REPORT ON ANTARCTIC FIELD WORK

DEFORMATION OF GRANITIC PLUTONS IN EASTERN PALMER LAND

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The Antarctic Peninsula was the site of subduction of oceanic 'Pacific' crust from the late Palaeozoic until the Tertiary. This subduction, and the resultant build-up of new crustal material in an accretionary prism, magmatic arc and fore- and back-arc basins is considered to have taken place against the pre-late Palaeozoic Gondwanaland craton (Smellie, 1981). Widespread outcrops of gneiss and schist in northern Palmer Land and the Marguerite Bay area and scattered outcrops of similar rocks in Graham Land were thought to be representatives of this sialic basement. However, radiometric dating has so far revealed only two localities in eastern Graham Land with rocks old enough to be considered basement (Pankhurst, in press). Gneisses further south have yielded only Mesozoic ages and it has been suggested that they represent deformed early Mesozoic plutons (Pankhurst, in press). The purpose of the 1982–83 season's work was to examine in detail the field relations and structure of the metamorphic rocks in eastern Palmer Land and determine their origin. Two main areas were investigated: the central Black Coast and Engel Peaks (Fig. 1).

CENTRAL BLACK COAST

Singleton (1980) recognized three main rock groups in the central Black Coast area (Fig. 1):

Mesozoic plutons
Mount Hill Formation (= Middle–Upper Jurassic Latady Formation (Rowley and Williams, 1982))
Palaeozoic metamorphic complex

The Mesozoic plutons (dated as mid-Cretaceous by Pankhurst (1980)) are essentially undeformed and cut both the Mount Hill Formation and the 'metamorphic complex', but no contact between the last two rock groups was seen and the antiquity of the 'metamorphic complex' was not proven.

During the 1982–83 season numerous transitions from undeformed granitic rocks into the 'metamorphic complex' were mapped. Granitic plutons are cut by steep north–south trending shear zones up to 1 km wide producing gneisses and multiply-deformed schists and mylonites. The shear zones are characterized by a strong stretching lineation and fold axes parallel to stretching. Sheath folds (Cobbold and Quinquis, 1980) elongated parallel to stretching were also seen. These features are typical of shear zone deformation. The west-plunging stretching lineation and the progressive steepening of the west-dipping first foliation within the shear zones implies a normal displacement with downthrow to the west. At several localities gneisses were cut by granite and both were then deformed; the foliation in the gneiss

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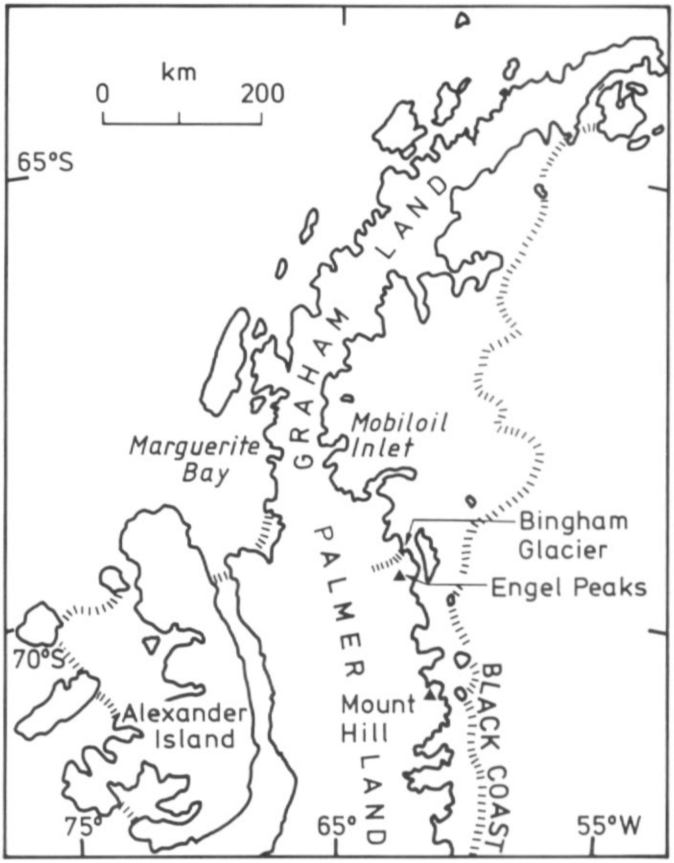

Fig. 1. Locality map of Antarctic Peninsula.

was refolded and a first foliation was developed in the granite. Deformation at pluton contacts is often complex with local structures probably related to forceful intrusion.

Essentially undeformed mid-Cretaceous granodiorite plutons cut the shear zones and most have a weak foliation parallel to their contact that probably formed during diapiric intrusion. These undeformed granodiorites are mineralogically indistinguishable from some of the sheared plutons and it is possible that at least some of the deformed plutons are Mesozoic. The deformed granodiorite was previously included in the metamorphic complex simply because it is deformed. Thus the 'metamorphic complex' and Mesozoic intrusives may represent a continuous period of pluton emplacement in which the early intrusions are pre-tectonic or syn-tectonic with respect to regional shear zone deformation. No contacts between the 'metamorphic complex' and the Mount Hill Formation were found and the possibility remains that some outcrops of the former represent true metamorphic basement orthogneiss (Pankhurst, in press). Specimens collected this season for geochronological studies may help to solve this problem.

Deformed specimens of possible belemnite and plant fragments collected this season from the Mount Hill Formation support its correlation with the Middle–Upper Jurassic Latady Formation.

The shear zones imply large ductile normal fault movement and thus east–west extension in this part of the peninsula. Gneisses examined by the author during the 1980–81 field season on the north side of the Bingham Glacier (Fig. 1) were also interpreted as having formed in shear zones with a similar geometry. Similar gneisses and schists cropping out widely in northern Palmer Land and Graham Land may also be shear zone rocks. Considerable regional displacements may be involved although the sense of movement can only be determined by detailed field mapping.

Engel Peaks

Engel Peaks in north-east Palmer Land has long been a key locality in Antarctic Peninsula stratigraphy because it was the site of the only recorded unconformity overlying supposed pre-Jurassic plutonic rocks. Davies (1976) correlated outcrops of metasedimentary and metavolcanic rocks in the area with the (?) Upper Palaeozoic Trinity Peninsula Group of Graham Land. At Engel Peaks, rocks, which he believed represented a conglomerate facies of this unit, were seen resting unconformably on granite and it was therefore assumed that the granite was pre-late Palaeozoic. Holmes (1966) and Davies (1976) also describe a possible fossil soil along the contact and a large thickness of sheared crystal tuffs overlying the conglomerates.

By contrast a detailed reinterpretation of the rocks at Engel Peaks this season indicates that they represent a moderately west-dipping zone of fault breccia and mylonites overlying and derived from the granite. The breccia indeed resembles a sedimentary deposit or volcanic agglomerate but the well exposed transition from granite points to a tectonic origin. Deformation of the granite may be either brittle (with breccia and pseudotachylite) or more ductile (with porphyroclastic mylonite). The sequence of breakdown of the granite at the contact is as follows:

i. Incipient brecciation. Discrete shear fractures, and zones and veins of pseudotachylite or ultramylonite.
ii. Lenses of relict granite bounded by anastomosing shears or porphyroclastic mylonite.
iii. Fault breccia up to 25 m thick. The breccia is banded on all scales up to 1 m and consists of angular to rounded fragments (generally 1–10 cm) of granite and early pseudotachylite or ultramylonite in a recrystallized, fine-grained quartz/feldspar matrix. More ductile deformation leads directly to porphyroclastic mylonite up to 1 km thick in western Engel Peaks. A small area of tectonic mélange is present about 30 m above the contact. It consists of blocks of banded mylonite in a sheared matrix.

The following table shows how the rock units recognized by previous workers have been reinterpreted this season.

Holmes (1966) and Davies (1976)	*New interpretation*
Sheared crystal tuffs	Porphyroclastic mylonite
Conglomerates and sandstones	Fault breccia
Fossil soil	Ultramylonite and pseudotachylite
Unconformity	Lower boundary of fault zone

This new interpretation is supported by the occurrence of numerous narrow shear zones (up to 100 m wide), which show a similar transition to breccias and mylonites, in granite below the main fault zone. An area of granite several tens of metres across is isolated within mylonites 40 m above the contact. It is unlikely that it is a clast in either a sedimentary or volcanic breccia and is thought to be a large pod of relatively undeformed granite within the shear zone.

A steep west or south-west dipping cleavage of variable intensity and slaty aspect post-dates the initial brecciation and mylonitization. Breccia fragments and relict crystals in mylonites are deformed and the matrix is foliated and wrapped around them. Deformed porphyroclasts, breccia fragments and amygdales in pre-deformation basalt dykes define a stretching lineation plunging generally steeply west but in places breccia fragments have north–south trending horizontal long axes.

The sense of movement in the shear zone is problematical as there are no marker horizons on which to determine displacement. Simple shear zone kinematics requires displacement roughly parallel to the stretching direction, i.e. to the east or west. Minor shear zones generally indicate east-directed thrusting but are not consistent. Initial brecciation and mylonitization did not have a conspicuous planar fabric whose orientation changed with higher strains (a relationship used to determine shear direction in the central Black Coast). The Engel Peaks fault zone may be a correlative of the thrust faults affecting Jurassic–Cretaceous rocks along the coast south of Mobiloil Inlet (Fraser and Grimley, 1972).

Conclusions

Schists and gneisses in eastern Palmer Land and supposed metasedimentary and metavolcanic rocks at Engel Peaks have been shown to be deformed granitic plutons. Thus metamorphic rocks in Palmer Land, previously thought to be pre-late Palaeozoic sialic basement, may be sheared Mesozoic plutons and the presence of exposed basement rocks in Palmer Land has yet to be proven.

Deformation took place in major shear zones that generally dip westwards at moderate angles and which involve mainly dip-slip displacement. The brittle nature of the deformation at the margin of the Engel Peaks fault zone contrasts markedly with the more ductile shearing of the plutonic rocks elsewhere in eastern Palmer Land. It is possible that the former represents a higher structural level of erosion within an area of contemporaneous shearing.

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