facies changes do not appear to be present while more massive, thickly bedded units seem to become dominant higher in the section.

At higher grades the metagreywacke-phyllite is transformed through the intermediate step of nonmigmatitic paragneiss into a rusty to medium brown migmatitic paragneiss. Original sedimentary layering is transposed parallel to a strong schistosity and, where disrupted, blocks containing relict layering in a more schistose matrix may be observed. Where folding and boudinage have not been severe, the paragneiss is made up of blocky biotite-quartz-feldspar horizons alternating with schistose biotite-garnet-sillimanite-quartz-feldspar horizons. Both this alternation and regular variations in the content of sillimanite pods are probably partly equivalent, respectively, to original sedimentary layering and grading. Boudins of hornblende-plagioclase amphibolite and more rarely hornblendite are scattered throughout while the high-grade equivalents of calcsilicate pods are not as abundant as at lower grade.

Abundant white pegmatite in the form of veins, sheets and boudins makes up from 10 to 90 per cent of the pegmatite paragneiss but shows no systematic regional variation with the alternation of pegmatitic and paragneiss occurring on the scales of centimetres to tens of metres. The boundary across which pegmatite appears is very marked and is accompanied by the recrystallization of the metagreywacke into a paragneiss.

Metamorphism

The single most important metamorphic reaction to have affected the rocks in the study area is the breakdown of muscovite in the presence of quartz to produce sillimanite and K-feldspar. This reaction occurred at progressively higher stratigraphic levels to the south suggesting some sort of metamorphic culmination in that direction. Distinctive pods of sillimanite, feldspar and quartz characterize the altered basal quartzite as well as some horizons in the migmatitic paragneiss. Reactions which produced garnet and sillimanite have not yet been defined. The restricted chemical compositions of the gneisses, quartzites and metagreywackes prevented the development of index minerals which might have detailed the metamorphic conditions more exactly.

It should be noted that the bulk of the white pegmatite which cross-cuts the paragneiss sequence is trondjemitic in composition. This probably relates to the K-feldspar deficient nature of the original metasediments such that although the first increment of melting would have produced a "normal" granite-quartz monzonite, the rapid loss of all K-feldspar in the restite would have permitted the composition of the melt to progressively approach that of the plagioclase-rich paleosome. Both the lack of in situ anatectic textures in the zone of first appearance of melt and some space problems north of Dome 3 indicate that considerable mobilization of melt from deeper regions has occurred. As well, the abrupt termination of a high degree of anatexis at the basement-cover contact indicates that although the basement was of a more favourable composition for a high degree of anatexis, it was relatively anhydrous during the peak of metamorphism and could not produce the same percentage of melt as did the water-saturated metasediments.

Textural data indicate that the metamorphic peak preceded the last regionally penetrative deformation whose associated schistosity is axial planar to folded pegmatites probably generated during anatexis. Late annealing recrystallization has been pervasive with the exception of plagioclase which is often fractured and shows evidence of retrograde metamorphism. Although the schistosity is bent around porphyroblasts, it is difficult to determine the actual timing of metamorphism since the latest phase is often coplanar with earlier phases in critical areas. Evidence from the southern migmatites suggests, however, that the peak was syndeformational with the major earlier phase.

Structural Interpretation

The structures observed in the area are interpreted in terms of three phases of deformation.

1. D1

As mentioned above, compositional layering in the basement gneisses is oblique to schistosity along the northern margin of Dome 2 and is transposed parallel to it elsewhere. This, combined with the presence of amphibolites, ultramafics and possible early dehydration, suggests one or more presedimentary phases of deformation which have been collectively referred to as D1. The shape and orientation of D1 folds are not known.

2. D

At low stratigraphic levels to the north and at progressively higher ones to the south, a subhorizontal schistosity exists which is axial-planar to isoclinal folds of the basement-cover contact. Mesoscopic folds associated with this deformation are present in several locations in both gneiss and metasediments and have hinges generally colinear with or at a small angle to the present domal trend. The size of major D2 structures is unknown but, with the exception of tongues of gneiss and quartzite up to 0.1 km in thickness and 10-15 km in length which are closely confined to the vicinity of the domes (Figs. 35.2, 35.3), major structures involving inversion of the stratigraphic sequence have not been outlined. Mineral lineations of biotite, sillimanite and hornblende have been correlated with this phase although their mechanical significance is unclear. Metamorphism is tenatively interpreted as being synchronous with this phase of deformation

3. D3

The regional expression of the third phase of deformation is a refolding of the early basement-cover isoclines (D2) and their related subhorizontal schistosity by folds with steeply dipping axial planes and gently plunging hinges (D3). In addition, however, some of the observed fabric relationships require further explanation. These fabric relationships are summarized below:

– A strong fabric gently arches across the domes without being folded by recognizable compressional structures.

– Extensive chocolate-tablet boudinage of quartz veins and pegmatites occurs along both the ends and flanks of the domes.

– Zones next to the basement-cover contact contain folds of reversed or "cascading" vergence which deform the dominant schistosity.

- In zones farther from the domes, the dominant schistosity is a crenulation of the schistosity which passes over the domes.
- In zones still farther from the domes, this crenulation cleavage passes into a new schistosity which defines intersection lineations in the low grade metasedimentary rocks which they contain. The pocket between Domes 3 and 4 is a doubly plunging synform while the one between Domes 2 and 3 has not been observed to close to either east or west. Lineations plunge at up to 70 degrees to the east in the latter area.

Gneiss doming of a terrane previously possessing a subhorizontal schistosity would account for the above features, however, another set of observations requiring explanation also exists.

- The domes posses a pronounced linear form with Dome 3 probably being a composite of two closely-spaced en echelon domes.
- The broad flysch basin to the north is folded about upright, shallowly plunging folds showing no spatial relationship to gneiss doming.
- Upright D3 closures at 1-2 km intervals fold S2 in the southern migmatites as well as over the crest of Domes 4 and 6.
- Folds away from the basement-cover contact have the vergence expected for compressional deformation.

As a result, a combination of lateral compression and gneiss doming is required to explain the observed fabrics and geometry. Compressional folding localized the position and shape of the incipient domes with the gneiss being remobilized along the antiformal hinges and subsequently dominating the deformation at lower levels. Higher in the section and to the south, as well as in the central part of the belt and the pockets of upright D3 schistosity between Domes 2 and 3 and Domes 3 and 4, compressional deformation was prevalent producing strong folding of both the migmatitic paragneiss and the metagreywacke-phyllite. The relative contributions of lateral compression and of pinching between the rising domes in the deformation of the above-mentioned pockets is unclear.

There are very few areas in which S2 has been preserved from D3. On the top and margins of the domes the two phases were roughly coplanar producing minor rotation and further flattening of the earlier fabrics, such that there the penetrative schistosity is properly called S2/S3. The increasing divergence of S2 and S3 off the margins of the domes is responsible for the zones in which S3 is a crenulation of S2. Above the zone in which S2 was originally developed, S3 is the first schistosity to have developed in the rocks. Compressional folding was responsible for much more of the D3 deformation to the south as compared to the north. Quartzite is folded into the crest of Dome 4 about upright axial planes and cascading folds are rare.

Several differences exist between this sequence and that of Morgan et al. (1976) although D1 and D2 are similar. Gravity-driven doming during D3 was not considered earlier as an active force in the formation of the basement culminations which were interpreted as solely the result of compressional folding. Variable plunges along the domal trend were thought to be the result of D4 cross-folding and although some sporadic crenulations at high angles to that trend were observed during the present study, they are neither persistent nor strong enough to be related to such a regional cross-folding. The variation in hinge lines is considered here to be a natural part of compressional folding and gneiss doming.

The age of the structural and stratigraphic break south of Dome 5 is unknown but as it truncates part of a dome south of the main dome, it is presumably post-D3. Stratigraphically it is south side down and possesses considerable offset in both vertical and horizontal directions as no trace of the truncated dome is present south of the break.

Unit 6 is of unknown origin and may be either remobilized basement which has pierced the quartzite-amphibolite cover sequence during its ascent, or a plutonic intrusive. The unit is at least pre-D3 and D3 folds wrap around it and it appears to contain an even earlier fabric (S2?).

Economic Geology

The major amphibolite north of Dome 3 is associated with an extensive gossan made up predominantly of rusty schists. Just west of the lake system (68°33'N, 71°14'W) blocks of massive pyrrhotite with 2-3 per cent disseminated chalcopyrite and bornite are derived from a layer in the gossan estimated to be 40-50 cm in thickness. Along strike to the west a small amount of malachite stain occurs in a calcsilicate associated with the same amphibolite (68°33'N, 71°19'30"W). Farther south, a 1 cm pod of molybdenite was observed in a granitoid vein which cross-cuts Dome 5 (68°22'N, 71°41'30"W).

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