Current systematic regional mapping — new potentials for mineral discovery

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ABSTRACT

The current programme for the systematic, multi-purpose, geological maps of the Geological Atlas 1:50 000 Series includes the revision of the 25-year old map of the Zeehan Quadrangle in western Tasmania, the mapping of the Trowutta Quadrangle in northwestern Tasmania, and the mapping of the Alberton Quadrangle in northeastern Tasmania.

Although the scale of publication is 1:50 000, compilation of field data occurs on 1:25 000 scale maps. The latter maps contain more data than can normally be represented on the 1:50 000 scale maps of the Geological Atlas Series, and the field maps can be made available for copying on request.

Mapping of the Alberton Quadrangle and compilation of field data has been completed. It is anticipated that this map will be published during the 1992/93 financial year. Field revision of the Zeehan Quadrangle has been completed and map compilation is in progress. A publication date of late 1993 is envisaged for this map, although provisional compilation sheets are available. Compilation of completed field mapping on the Trowutta Quadrangle is expected by June 1993.

GEOLOGICAL ATLAS 1:50 000 SERIES — ZEEHAN QUADRANGLE

INTRODUCTION

New discoveries of major importance arising from revision of the Zeehan Quadrangle geological map include:

1. extensive thrust faulting throughout the Cambrian volcano-sedimentary sequence.
2. early-stage Devonian thrust faulting of Precambrian rocks across Cambrian ultramafic-mafic and sedimentary sequences and Ordovician limestone. This phase of thrusting was first recognised in the Macquarie Harbour Quadrangle by M. P. McClenaghan in 1984.
3. possibly late-stage Devonian reverse faulting in the western part of the quadrangle.
4. post-Permian shortening of possibly 20%, as seen in the Zeehan Tillite.

These structures affect the main sequences hosting mineralisation; these are the Precambrian carbonate horizons, the Eocambrian Success Creek Group, the Cambrian volcano-sedimentary formations, the Ordovician Gordon Limestone, and the overlying Siluro-Devonian Bell Shale.

The implications of the proven thrust faulting extend well beyond the Zeehan Quadrangle because, as well as being recongised in the Macquarie Harbour area, it has also been demonstrated in the as yet uncompleted mapping of the Point Hibbs Quadrangle and was also described on the northwest coast by Burns (1964).

PRECAMBRIAN ROCKS (RHF)

The Precambrian sequence is represented by the Oonah Formation to the west and northwest of Zeehan, and a sequence of dominantly quartzwacke sandstone, siltstone, pelite, and their schistose derivatives near Dundas (Dundas Inlier; Turner *in* Burrett and Martin, 1989). The Oonah Formation has been assigned a Precambrian age on the basis of its complex deformational history, its relationship to rocks of possible Eocambrian age, and whole-rock K-Ar radiometric ages of about 680–690 Ma (Adams *et al.*, 1985). The supposed Precambrian rocks of the Dundas area have been assigned a Precambrian age on the basis of one K-Ar whole rock age of 684 ± 10 my from a slate bed (Adams *et al.*, 1985).

OONAH FORMATION

Introduction

The Oonah Formation is dominantly a quartwacke sandstone/siliceous siltstone/pelite association also containing highly carbonaceous, sulphide-bearing slate beds. It also contains subordinate, highly vesicular pillow lavas of small areal extent and which, in places, appear to be large boudins. Also present are carbonate beds which have acted as hosts for the Sn-Pb-Zn mineralisation derived from the Devonian Heemskirk Granite.

Other than within the thermal aureole of the Heemskirk Granite, metamorphism in the Oonah Formation is of low grade. In the east, the pelitic beds display a slaty cleavage and a sub-phyllitic appearance, whereas to the west (Reece Dam area; northern Granville Harbour) the rocks are strongly schistose and are of low greenschist facies grade.

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Structural geology

The Oonah Formation is generally more complex structurally than the adjacent Eocambrian and Cambrian sequences, although five deformations have been identified adjacent to deformed faults in some Eocambrian beds.

Three deformational events may be identified at many outcrops within the Oonah Formation, and analysis of outcrops along the Zeehan–Granville Harbour and Zeehan–Trial Harbour roads has indicated that as many as five cleavage-forming events have occurred. The first formed fabric (S_1) is related to isoclinal folding and boudinage, is invariably a weak to strongly-developed schistosity (equivalent in appearance to textural zones 2A to 3A of Bishop, 1972), and is oriented generally parallel to subparallel to bedding. The subsequent cleavages are crenulation cleavages following northeast, north, west, and WNW to NW trends. Additional structural complexity is conferred by at least two generations of probably Devonian thrusting and possibly synchronous and younger steeply-dipping faults.

This thrusting is of prime importance to the relationship between the Oonah Formation and younger rocks, and may be of key economic importance in respect of mineral exploration programmes within the younger rocks. It is presently thought that two episodes of thrusting have affected the Oonah Formation. The first event (10th Legion Thrust) was described in detail by Findlay and Brown (1992) in the Comstock Mine area (fig. 1 and 2), where there is clear evidence that the Oonah Formation has been thrust southeast, over probably Middle Cambrian ultramafic and mafic rocks which include boninitic lavas, a probable Middle Cambrian sedimentary sequence which includes possible correlates of the Dundas Group, and possibly Ordovician limestone beds. These last are thought to be hosts for the mineralisation in the 10th Legion Mine area (fig. 1).

Findlay and Brown (1992) argued that the thrust plane was folded and thus occurred during the early phase of Devonian deformation. In contrast, thrusts and reverse faults seen in the Oonah Formation by Findlay in the Piney Creek area, and by Goscombe (unpublished data) in the coastal section north of Granville Harbour, may have formed during the later stage of Devonian deformation. Goscombe (unpublished data) reports:

- high-angle thrusts related to monoclinal folds;
- the thrusts follow the axial planes of the folds;
- the reverse sense of movement is consistent with the vergence of the monoclines;
- the sense of shear is southwest over northeast (contrary to that of the 10th Legion Thrust);
- the thrusts are not folded by the folds affecting the Ordovician–Early Devonian sequence;
- the thrusts follow the 80–110° trend of the cleavage developed in the Duck Creek syncline.

This syncline has been described by Williams (1976) as due to late-stage Devonian folding, although Goscombe (unpublished data) has suggested that from the outcrop pattern, the Duck Creek Syncline has been cross-folded by northwest-trending folds. The northwest-trending folds elsewhere in western Tasmania have been referred to as post-dating the east-west folds (Williams, 1976).

These new reports of thrusting extend the work of Burns (1964), who described both early and late-stage Devonian thrust-faulting in the Devonport Quadrangle. They also reaffirm the observations made first by McClenaghan in 1984, during mapping of the Macquarie Harbour Quadrangle (McClenaghan and Findlay, 1989), that Devonian thrusting has juxtaposed Precambrian rocks over younger sequences. Data from the as yet uncompleted mapping of the Point Hibbs Quadrangle (Brown *et al.*, 1991; McClenaghan *et al.*, in press) have confirmed the earlier observations of Carey and Berry (1988) that later Devonian thrusting, such as that described by Goscombe (unpublished data) in the Zeehan Quadrangle, is also important.

The recognition that thrusting has had a major role to play in Devonian tectonics, and that this has involved Precambrian rocks, is of major importance in interpreting the regional geology of western Tasmania, and, given the possibility of regionally-extensive thin-skinned tectonics, may extend the prospectivity of this region to include areas formerly thought to be of little economic consequence.

PRECAMBRIAN ROCKS OF THE DUNDAS AREA (DUNDAS INLIER)

These units have been correlated with the Oonah Formation because of their similar lithology and their structural and metamorphic complexity (see Blissett, 1962; Turner, 1979; Turner *in* Burrett and Martin, 1989). Geochronological data, in the form of a single K-Ar whole-rock age from a very low-grade slate bed (Adams *et al.*, 1985), may support this proposal.

The non-metamorphosed rocks consist of slate-grade quartzwacke sandstone, pelite, and slate beds which also contain dark graphitic slates. The sequence passes apparently gradationally into a phyllite-dominated sequence including quartz-rich schist and dolomite horizons (Concert schist; Blissett, 1962). The transitional zone appears to be from only a few tens of metres wide to missing in the northern part of the inlier, in contrast to the central area where the transitional zone is 0.5 km wide. This suggests that faulting has cut out part of the transitional zone, although the fault(s) have not been clearly identified.

The Concert Schist contains numerous quartz 'sweats' which have been mined; the adits are short and were presumably unproductive. Much mining activity has been carried out in the ridge south of Comet Creek. Here the adits enter the calcareous beds overlying the fault separating them from the rocks of the Dundas Inlier. This mine area is close to the presently productive South Comet Mine, in which the mineralisation (Zn-Pb-Sn) appears to fault controlled and hosted in carbonate veins. The fault contact between the Dundas Inlier and the adjacent rocks may therefore also be prospective.

Structural Geology

An as yet incomplete analysis of field observations indicates multiple deformation within the non-metamorphosed part of the sequence. The dominant structures (as exemplified principally between CP708624 and CP703625) are variably oriented chevron folds, some of which display collapsed hinges or which show rapid changes in shape in the fold stack. These folds plunge shallowly to moderately southeast, northeast and also steeply; they include antiformal synforms and upside-down beds. Some of these structures are asymmetric and verge northeast; others are symmetric and

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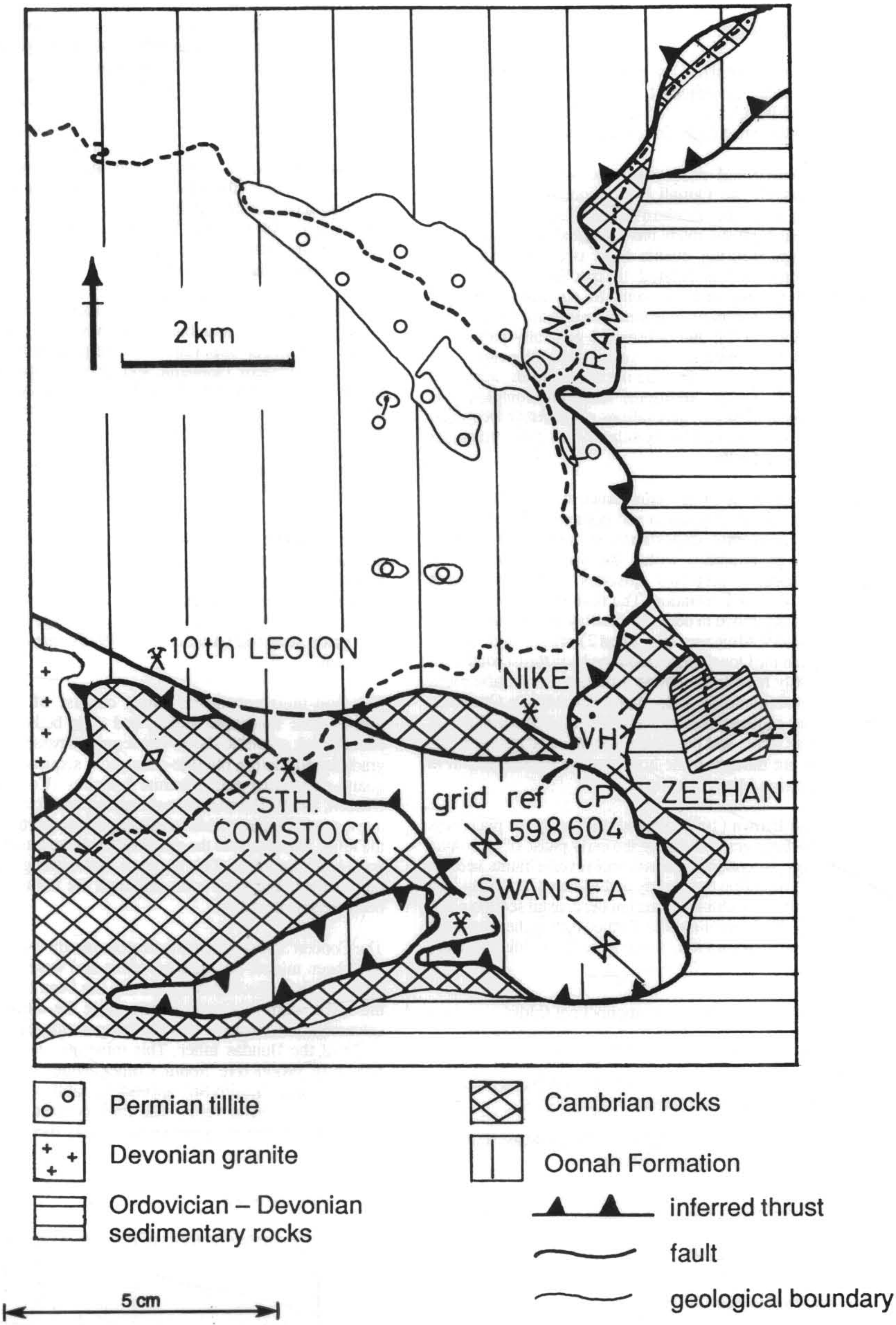

Figure 1

Regional geological summary map showing mapped extent of 10th Legion Thrust. VH = Vanoaness Hill

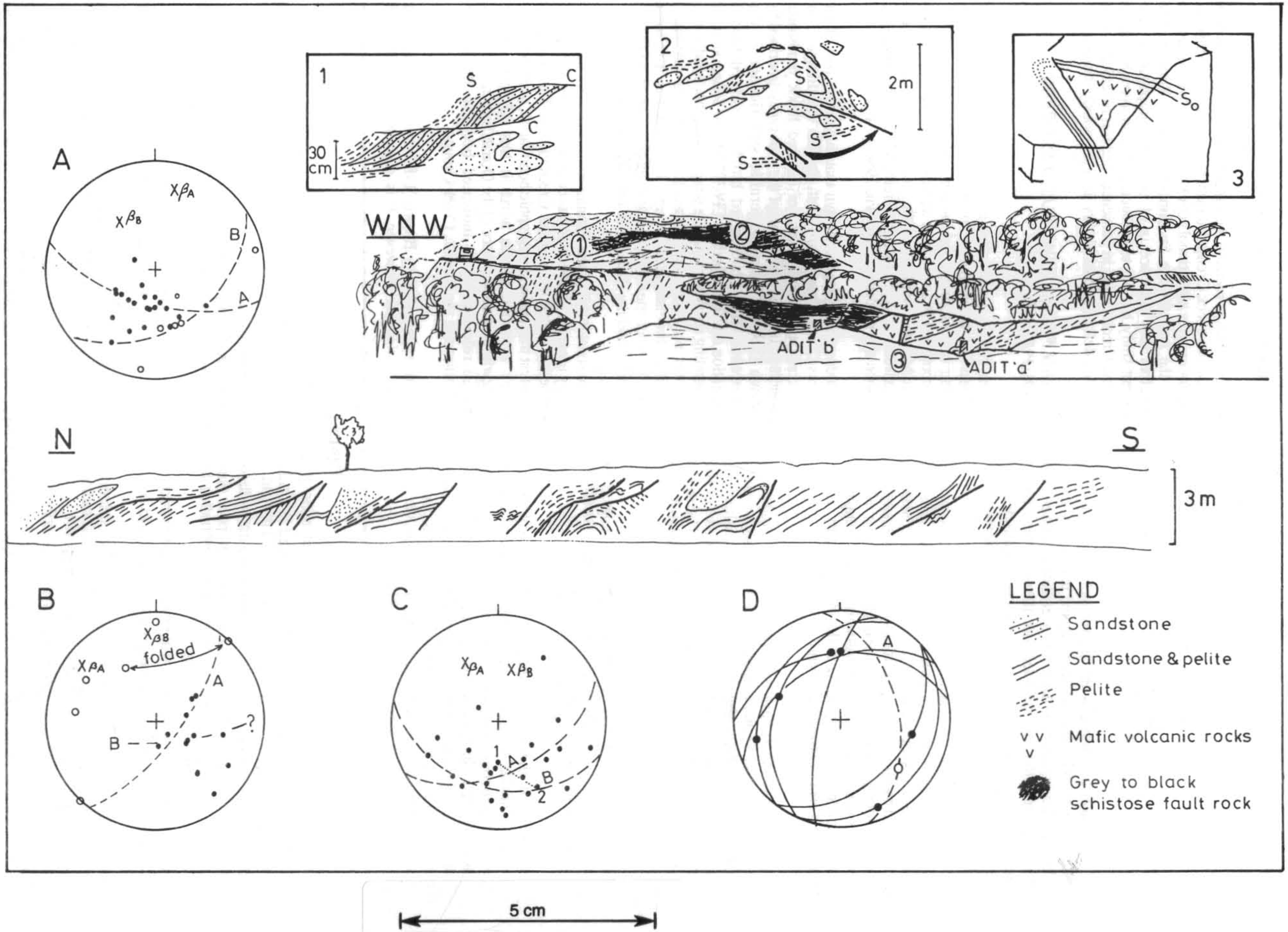
A
B
C
D
1
2
3
S
C
30 cm
2m
S_o
WNW
ADIT 'b'
ADIT 'a'
N
S
3m
folded
LEGEND
Sandstone
Sandstone & pelite
Pelite
Mafic volcanic rocks
Grey to black schistose fault rock
5 cm

Figure 2

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either upright or recumbent. Invariably, they all fold a fabric which is penetrative in the siltstone and pelite beds, and which is, in places, slightly (10°) oblique to bedding. Quartz-fibre striations on bedding surfaces and limb faults at low angles to bedding attest to flexural slip during folding.

This structural complexity is less than in the Oonah Formation to the west of Zeehan.

The relationship between the quartzwacke/slate sequence and Concert Schist was first investigated in detail by Turner (1979), who argued that there was a transition between the two units and that the third tectonic fabric in the Concert Schist corresponded to the second weak crenulation cleavage seen only in the slate beds of the quartzwacke/slate sequence.

The present work has confirmed the transition between the Concert Schist and the quartzwacke/slate sequence, although this transition is thought to be faulted. The Concert Schist is dominated by two fabrics, a bedding-parallel schistosity (S_1) and a closely-spaced crenulation cleavage (S_2) which appears to increase in intensity eastward. A third crenulation surface of less intensity to S_2 is developed locally, as are numerous cross-cutting kink bands.

No folds related to S_1 have been identified; S_2 is axial plane to crenulations on S_1 and to mesoscopic folds found mainly in the east. These folds plunge at very low angles, either ESE or WNW. Orientation of S_2 varies; in the major part of the inlier S_2 dips steeply west and strikes ESE to SE, whereas in the southernmost part it dips steeply to vertical and strikes to the south.

Both S_1 and S_2 are recognisable through the transitional zone but cannot be confirmed in this preliminary report as extending into the quartzwacke slate sequence.

The rocks of the Dundas Inlier are faulted against the adjacent Dundas Group. On the hillside south of Comet Creek, calcareous lithicwacke and a sequence of quartz sandstone beds interbedded with carbonate horizons and minor quartz-pebble conglomerate beds appear to be faulted over the rocks of the Dundas Inlier. Here, the fault plane is folded, although immediately east of Kosminski Hill the fault appears to dip south at possibly 30° to 40°.

EOCAMBRIAN ROCKS (RHF)

The Eocambrian rocks in the Zeehan Quadrangle consist of the Success Creek Group and the Crimson Creek Formation. The rocks in the transitional zone between the two formations form the host for the Sn mineralisation at Renison, and therefore this sequence is of economic importance. The present study has led to revision of the stratigraphy of the Success Creek Group in particular, and has revealed a more complex deformational history than previously thought.

OONAH FORMATION / SUCCESS CREEK GROUP BOUNDARY

Brown (1986) argued that in the Pieman River area the Success Creek Group overlies the Oonah Formation with an angular unconformity, and the top of the Oonah Formation here consisted of an "Upper" succession containing units of, "...carbonate, sandstone, fine conglomerate, tuff and volcaniclastic lithicwacke interbedded with laminated siltstone and mudstone" (Brown, 1986, p. 15).

The present mapping has shown that this unit is part of the Success Creek Group (unit Esdf, Zeehan Quadrangle); the unit consists predominantly of sheared black mudstone, including phacoids and lenses of the rock types described by Brown (1986). Of considerable significance is the occurrence of a boudinaged block of veined Oonah Formation sandstone beds at CP632769. The foliation in the surrounding sheared mudstone wraps round this boudin, and truncates a quartz vein within the block and orientated normal to the sandstone layers. This indicates a tectonic hiatus between the deposition and deformation of the Oonah Formation and the shearing of the black mudstone.

On the south bank of the Pieman River, opposite the Misty Valley area, the sheared mudstone unit occupies the core of a syncline within the Success Creek Group. Therefore, this unit must transgress stratigraphic boundaries, as in the Misty Valley area and to the north it lies adjacent to the quartzwacke-slate sequence of the Oonah Formation. Thus a faulted relationship is indicated between the Oonah Formation and the Success Creek Group.

The outcrops visited by Brown (1986) in the Pieman River are now flooded. However, it is clear that the structural

Figure 2

Top sketch: Bird's-eye view of South Comstock Mine area (see legend for rock types).

Bottom sketch: Summary of structures exposed in road north of South Comstock Mine, showing faulting in upper plate immediately overlying the fault rock. Section 40 m long.

Inset 1: C-S structures in rocks of upper plate immediately overlying fault rock.

Inset 2: Transposed isoclinal fold at margin of upper plate and fault rock; the age of this structure relative to thrusting is uncertain; bedding is transposed along a penetrative fabric generally parallel to the S-fabric of the fault rock and the structure is folded by a northward-trending fold.

Inset 3: NW-trending fold in lower plate within layered chert-siltstone-mafic volcanic sequence.

Stereonet A: Poles to C-planes (solid circles) and bedding (open circles) of fold in inset 3. Likely statistical fold axes shown.

Stereonet B: Poles to schistosity (solid circles), commonly parallel to bedding, in the pelitic units in lower sketch section (upper plate rocks). Open circles are crenulation lineations possibly associated with folding on north and northwest trends; note one crenulation lineation is folded, as shown.

Stereonet C: Poles to all faults. Faults 1 and 2 (linked by dotted line) form a fault splay with an interfault angle of 36°.

Stereonet D: Solid great circles with solid circles are faults carrying quartz-fibre striations. The broken great circle represents a tension gash array thought related to slip on fault A, with open circle showing orientation of compression axis.

All stereonets are equal-area southern-hemisphere projections.

history of the Oonah Formation is more complex than that of the Success Creek Group, and that the quartzwacke sandstones of the Oonah Formation show greater recrystallisation and corrosion of grains than do the sandstone of the Success Creek Group. These data support Brown's observations that there is an unconformity between the Oonah Formation and Success Creek Group.

SUCCESS CREEK GROUP

The Success Creek Group is divided broadly into two units; a lower, dominantly quartz sandstone sequence with siltstone, and mudstone beds; Brown (1986) has described local pebbly sandstone and conglomerate horizons. Brown also reports thin tuffaceous horizons; in one thin section of a volcaniclastic fine-pebble conglomerate from these units, which occur in Misty Valley, there is a clast containing chloritic pseudomorphs of pyroxene phenocrysts in a fine matrix. This clast does not contain chrome spinels.

Also present in this sequence are grey-green beds of volcaniclastic lithicwacke and siltstone. These beds contain chloritic pseudomorphs of detrital mafic mineral, together with clasts of devitrified glass and volcanic quartz displaying two or more crystal faces and embayments containing devitrified glass. Such units occur throughout the Success Creek Group and in the Crimson Creek Formation, although they have not been reported previously.

The sandstone beds of this lower sequence commonly display small-scale cross-bedding and also metre-scale cross-bedding in the rare large exposures. The sandstone beds are commonly rich in quartz grains (70–90%) which are generally rounded. Also present are tabular mud flakes (as large as 20 mm in some beds), and detrital mica is found throughout.

The upper unit is a sequence of well-sorted quartz sandstone beds, with grey siliceous siltstone units also containing interbeds of red to purple siltstone, thin red to pink chert horizons, chert pebble conglomerate, pink quartz-sandstone, green siltstone, dolomitic beds, and lithicwacke with mafic and felsic volcanic clasts. The sequence shows lateral facies variations, and the detailed stratigraphy of the mine sequence at Renison Bell may not hold throughout the mapped area.

The upper part of this sequence is notable for the persistent occurrence of one or more horizons (Unit Esdf on Zeehan 1:50 000 map) of black graphitic mudstone containing predominantly blocks and boudins of sandstone; other lithologies are also known in the Misty Valley region, as described above. This unit is invariably intensely sheared and contains cleavage surfaces which have been folded. In some places, it crosses bedding in the structurally underlying sequence at near right angles, although it may be concordant to the overlying beds into which it may grade. In the upper reaches of Crimson Creek the unit has been mapped as separating structurally overlying Success Creek Group beds from structurally underlying units of the stratigraphically higher Crimson Creek Formation.

This black sheared mudstone has been described by Brown (1986, p. 25) as "...highly disturbed sedimentary rocks which show all degrees of deformation from soft-sediment slumping to sliding, resulting in places in a highly deformed melange...[with]...an over and under zone of boudinaged sandstone and blocks of undisrupted laminated material in a schistose and brecciated siltstone-mudstone matrix". Brown described the unit as gradational with the Dalcoath Formation of the Renison Mine sequence. E. Williams (pers. comm., 1992) has indicated that near the Argent Dam, this unit grades into relatively undisturbed siltstone beds showing signs of soft-sediment deformation.

The section studied by Williams (unpublished data) is now covered by gorse. Wherever seen by the present author, this sheared black unit closely resembles the smashed black cataclasites seen along such major faults as the Federal-Bassett and Stanley River Faults, although in contrast to these structures, the unit Esdf is folded by the deformation affecting the Success Creek Group and Crimson Creek Formation. It is therefore likely that unit Esdf (Zeehan Map) has acted as the locus for strain during an early episode of slumping and soft-sediment deformation and later tectonic strain preceding the folding of these two formations, as indicated in Brown (1986).

CRIMSON CREEK FORMATION

The reader is referred to Brown (1986) for a detailed description of this unit, which is dominantly a succession of volcaniclastic lithicwacke sandstone, siltstone and pelite beds. The clastic content is predominantly mafic, although beds with felsic volcanic detritus are also present near the base. Also present are intercalations of basalt and rare carbonate horizons. The Crimson Creek Formation is gradational from the upper part of the Success Creek Group, and given the presence of volcaniclastic lithicwacke horizons in the latter, the contact between the two units is not always easy to define in the field.

Structure

The regional outcrop pattern of the Eocambrian rocks may be interpreted as a Type 2 (Ramsay, 1967) interference pattern, interrupted internally and in the east by faults. The Federal-Bassett Fault (or more correctly fault system) appears to truncate the eastern margin of this possible fold interference pattern.

The earliest structure recognised is the sheared unit Esdf, discussed above. In the area south of the Pieman River this unit, together with the upper part of the Success Creek Group, occupies the core of a tight syncline which is overturned to the northeast and is interpreted as an F_1 fold. This structure appears to be cross-folded about a northwest trend. Detailed geological mapping in the creek system east of Argent Dam has also revealed an outcrop pattern resembling a Type 2 fold-interference pattern, formed by cross-folding of early northeast-verging folds by late northwest-trending structures. Detailed structural analysis of this area is as yet incomplete; the small circle distribution of poles to bedding within this area indicates greater complexity of folding than realised previously (see Brown, 1986).

The latest deformation is restricted to northwest-trending faults, which dip between 40° and vertical. At least one of these structures has a reverse component, as it juxtaposes the Oonah Formation over rocks of the Success Creek Group.

Two cleavages may be recognised in the Eocambrian sequence. The earlier cleavage is slaty in the pelitic beds and is subparallel to oblique to bedding. The second cleavage, recognised principally in the low hills in between about CP670690 and the Upper Cuni River area, and in the Pieman River area, trends NNW to NW as close-spaced but non-penetrative surfaces. This cleavage follows the regional trend of the inferred second phase of folding.

FOSSILIFEROUS CAMBRIAN AND ASSOCIATED SUCCESSIONS (AVB)

Remapping of the fossiliferous Cambrian and associated volcano-sedimentary rock successions along the eastern side of the Zeehan Quadrangle revealed three sequences which appear to have been proximal, intermediate and distal to felsic volcanism in the Middle Cambrian, but are now juxtaposed by fault or thrust contacts resulting in a east-over-west stacking of originally time-equivalent successions. The result is that successions mapped in the Rosebery area as belonging to the 'Rosebery Group' are now known to occur throughout the eastern side of the quadrangle from the southern end of Colebrook Hill south along the western side of Moores Pimple and Mt Dundas. The South Comet Mine occurs in a succession of interbedded dolomitic mudstone and siltstone, and dolomite, with lenses and interbeds of felsic volcaniclastic conglomerate, sandstone and wacke and minor shard-rich siltstone and andesitic lava, which has been correlated with the "Wescott Argillite" in the Rosebery area (see Green, 1984 for a review of the stratigraphy in the Rosebery area).

The Dundas Group, as found in the Dundas area, still gives a coherent time-rock unit succession, but when similar age successions are encountered to the north, in the Huskisson River, and east, along the western side of the Moores Pimple–Mt Dundas area, the source changes from dominantly mafic volcanic and metasedimentary detritus to felsic volcanic detritus. The only fossil faunas found within the felsic volcaniclastic rocks are Middle Cambrian in age.

The Late Cambrian successions, both within the Zeehan Quadrangle and to the north in the Huskisson River–Burns Peak area (Higgins Creek) (Jell *et al.*, 1991), consist of interbedded, siliceous, open to closed framework, pebble to cobble conglomerate, pebbly sandstone, sandstone and lithic wacke, siltstone and mudstone. Structures, such as the ramp-style thrust fault indicated by the reverse juxtaposition of Late and Middle Cambrian rocks in the Higgins Creek area to the north, probably extend down the eastern side of the Zeehan Quadrangle and produce the observed east-over-west structures along the eastern boundary of the quadrangle.

LATE CAMBRIAN–ORDOVICIAN (DBS)

Remapping of Late Cambrian to Ordovician successions in the Zeehan region has provided greater structural detail, and has indicated significant differences between the main outcrop areas of the Mount Zeehan Conglomerate and its correlates. These differences relate mainly to the presence or absence of recognisable internal stratigraphy in the successions and to clast composition in the conglomerates (possibly suggesting differences in provenance), and may indicate the existence of separate sub-basins during deposition of the formation.

Most of the length of the Professor Range shows Mount Zeehan Conglomerate correlates exposed in a single, consistently southwest-dipping fold limb probably faulted against Gordon Group rocks along its northeastern margin. Consideration of large fold structures in the Eldon Group to the northwest of the range suggests that this pattern may have resulted from telescoping of one limb of a large northwest-trending anticline over the other, perhaps by movement on a low-angle scissor fault hinging near CP648523. Only on the southeastern end of the range is a complete large fold closure present, corresponding to a syncline in the Eldon Group just to the north. The Professor Range sequence shows a recognisable stratigraphy of four units (the lower two being thin and impersistent), and overall contains a higher proportion of sandstone than the Mt Zeehan sequence. Conglomerate clasts are dominantly quartzite (including foliated metaquartzite), with lesser vein quartz, chert ranging from minor to 24%, and minor quartz sandstone, indicating a dominantly Tyennan provenance. Contact relationships are inconclusive with the underlying fossiliferous Cambrian sequence, but are gradational with the overlying Moina Sandstone.

The Mount Zeehan Conglomerate at Mt Zeehan is exposed in a large open northwest-trending anticline. In comparison to the Professor Range, the sequence shows no recognisable internal stratigraphy, is thicker and generally coarser (to boulder grade) overall, and commonly shows distinctly purplish weathering due in part to clast composition dominated by ferruginous quartz sandstone, with lesser quartzite, vein quartz and minor chert. The provenance may be dominantly non-Tyennan. Upper and lower contact relationships are similar to those at Professor Range.

In comparison to the other areas, the Mount Zeehan Conglomerate–Moina Sandstone sequence in the Duck Creek area is very much thinned, and the conglomerate is commonly only pebble grade with clasts dominantly of quartz. The sequence here rests with angular unconformity on the Precambrian Oonah Formation.

Mineralisation in the Late Cambrian to Ordovician sequences in the Zeehan region is essentially restricted to the carbonate rocks of the Gordon Group, which are poorly exposed at the surface. The following account is summarised from Taylor (1989). The greatest concentration of Pb-Zn-Ag mineralisation in the Gordon Group carbonates is in the Zeehan Mineral Field, where several deposits were mined for their Pb-Ag content. Compared to other deposits of the Zeehan area, the carbonate-hosted orebodies were less attractive mining propositions because of lower Ag content and the high production costs caused by poor ground and high water inflows. The most significant deposit was Oceana [CP622574]. A re-evaluation of this deposit in 1978–1984 defined two distinctly different styles of mineralisation: one, grossly discordant to the host rock, consisting mostly of generally coarse galena, sphalerite and siderite occurring as open-space infillings of veins, cavities and intraclastic areas of breccias in a recrystallised, silicified and dolomitised limestone; the other comprising two separate stratiform horizons of semi-massive fine-grained galena, sphalerite and siderite, with replacement-indicative textures, lying at the top and bottom of a 30 m thick unit of limestone breccia. The previously accepted genetic model for the Oceana deposit involved deposition in structurally-controlled fissure veins from mineralising fluids emanating from the Devonian Heemskirk Granite. However, the whole deposit is now regarded as a variant of the sedimentary exhalative class and therefore Ordovician in age, an interpretation supported by recent Pb isotope determinations on galena. The distinctive limestone breccias are now thought to be of submarine debris-flow origin during deposition of the Gordon Group. Recent exploration activity in the vicinity of other, more minor old workings in the Gordon Group has discovered low-grade sub-economic mineralisation in three stratigraphic positions at the base, middle and top of the sequence. In some of these occurrences the mineralisation is syndiagenetic, similar to the stratiform part of the Oceana deposit.

ELDON GROUP (MPM)

Remapping of the Eldon Group rocks in the Zeehan area has confirmed the stratigraphy described by Blissett (1962). More structural data has been obtained from the eastern outcrops of the group, and the pattern of faults has been partly modified based on re-interpretation of the data.

DEVONIAN GRANITOIDS (MPM)

The Heemskirk Granite intruded the Precambrian Oonah Formation in the Late Devonian, and has been recognised as a composite body consisting of red and white granite (Brooks and Compston, 1965; Klominsky, 1972). The present mapping has confirmed the essential accuracy of Klominsky's mapping and has made only minor alterations to his boundary between the red and white granite types. The texture of both granite types ranges from porphyritic to equigranular and from fine-grained to coarse-grained. The red granite is intruded and underlain by the white granite, although intrusion of the white granite must have closely followed the red as they are indistinguishable on radiometric age (Brooks and Compston, 1965). In spite of the colour difference the two granite types are very similar in chemical and mineralogical composition. The white granite generally has a greater abundance of miarolitic cavities, has more quartz-tourmaline segregations and nodules, and is more altered. The red granite was formed by multiple intrusions which produced layers, each of which intruded and chilled against an upper previous layer. Evidence for multiple intrusion in the white granite is present in a few localities, although there is a general increase in the grainsize away from the contact with the red granite.

The mode of formation of the granite body appears to be by intrusion of sheets into space formed by subsidence within a cauldron-type structure (Klominsky, 1972; Hajitaheri, 1985).

Both the red and white granite consist of quartz, feldspar and biotite, with minor amounts of hornblende present in some areas of the red granite. Accessory magnetite, sphene and allanite are confined to the red granite, which suggests that it is an I-type granite, whereas the mineralogy of the white granite is consistent with it being an S-type granite. The composition of the body ranges from adamellite to alkali-feldspar granite.

Both granite types are peraluminous and show LREE enrichment and HREE depletion with a negative Eu anomaly.

Exsolution of hydrothermal fluids following crystallisation of the granite was greatest for the white granite, but occurs in both types and has produced widespread alteration of the feldspar and mica. In addition, segregations and nodules of quartz-tourmaline are common in both the main granite types, particularly near the finer-grained tops to sheets and near the contact of the white granite with the red. Quartz-tourmaline veins following the cooling joints are widespread, particularly in the lower part of the red granite. Cassiterite mineralisation occurs in these veins in the southern part of the body, and the veins also include topaz and sulphides. The hydrothermal fluid has also penetrated the country rocks, and the present mapping has partly defined the zone within which tourmaline, derived from the granite, has been deposited.

Gravity data indicate that granite occurs within two kilometres of the surface over a large part of the Zeehan Quadrangle in a zone extending eastward from the Heemskirk Granite in the direction of the Granite Tor Granite (Leaman and Richardson, 1992). Most of the known mineral deposits in the Zeehan area occur within this zone and are considered to be related to the granite intrusion. The deposits include the dominantly carbonate-replacement tin deposits at Renison and Zeehan, and the Pb-Zn-Ag deposits in the mines near Zeehan. Host rocks for these deposits are the Precambrian Oonah Formation, the Eocambrian Success Creek Group, and the Crimson Creek Formation.

The original source for the tin in the mineralising fluid is clearly the Devonian granite, but the Pb-Zn-Ag mineralisation related to the granite in the Zeehan area appears to be a result of scavenging of these elements from the rocks through which the hydrothermal fluids from the granite passed. The Gordon Limestone, which is host to Pb-Zn-Ag exhalitive mineralisation (Taylor, 1989), and the Eocambrian Crimson Creek Formation are possible sources for these elements, and the presence of these units closely above postulated subsurface extensions of the granite may enhance the prospectivity of an area. As faults provide a conduit for the hydrothermal fluids from the granite, areas close to faults, even where the granite is considered to be at greater than two kilometres depths, may be prospective. The revision of the Zeehan map sheet has produced more detailed subdivision and distribution of these rock units and the location of faults, which will be of assistance in identifying exploration targets.

PERMIAN TILLITE (RHF)

STRUCTURE

Goscombe (1991) has demonstrated that there exists a cleavage of a 'diamond' pattern in beds of the Permian tillite which are exposed in the Montana Mine region and in the Reece Dam area. The cleavage is formed by a dominant surface following a northwesterly trend, together with a less dominant surface along a NNW trend. This cleavage is not the bedding-parallel cleavage described by Blissett (1962). Goscombe (1991) argued that the tillite has been folded about the northwest-trending cleavage, and that the outcrop pattern of the tillite in the Montana Mine region resembles a northwest-trending synformal basin. The cleavage is, "...apparently defined by aligned platy minerals in hand specimen, and has given rise to a finely spaced (<1 mm) foliation in many outcrops. In outcrop the cleavage is most easily discerned as very obvious cleavage planes spaced at 1–8 mm and accentuated in definition by recent weathering" (Goscombe, 1992, p. 4). E. Williams (pers. comm., 1992) has indicated that such seamed cleavages require a minimum shortening of 20%. Therefore, this first report (Goscombe, 1991) in the Zeehan area of post-Permian cleavage formation is of considerable importance in regional structural analysis.

In this context it should also be noted that Blissett (1962) cites the report of Campana and King (1958) that, in the now-flooded Montana Mine, the Oonah formation has been reverse-faulted over the Permian tillite by a northeast-dipping structure (Blissett, 1962, fig. 12), and that they regard the Oonah Formation in the Tasmanian Mine (southeast of the Tenth Legion Mine) as thrust over the pre-Permian surface. This later structure is presumably the

Tenth Legion Thrust, which in the Tasmanian Mine area Blissett and Gulline (1962) mapped as truncating beds of Permian tillite. Brown (pers. comm., 1992) has indicated that no beds of Permain age or characteristics have been found at these localities; rather the beds in question are interbedded siltstone and chert-granule conglomerate of probable Cambrian age. However, there does remain the possibility of re-activation of parts of the Tenth Legion Thrust during post-Permian faulting.

Finally, cleaved Permian tillite occupies the deeply incised valley of Stringers Rivulet in the region due north of the abandoned HEC camp east of the Reece Dam. To the north of these outcrops, the Oonah Formation occupies the high ground; however, the contact between the two formations has not yet been examined.

PERMIAN AND YOUNGER SUCCESSIONS (AVB)

Generally, revision of the Permian and younger successions was not carried out in detail, as where these faulted sequences were observed the work of Blissett and Gulline (1962) was confirmed.

GEOLOGICAL ATLAS 1:50 000 SERIES — TROWUTTA (JLE,DBS,AVB)

INTRODUCTION

This project, in the Arthur River–Rapid River area of North West Tasmania, involves detailed mapping of major rock units in the southeastern part of the Smithton Basin, the Rocky Cape Group, and the Arthur Metamorphic Complex. When completed, the work will complement the existing published Smithton and Woolnorth 1:50 000 map sheets to provide a modern geological map coverage of most of the northern half of the Rocky Cape Region of North West Tasmania. Some of the main contributions of the work in this region are given below.

SMITHTON BASIN

STRATIGRAPHY

Knowledge of the stratigraphy and basement-cover relationships of the Late Precambrian to Middle Cambrian Smithton Basin has been greatly improved. This includes confirmation of the existence, in the basin, of two separate carbonate (and chert after carbonate) sequences, and the identification, associated with the lowermost of these two sequences, of volumetrically significant but irregularly developed (?discontinuous) coarse mixtite units containing a polymict assemblage of rock fragments including basalt, chert, and stromatolitic carbonate. One of the mixtite units, underlying the lowermost tholeiitic basalt flow in the Trowutta area, contains acid volcanic detritus which consists of dacitic to rhyolitic lava and welded tuff fragments. The new data are providing a considerably enhanced geological basis for resource assessment and regional and interstate correlations, and sample control for recent stable isotope research on the carbonate sequences. The latter promises to provide important age control on previously poorly constrained Tasmanian ?Late Precambrian–?Early Cambrian rock sequences, and in the Smithton Basin in particular, may confirm the existence of a long-suspected major time break somewhere in the vicinity of the contact between the upper carbonate unit (the Smithton Dolomite) and the overlying fossiliferous late Middle Cambrian to early Late Cambrian clastic sedimentary sequence.

Reconnaissance mapping in the northwestern sector of the Magnet Quadrangle, to the south of Trowutta Quadrangle, has revealed an outlier of Smithton Basin rocks, including Black River Dolomite, chert and basalt, occupying a narrow, 5 km long, east-west trending structural basin in the Leigh River area.

BASALTIC ROCKS

Studies of the petrography and geochemistry of the basaltic rocks of the Smithton Basin have shown that at least four distinct groups are present, each characterised by a distinct range of TiO_2 values. The stratigraphically oldest are low TiO_2 (0.6–0.7 wt.%), MgO-rich basalts with altered phenocrysts of former olivine. These are followed by two younger suites with 1.0–1.1 wt.% and 1.6–1.7 wt.% TiO_2 respectively, containing phenocrysts of plagioclase and/or augite in an altered, fine-grained groundmass. The fourth and possibly youngest suite, with 2.1–2.4 wt.% TiO_2, is restricted to the Montagu area in the Woolnorth Quadrangle (Seymour and Baillie, 1992). Following a preliminary study by Brown (1989, pp. 70–77), the four suites are interpreted as the result of four batches of partial melting, each progressively enriched in TiO_2, Zr and other incompatible elements, and depleted in MgO, Ni and Cr, relative to the previous batch. Each of the four batches has subsequently been modified by crystal fractionation of olivine, or augite and plagioclase, following a tholeiitic differentiation trend. Trace element and rare-earth element data confirm that the latter two augite-plagioclase-phyric suites are correlates of the tholeiitic basalts within the Crimson Creek Formation of the Zeehan area. Most samples are highly magnetic, and their regional distribution is obvious on contoured aeromagnetic maps.

DOLERITE DYKES WITHIN THE PRECAMBRIAN ROCKY CAPE GROUP

The dolerite dyke swarm within the Rocky Cape Group, which extends from the Norfolk Range, east of Balfour and through the Rapid River area to the north coast, is being mapped and studied petrologically. Although at an early stage of assessment, geochemical data suggest that at least two of the five types of dyke identified by Brown (1989) on the north coast are present in the Trowutta Quadrangle. These are his "massive tholeiitic" and andesitic "calc-alkaline" types. However, the data do not support Brown's suggestion that the former may be feeders for the Eocambrian basalts of the Smithton Basin.

ARTHUR METAMORPHIC COMPLEX

Further progress has been made on the determination of the internal structure and lithological subdivision of the northern part of the economically important Arthur Metamorphic Complex. This hosts the Savage River iron ore deposit and also contains cupriferous sulphide deposits, magnesite deposits, gold-bearing quartz veins and associated alluvial gold, and silicified dolomite units from which have formed residual silica deposits. To date three subdivisions of the Precambrian rocks of this Complex have been recognised in the Keith River–Arthur River–Lyons River area. The westernmost unit comprises a relatively thin belt of phyllite and foliated quartzite, showing both structural and metamorphic transitions westward into the relatively unmetamorphosed Rocky Cape Group (see also Gee, 1977;

Turner, 1990). The central unit comprises commonly chlorite-rich and/or carbonate-rich greenschist-facies schist and subordinate amphibolite, and near its eastern boundary includes magnesite deposits and chalcopyrite-bearing pyrite-magnetite lodes (see also Turner, 1988; 1990). The easternmost unit comprises quartz-muscovite rich schist, phyllite and foliated micaceous quartzite which appear to show gradual metamorphic and structural transitions into relatively unmetamorphosed clastic sedimentary rocks probably equivalent to the eastern sedimentary association of the Rocky Cape Region (the Burnie Formation and equivalents).

STRUCTURAL PROFILES

A detailed composite structural profile is being progressively constructed from the northwest coast near Marrawah, through the Smithton Basin, Rocky Cape Group and the northern part of the Arthur Metamorphic Complex. The structural profile should provide invaluable control on tectonic interpretations (including those based on geophysics) of the various major rock units it crosses. In particular, the profile should enhance understanding of the three-dimensional geometric and structural relationships of the Arthur Metamorphic Complex to the less metamorphosed Precambrian sequences adjoining it to the east and west. It will also provide a basis for comparison with the recently published work on the southern part of the Complex and adjoining sequences in the Corinna area (Turner *et al.*, 1991), and with the proposed northern Tasmania deep seismic profile by the BMR.

GEOLOGICAL ATLAS 1:50 000 SERIES — ALBERTON (JLE,MPM,RHF)

INTRODUCTION

Field work for the Alberton geological map sheet, which also includes the Mathinna, West Pyengana, Upper Blessington and Mt Maurice areas, was completed in December 1991. The publication of this map will complete the first edition 1:50 000 scale Geological Atlas coverage of northeastern Tasmania.

The geology of the quadrangle consists broadly of a lower Palaeozoic turbidite sequence which has been folded and intruded by granitoids in the Devonian, unconformably overlain by Permian sedimentary rocks which have been intruded by Jurassic dolerite, and locally covered by Tertiary basalt flows and Cainozoic sediments.

PALAEOZOIC MATHINNA BEDS AND ENCLOSED AURIFEROUS QUARTZ VEINS

The oldest rocks in the area belong to a quartzwacke/slate turbidite sequence, the Mathinna Beds, which have been folded along NNW-trending axes and have undergone low-grade regional metamorphism in the Early to Middle Devonian in an event correlated with the Tabberabberan Orogeny of eastern Australia. A more detailed discussion of the structures in the Mathinna Beds is given by Goscombe and Findlay (1989).

The Mathinna Beds consist of interbedded sandstone, siltstone and mudstone, and individual units are generally not regionally mappable. However, in the southwest of the quadrangle a lutite-dominated sequence occurs which appears to be a strike extension of similar sequences in the Lebrina–Myrtle Bank and Lefroy–Bangor areas, where these sequences contain Early Ordovician graptolites and are quarried for slate. The main part of the Mathinna Beds in the east of the quadrangle is dominantly a mixed arenite/lutite sequence, although in some areas individual units of mudstone and quartzite can be mapped. This tract, which may belong to the sequence in which Silurian graptolites have been described (G. J. Davidson, pers. comm., 1992; Rickards *et al.*, in prep.), hosts significant and historically important gold mineralisation in a more-or-less linear belt extending from Mangana, through Mathinna and along the Dans Rivulet and Alberton valleys.

Structural studies of the Mathinna Beds, together with reconnaissance fluid inclusion studies by J. Taheri, point to fault control of the auriferous quartz veins which have originated by metamorphic processes unrelated to granitoid intrusion (Taheri and Findlay, 1992). Indeed, it is possible that these quartz veins post-date granitoid intrusion. In addition, structural studies have identified:

- large, generally northwest-trending chevron folds with low to high axial plunges;
- subsequent mega-kinking (Goscombe and Findlay, 1989) across generally northeast kink planes;
- multiple quartz veining; and
- later faulting.

Although the fault relationships are still being analysed, Findlay (in Taheri and Findlay, ibid), based on reconnaissance analysis of striated small faults, has offered the idea that strike-slip faulting is important. This has led to the, as yet unproven, idea that the gold mineralisation along the Mangana–Alberton lineament occurs mainly in veins localised principally at east-stepping, *en echelon* jogs within a broadly northwest-striking dextral strike-slip system.

DEVONIAN GRANITOID MASSES

SCOTTSDALE BATHOLITH

The Scottsdale Batholith is the westernmost of the three major granitoid batholiths in northeastern Tasmania, stretching south from Bridport to the northern flanks of Ben Lomond, where it disappears beneath Permian and Jurassic dolerite cover. In the Bridport–Scottsdale area it is mainly covered by thin Tertiary sediments and basalt, and the best exposures are generally to the south in the Alberton Quadrangle.

The granitoids have intruded the Mathinna Beds, producing narrow contact metamorphic aureoles with assemblages containing biotite and locally cordierite and/or andalusite. Individual plutons are generally steep-sided and elongated north-south in the regional fold trend. Intrusion took place shortly after regional folding. K/Ar biotite dating has given ages of 370–395 Ma and suggests two phases of igneous activity of slightly different age.

Regional geological mapping, aided by petrography and geochemistry, has shown that the Scottsdale Batholith can be subdivided into a number of discrete plutons, which can be grouped into two main geochemical suites; the Diddleum Suite and the Russells Road Suite.

The Diddleum Suite is meta-aluminous, with a few weakly per-aluminous samples, and consists of three granodiorite bodies. The Diddleum and Porcupine Creek plutons in the western part of the batholith are very similar bodies of equigranular, medium-grained to coarse-grained biotite-hornblende granodiorite, separated by a 2 km-wide screen of hornfelsed Mathinna Beds. Rare augite, surrounded by or closely associated with amphibole (hornblende to actinolite), occurs within some samples from the Diddleum pluton. The Tulendeena pluton, composed of similar biotite-hornblende granodiorite, occurs on the eastern margin of the batholith, east of Scottsdale, and does not extend south to the Alberton Quadrangle. Field relations, such as chilling of other plutons near contacts, indicate that the granodiorites are the oldest components of the batholith.

The Russells Road Suite is weakly per-aluminous and more heterogeneous, ranging in composition from granodiorite to alkali-feldspar granite. The suite consists of four plutons. The most mafic is the Upper Blessington pluton, an irregular body of equigranular to seriate, coarse-grained to very-coarse grained biotite-hornblende granodiorite on the southwestern margin of the batholith, apparently plunging shallowly south beneath the Ben Lomond plateau. Sparse augite also occurs in this granitoid body. To its northeast is the Russells Road pluton, consisting of equigranular, coarse-grained to very coarse-grained, white to pink biotite ± hornblende granodiorite/adamellite, which forms an almost complete rim around the younger, similar but less coarse-grained Hogarth Road pluton. Both the Russells Road and the Hogarth Road plutons become more mafic (granodioritic) to the south, where they contain hornblende, and where the Hogarth Road pluton is characterised by very abundant quartz diorite xenoliths. The youngest major component of the batholith, the Tombstone Creek pluton, forms an elongate body in the centre of the Hogarth Road pluton, and tapers northward and becomes finer grained in the Upper Maurice River area. The pluton consists of sparsely porphyritic, fine-grained to coarse-grained biotite granite/adamellite, with a more leucocratic, equigranular marginal zone of alkali-feldspar granite, characterised by pink K-feldspar and iron-rich biotite (annite). This is attributed to autometasomatism by hydrothermal fluids released by crystallisation of the rest of the body. The pink granite variant of the Russells Road pluton, in the Kamona–Mt Stronach area east of Scottsdale, is very similar and probably formed in the same way.

Thus the Scottsdale Batholith exhibits a roughly zonal arrangement of its constituent plutons, with the older granodiorite plutons near its margins, and the younger granite/adamellite plutons in its core.

In contrast to the abundant tin mineralisation within the Blue Tier Batholith, known mineralisation within the Scottsdale Batholith is confined to a few Sn-Cu-Mo-Bi veins near Mt Maurice, and disseminated Mo at Mt Stronach near Scottsdale, although little exploration has been done. A possible explanation for this apparent paucity of mineralisation may lie in the petrology of the batholith. The presence of hornblende, pyroxene, and accessory minerals such as sphene and allanite, suggest that the granitoids of the Scottsdale Batholith are I-types (i.e. derived from partial melting of igneous source rocks) on the restite model of Chappell and White (1974), whilst most granitoids associated with tin mineralisation in Tasmania and elsewhere are S-types (i.e. derived from partial melting of sedimentary source rocks). Possibly Cu-Mo stockwork or disseminated mineralisation would represent a more appropriate target in this I-type batholith, although results to date have been disappointing (e.g. Ellis, 1984).

The Ben Lomond/Royal George Granite, lying south of the Ben Lomond plateau, has certain geochemical similarities with the Tombstone Creek Granite, and may represent an extreme fractionated phase (Findlay *et al.*, in prep.). However other evidence, such as abundant Sn-W mineralisation, accessory minerals and the lack of associated granodiorite, does not support its assignment to the Scottsdale Batholith.

The Tombstone Creek pluton, its marginal zone, and the chilled margin of the Russells Road pluton are currently all being quarried for building stone (trade names "Martich", "Jaydon" and "Tequila" respectively). The granodiorite plutons are also considered to have high to medium prospectivity for this commodity (Sharples, 1990).

BLUE TIER BATHOLITH

Part of the Blue Tier Batholith, lying in the northeastern part of the Alberton Quadrangle, has also been divided into constituent plutons. The Pyengana pluton consists of equigranular hornblende-biotite granodiorite, and is usually strongly magnetic. Marked local variations in susceptibility, and some large areas of relatively non-magnetic granodiorite, are attributed to fluctuations in oxygen fugacity during crystallisation of the magma, resulting in a variable abundance of magnetite, rather than separate intrusions. As noted in an earlier regional study by Gee and Groves (1971), this pluton is divided by an apparently dilational, dyke-like arm of the Poimena pluton (biotite ± muscovite granite/adamellite), in the vicinity of which the granodiorite is foliated, sometimes intensely so. However the southern portion of Groves' Poimena pluton is a slightly more melanocratic biotite adamellite with occasional hornblende, and represents the separate Haleys New Country pluton. It is separated from the Pyengana granodiorite by a wedge of Mathinna Beds, and is truncated by the arm of the Poimena pluton, also with local development of grain foliation near the contact. Mineralogical and geochemical data indicates that both the Pyengana and Haleys New Country plutons are I-type granitoids, with the later Poimena pluton having an ambiguous signature.

This part of the Blue Tier Batholith has little known mineralisation. However the Mt Paris pluton (associated with Sn mineralisation), which crops out just to the north of the map sheet, dips shallowly and irregularly beneath the northern part of the Rattler Range, making this area prospective for Sn-W mineralisation.

PARMEENER SUPERGROUP

The flat-lying Parmeener Supergroup, which unconformably overlies the basement rocks, is restricted in this area to a generally thin cover in highland areas. The unconformity on Mathinna Beds is usually nearly planar, and at Mathinna Plains and elsewhere corresponds to a striking physiographic surface at about 800 m elevation, representing an exhumed Carboniferous peneplain. On granitoid basement the base of the Supergroup is generally topographically more irregular. Regionally the rocks of the Supergroup dip at a few degrees to the south, and are disrupted by numerous, often NE-SW or NW-SE trending normal faults with small throws, which are often difficult to trace far into the basement rocks. The rocks of the Parmeener Supergroup are marine and non-marine sandstone, siltstone, mudstone, minor carbonaceous shale and basal conglomerate, wholly of Early to Middle Permian age. Correlates of the Castle Carey Formation (upper glaciomarine sequence), Aberfoyle

Formation (lower freshwater sequence), and Strickland Gorge Formation (lower glaciomarine sequence) have been mapped. In the eastern part of the quadrangle, the latter contains a stratigraphically lower, massive quartz sandstone facies which probably represents freshwater sedimentation during an earlier period of emergence, before deposition of the Aberfoyle Formation. No indication of coal or oil shale is known, and, except for a remote possibility of fossil placer deposits in basal freshwater units, these rocks are probably of no direct economic significance.

JURASSIC DOLERITE

Jurassic dolerite is confined to residuals capping Ben Nevis, Mt Saddleback, Mt Victoria, Mt Albert, Mt Blackboy and Mt Young. All contacts with the underlying Parmeener Supergroup are obscured by extensive scree and talus deposits, but it is probable that these mountains represent remnants of an extensive dolerite sheet, intruding at the stratigraphic level of upper Permian rocks, and once extending across northeast Tasmania. Feeders have not been recognised within the region. Areas of dolerite in lowland areas, occurring within basement, are shown as occurring within basement on some earlier maps, but these have been re-interpreted as probably older (Tertiary?) talus or lag deposits. Some of these deposits are also associated with similar boulder deposits composed of basal Permian conglomerate.

TERTIARY BASALT

The generally limited flows of Tertiary basalt in the area range in composition from alkali-olivine basalt to olivine nephelinite. Drilling of a small intense magnetic anomaly near Upper Esk has revealed a basaltic pyroclastic vent within the Mathinna Beds, concealed by river alluvium. South of Ringarooma, Olivers Hill represents the probable source of extensive Miocene(?) olivine-nephelinite basalt flows extending northward. The Eocene alkali-olivine basalt and pyroclastic rocks of the Weldborough Pass area extend to West Pyengana, and have been prospected for heavy minerals (Morrison, 1988), notably sapphire and zircon which also have been reworked into local gravels. These and other minerals, such as spinel, garnet and the rare earth phosphate florenceite, represent fragments of high-pressure origin brought to the surface by the basalt.

QUATERNARY ALLUVIUM

Extensive tracts of Quaternary alluvium are present in the Dorset and New River valleys, where they have been worked for gold, and in the South Esk valley near Mathinna, where they have been unsuccessfully prospected for gold (Mellor, 1982).

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