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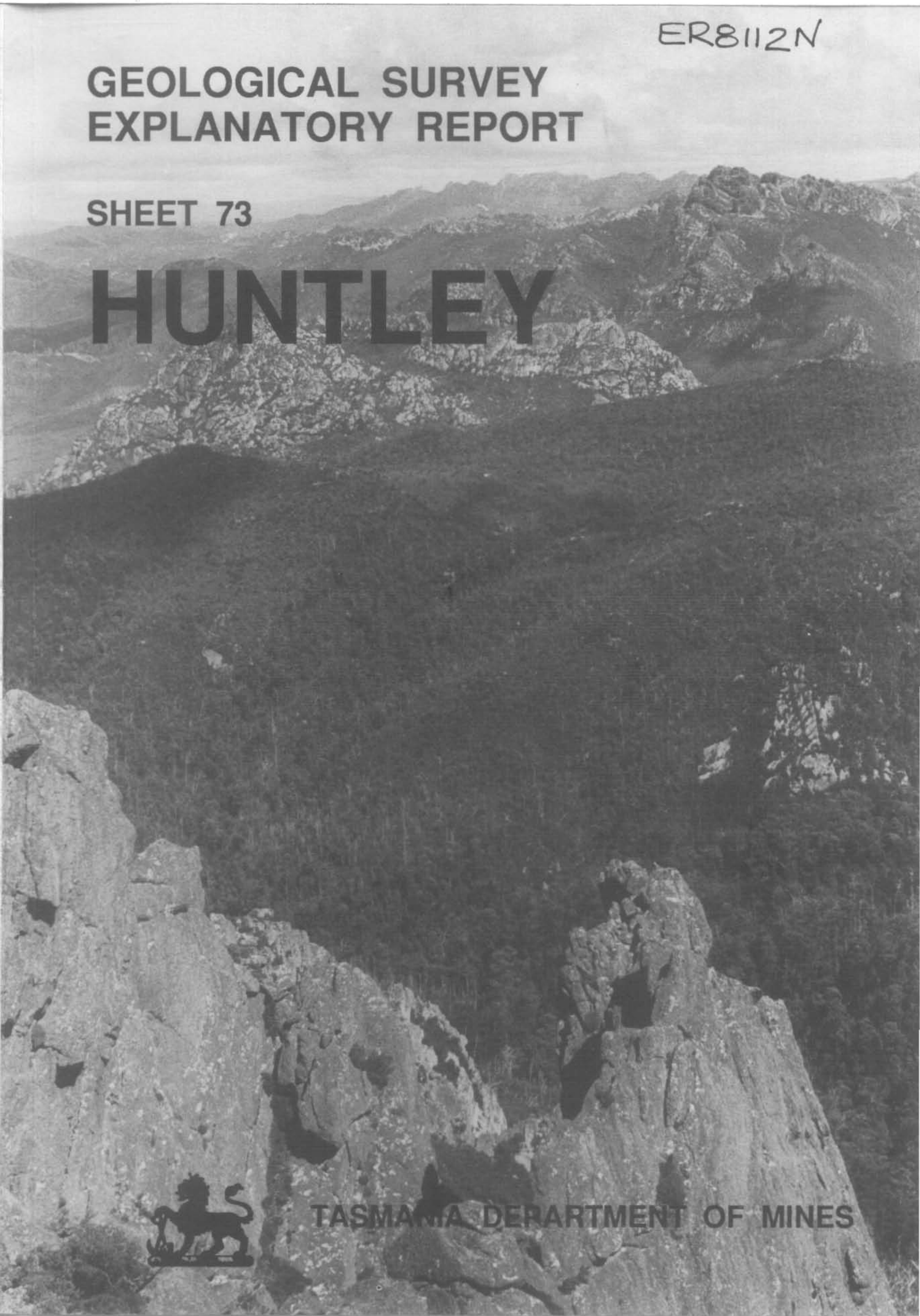
GEOLOGICAL SURVEY EXPLANATORY REPORT

SHEET 73

HUNTLEY



TASMANIA DEPARTMENT OF MINES

GEOLOGICAL SURVEY 1:50 000 EXPLANATORY REPORT HUNTLEY SHEET 73 1989 ISBN 0 7246 1969 8

TASMANIA DEPARTMENT OF MINES

1989

GEOLOGICAL SURVEY EXPLANATORY REPORT

GEOLOGICAL ATLAS 1:50 000 SERIES

SHEET 73 (8112N)

HUNTLEY

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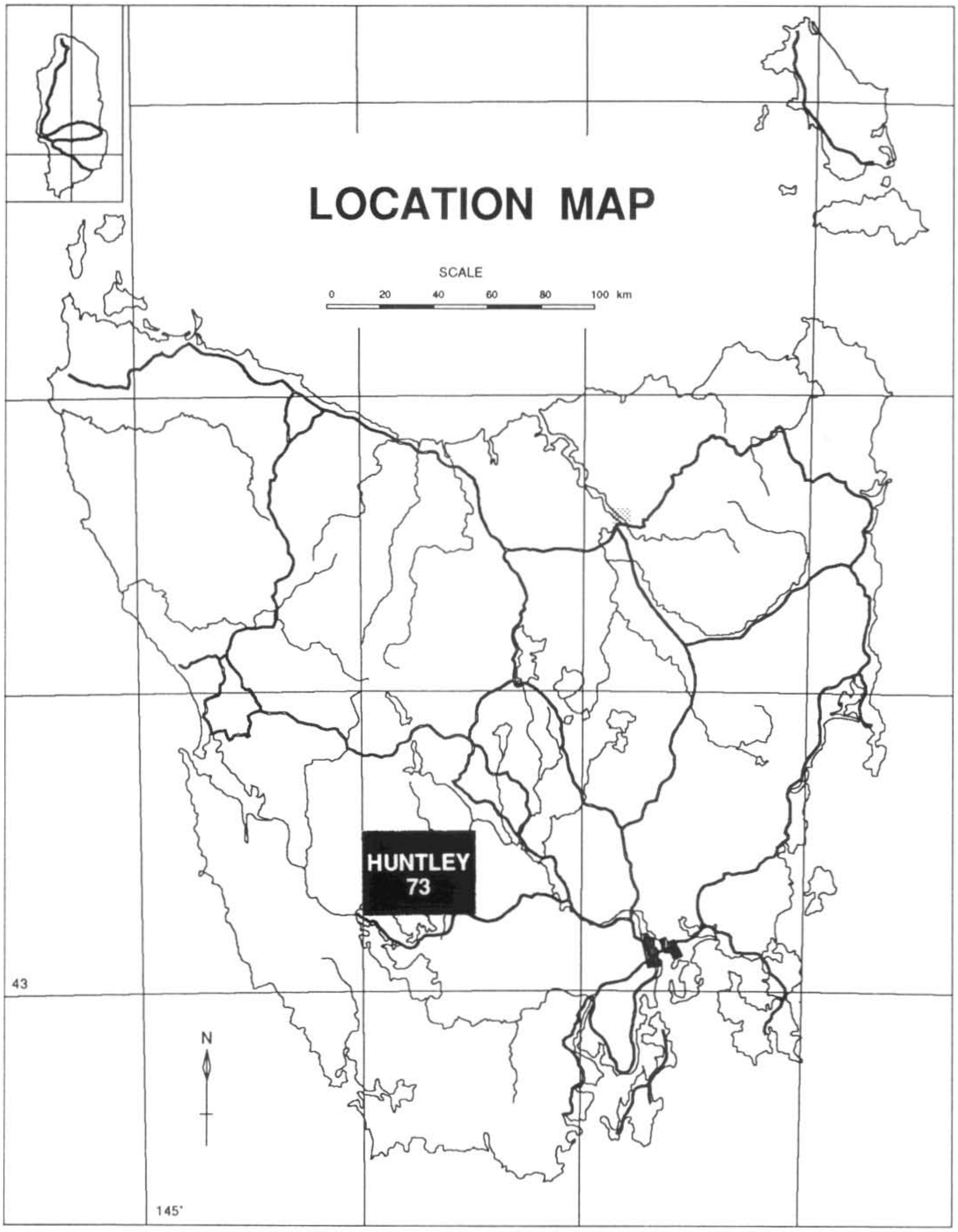
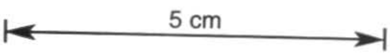


Figure 1. Location map.



INTRODUCTION

The Huntley Quadrangle is situated in the central part of south-western Tasmania and is accessible from Hobart via Maydena and the Gordon River Road. Numerous forestry roads provide access to many parts of the Quadrangle. The old town of Adamsfield [DN445696] is accessible by the Clear Hill Road or by a four-wheel drive track along the Saw Back Range. The northern end of Lake Gordon is accesible by a continuation of the Clear Hill Road beyond the Adam Falls. The township of Strathgordon [DN224644] lies 1.5 km to the south of the western side of the sheet.

Mapping commenced early in 1973 and was concluded in the summer of 1976–1977, following a request from the Hydro-electric Commission for a regional geological and structural interpretation of the area so that the effects of the flooding by Lake Gordon could be predicted. Mapping was carried out on a scale of 1:15 840 and complied for publication at a scale of 1:50 000.

LAND USE

Most of the Quadrangle lies within the South-West Conservation Area. The north-eastern part of the sheet is part of the ANM forestry concession. Large areas of the quadrangle are used for recreation - bushwalking - with tracks along the Vale of Rasselas leading to the Denison Range and Lake Curly. Trout fishing is popular on Lake Gordon. The Quadrangle is mainly covered by relatively dense rain forest and large areas of button grass plain, the latter now mainly flooded by Lake Gordon. The ridge tops are largely open buttongrass - heath country.

Historically the Adamsfield area was world famous as a source of 'osmiridium' in the early 1920s. Small scale prospecting has been carried out since then and the area is presently being re-prospected as a source of platinum-group elements. Quarries for road metal along the western face of Clear Hill were opened in the early 1970s as a souce of material for road construction during forestry salvage of eucalypts and Huon Pine from below the new lake level.

The report was compile by A. V. Brown, using the data of, and unpublished reports written by, A. V. Brown, M. P. McClenaghan, N. J. Turner, P. W. Baillie, J. McClenaghan, P. Lennox and P. R. Williams. The individual geologists responsible for the information given are referred to wherever possible by their initials within parentheses. The work was supervised by Dr Emyr Williams.

LANDSCAPE

N. J. Turner

The landscape formed by the folded rocks which underlie most of the Huntley map sheet is characterised by steep-sided strike ridges capped by resistant rock types with narrow to broad intervening valleys. In the western part of the map sheet ridges such as The Pleiades, Spires and Prince of Wales Range are capped by quartzite of Precambrian age and attain a maximum elevation of about 1100 m at Shining Mountain. Further east the northerly trending series of ridges extending from Ragged Range in the south to Denison Range in the north is formed by siliceous conglomerate and sandstone (Denison Group) of Cambrian to Ordovician age. With an elevation exceeding 1240 m Reeds Peak on Denison Range is the highest feature in Huntley map sheet. Jurassic dolerite which is a major mountain-forming rock type elsewhere in Tasmania, is restricted to the easternmost part of the map sheet where it caps Wherretts Lookout and a plateau area which includes Mt Dawson.

The Gordon River is the largest river in the Quadrangle although a long segment of it is now inundated by Lake Gordon, a hydro-electric reservoir. For much of its original course the river flowed in a westerly direction across the strike of resistant rock-types which suggests that the drainage trend was superimposed. The trend probably developed on overlying unfolded rocks of Late Palaeozoic and Mesozoic age which have since been removed by erosion.

Resistant lithologies such as quartzite and siliceous conglomerate form barriers in many rivers which cause the tracts of the rivers on the upstream side of the barriers to be at, or near temporary base level. In these tracts the streams have low gradients and may have flood plains on which there are thin deposits of alluvium. Terraces and incised stream channels attest to periods of rejuvenation. Where there are extensive belts of easily eroded rocks on the upstream sides of bars broad valleys have developed. For example, Gordon Limestone and Florentine Valley Mudstone underlie the broad Vale of Rasselas upstream of Gordon Gorge. These formations also underlie a valley upstream of Adams Falls and the large valley of the Florentine River whose low gradient is controlled by a bar outside Huntley quadrangle.

A variety of rock-types of Precambrian to Cambrian age including readily erodable mudstones and deeply weathered labile sandstones underlie the very broad valley upstream of Erskine Point which is now occupied by the eastern portion of Lake Gordon. Carbonate rocks possibly occupy much of the broad valley of Denison River since dolomite occurs in the bed of the river near the northern edge of Huntley map. The barrier causing the low gradient of the Denison River is formed by the same band of quartzite that caps Prince of Wales Range but lies to the west, outside the Huntley Quadrangle. River capture and the development of the Gordon and Florentine drainage systems are discussed by Jennings (1956).

Cirque lakes and moraine ridges demonstrate the modifying effect of Pleistocene glaciation on the high country landforms between Denison Range and The Spires and on The Thumbs. The effect of ice-action on landscape appears to have been largely confined to highland areas with little evidence of its effect in lower valley regions although glacial outwash deposits are extensive east of the Florentine River and local till deposits demonstrate that glaciers reached these lower elevations.

The effect of glaciation is evident in the valleys of intermediate elevation which are east and west of Mt Curley. To the west, Lake Curley is a shallow body of water occupying a section of valley over deepened by ice. Bedrock crops out at the exit of the lake and quartzite on the western face of Mt Curley is polished and striated to a height of approximately 170 m above the valley floor. East of the mountain, ice-action is demonstrated in the valley of the upper Pokana River by the wide distribution of huge quartzite erratics. Glacial striae were found on outcrop on the floor of this valley near DN328896 and they indicate ice flowing from the cirque-like feature immediately to the west. Other ice flows came from the area of the three small cirque lakes overlooking the southern end of the valley.

STRATIGRAPHY

Precambrian

INTRODUCTION

Previous work on the Precambrian rocks in Huntley Map Sheet was mainly limited to reconnaissance mapping by the BHP Co. Ltd (Whitehead, 1964; Hall, 1966; Hall *et al.*, 1969). However, a number detailed studies had also been carried out on Precambrian rocks in areas adjacent to the south-western corner of the sheet. Engineering geology studies of the Gordon and Serpentine Dam sites were carried out by the HEC (e.g. Andric *et al.*, 1976), as well as structural and sedimentological studies in the same area by Powell (1969) and Boulter (1978). Metamorphic conditions were determined by Boulter and Råheim (1974) and Råheim (1977); and geochronological data are provided by Råheim and Compston (1977) and Adams *et al.* (1985).

During the course of the mapping programme described in this report a fairly detailed geological coverage was achieved in the more accessible parts of the area underlain by Precambrian rocks. However, coverage in the least accessible parts of the map sheet is limited to air photo interpretation and helicopter landings at several isolated points.

The following description of the Precambrian stratigraphy is based on the work of J. and M. P. McClenaghan in the Twelvetrees Range, M. P. McClenaghan in The Pleiades area, N. J. Turner in the Junction Range (west) area, Denison Plain area and Shining Mountain – Denison Gap area. The work of P. R. Williams in the Junction Range (east) area has been included under the heading 'Twelvetrees Range – The Pleiades Area'.

TWELVETREES RANGE – THE PLEIADES AREA

J. McClenaghan
M. P. McClenaghan

STRATIGRAPHY

The Precambrian rocks of the Huntley sheet belong to the older Precambrian group (Spry, 1962), and consist of regionally metamorphosed phyllite, amphibolite, schistose quartzite and massive quartzite. An overall stratigraphic succession cannot be established because of the complex history of deformation.

In the area between the Frankland Range and the Twelvetrees Range, quartzite forms well defined N-trending ridges and phyllitic rock occupies the intervening valleys and lower ground. The sequence of rock types encountered moving eastward from the Frankland Range to the Twelvetrees Range is as follows; light green-grey phyllite (Ꝑl), white quartzite (Ꝑq), a sequence of mixed grey phyllite (Ꝑp), white quartzite (Ꝑq), light green-grey phyllite (Ꝑl) and finally white quartzite of the Twelvetrees Range (Ꝑg). The first two quartzite ridges merge north of the Gordon River and are part of the same unit. The sequence of mixed grey phyllite, found between these two quartzite ridges, forms the core of a southward plunging synform and the flanking light green-grey phyllites belong to a single body. Quartzite (Ꝑq), capping a ridge north of the Gordon River and west of the Twelvetrees Range, is a continuation of the same quartzite unit which also forms the Twelvetrees Range.

The light green-grey phyllite (Ꝑl) includes quartz-mica and mica-quartz phyllite with abundant white quartz veins deformed into lenticles. The strongly developed cleavage has obliterated sedimentary structures.

The sequence of mixed grey phyllite (Ꝑp) varies from pale to dark grey quartz-mica and mica-quartz phyllite to black carbonaceous phyllite with pyrite (Ꝑg). The cleavage is generally strongly developed but in outcrops along the Gordon River road on the Pedder sheet [DN191643] compositional layering and often a fine sedimentary lamination is preserved in dark grey massive quartz-mica phyllite. The sedimentary lamination is in places sharply truncated showing scour-and-fill structures. A common feature is soft-sediment clastic dykes (Boulter, 1974).

The quartzite (Ꝑq) in the Twelvetrees Range is typically massive, white and banded. In good exposures in the Gordon River gorge [DN225698] and along a PMG road at Strathgordon on the western side of the range on the Pedder sheet, abundant examples of current bedding can be seen within the bands and sets of ripples on the surfaces. Although tectonic pseudo-ripple marks are also found, the sedimentary origin of many is shown by their complicated pattern of opposing directions, in particular where there is a marked difference in the direction of ripples on the upper and lower surfaces of a particular band. The current bedding sets often show a herring-bone structure and examples of festoon current bedding can be seen. These structures indicate that the banding of the massive quartzites is in fact bedding. In places the massive, banded quartzite gives way to a schistose quartzite with a fine penetrative cleavage. This is particularly dominant along the eastern side of the Twelvetrees Range. The quartzite bands to the west of the Twelvetrees Range are composed of massive and schistose white quartzite. Tectonic flattening appears to have accentuated the original stratification giving the quartzite a more thinly banded structure in places. The impure quartzite layers have readily developed into phyllite.

East of the Twelvetrees Range is another unit of mixed grey phyllite (Ᵽp) which ranges from pale to dark grey and includes quartz-mica and mica-quartz phyllites. This unit is lithologically similar to the sequence of mixed grey phyllite west of the Twelvetrees Range. The strongly developed cleavage has obliterated any sign of sedimentary structures. On the eastern side of this phyllite belt a thin quartzite (Ᵽq) band occurs separating the phyllite from a north-south belt of chlorite-actinolite-epidote-albite schist (Ᵽs) (amphibolite).

To the east of the amphibolite belt another quartzite (Ᵽq) unit occurs which forms the crest of the Atkins Range. This is a banded and schistose, white quartzite. No sedimentary structures have been found in the quartzite and it is not known whether the banding represents bedding, although it is parallel to the compositional layering of the region. Intercalated within the quartzite are some units of dark grey and pale grey quartz-mica and mica-quartz phyllite (Ᵽp). Outcrops of banded ironstone (Ᵽi) are found at DN254707 and DN253725, but they are not traceable for any distance. The iron is in the form of specular hematite generally in thin layers along the banding in grey quartzite.

North of the Gordon River the ridge formed by the Atkins Range quartzite (Ᵽq) trends towards the eastern margin of the continuation of the Twelvetrees Range; however, it seems unlikely that it is part of the same unit as the Twelvetrees quartzite (Ᵽq), as the very distinct break in slope forming the eastern edge of the Twelvetrees quartzite shows no sign of a break in that area. Also the Atkins Range quartzite is probably considerably thinner than the Twelvetrees Range quartzite.

In the Gordon River to the east of the Atkins Range quartzite (Ᵽq) another unit of amphibolite (Ᵽs) occurs flanked by grey phyllite (Ᵽp) which is followed farther to the east by another N-trending quartzite (Ᵽq) unit. This quartzite is white, banded and schistose frequently micaceous and with pinch-and-swell of massive quartzite bands. The ridge formed by this quartzite merges southwards with that of the Atkins Range quartzite in an inaccessible area. It is possible that these quartzites are the same unit. To the east this quartzite gives way to quartzite with interlayered quartz-mica phyllite (Ᵽqp) which forms the western flanks of The Pleiades and extends southwards to Junction Range.

The Pleiades and the north-eastern part of Junction Range consist of units of pink to white quartzite (Ᵽq) and pale green-grey phyllite (Ᵽl). The quartzite is generally extremely massive with well developed current bedding allowing the way up of the beds to be established over most of the eastern part of the range. This has allowed a local succession to be established consisting of the following units: lower quartzite (Ᵽq), lower phyllite (Ᵽl), upper quartzite (Ᵽq), upper phyllite (Ᵽl).

The quartzites (Ᵽq) are usually coarse grained with well rounded grains visible in hand specimen. Mud pellets occur in several areas and at DN312760, where there are a few minor phyllite intercalations, there is a clear example of mud cracks. Needle-like structures scattered at random or radiating from a point on bedding surfaces at DN301742 consisting of recrystallised quartz grains, may have resulted from the original crystallisation of gypsum, by evaporation which was later replaced by quartz. These points together with the current bedding suggest shallow water and sedimentation with occasional emergence.

The quartz-mica and mica-quartz phyllites (Ᵽl) are strongly cleaved and no sedimentary features are preserved. Minor amounts of carbonate are present in the phyllite (Ᵽlc) at several localities.

The lower quartzite (Ᵽq) occurs in the northern part of Junction Range (PRW) and the southern part of The Pleiades and is overlain in turn by the other units to the north. Correlation of quartzite and phyllite units is complicated by the complexity of the deformation and faulting and relationships between units can only be established locally. These relationships are shown by means of structural profiles presented in the section on structure.

Table 1

AMPHIBOLE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA

Field No.			55				56			
Anal. No.		1	2	3	4	5	6	7	8	9
SiO_2		52.36	50.41	49.96	51.72	56.87	56.90	56.54	56.56	54.73
TiO_2		0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Al_2O_3		2.59	3.88	4.57	2.90	1.24	1.56	1.48	2.58	2.27
Cr_2O_3		0.25	0.30	0.22	0.28	0.26	0.34	0.29	0.28	0.20
Fe_2O_3		4.63	7.16	8.12	4.04	0.00	0.00	0.00	0.00	0.00
FeO		10.29	9.99	8.14	11.59	10.91	10.99	10.84	11.34	14.01
MnO		0.00	0.20	0.00	0.00	0.00	0.00	0.17	0.15	0.00
MgO		14.95	13.88	15.03	14.81	16.14	15.62	15.78	14.69	14.47
CaO		11.06	10.11	9.73	10.93	12.40	12.40	12.61	12.17	11.50
Na_2O		1.59	1.90	2.03	1.54	0.00	0.00	0.00	0.00	0.57
K_2O		0.10	0.11	0.12	0.12	0.06	0.07	0.07	0.11	0.08
H_2O		2.08	2.06	2.07	2.07	2.12	2.12	2.12	2.12	2.09
Structural formulae calculated with 23 oxygens										
	Si	7.559	7.334	7.222	7.504	8.037	8.041	8.015	7.999	7.865
	Al^{+4}	0.441	0.665	0.778	0.495	0.000	0.000	0.000	0.001	0.135
	Σ	8.000	8.000	8.000	8.000	8.037	8.041	8.015	8.000	8.000
Oct	Al^{+8}	0.000	0.000	0.000	0.000	0.207	0.261	0.248	0.429	0.250
	Ti	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011
	Fe^{+3}	0.503	0.784	0.884	0.441	0.000	0.000	0.000	0.000	0.000
M1-3	Cr	0.029	0.035	0.026	0.032	0.029	0.038	0.032	0.031	0.022
	Fe^{+2}	1.242	1.215	0.985	1.406	1.289	1.298	1.283	1.341	1.684
	Mn	0.000	0.025	0.000	0.000	0.000	0.000	0.020	0.018	0.000
	Mg	3.217	3.010	3.327	3.204	3.399	3.289	3.329	3.097	3.098
	Σ	5.001	5.070	5.131	5.084	4.924	4.886	4.912	4.917	5.064
X	M1-3	0.001	0.070	0.131	0.084	0.000	0.000	0.000	0.000	0.064
	Ca	1.711	1.576	1.508	1.700	1.878	1.877	1.192	1.843	1.770
M4	Na	0.287	0.354	0.361	0.217	0.000	0.000	0.000	0.000	0.158
	Σ	1.999	1.930	1.869	1.916	1.878	1.877	1.912	1.843	1.929
A	Na	0.157	0.181	0.208	0.217	0.000	0.000	0.000	0.000	0.000
	K	0.018	0.020	0.021	0.022	0.011	0.013	0.013	0.020	0.014
	Σ	0.175	0.201	0.230	0.239	0.011	0.013	0.013	0.020	0.014
	OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000

Field numbers 55 to 57 are from the chlorite-actinolite-epidote-albite schist. Whole rock analyses and grid references for these samples are presented in Table 6. Field number JG74/3 is from a banded ironstone at DN253725. Formulae calculated by the method developed by Papike *et al.* (1974) for a maximum Fe^{+3}. Ideal H_2O content assumed and analyses normalised to 100.

PETROGRAPHY

Ꝑs – *Chlorite-actinolite-epidote-albite schist (amphibolite)*

To the west of the Atkins Range is a N-trending belt of dull green schist containing albite, epidote, actinolite and chlorite with accessory ore. The dominant cleavage is depicted by these minerals and in places, e.g. at DN245691 and DN247693, it is seen to be a S_2 cleavage with an earlier cleavage defined by the same minerals. Porphyroblasts of epidote and chlorite appear to overgrow the dominant S_2 cleavage. At DN252708 large phengite crystals overgrow S_2 and at DN254688 there are porphyroblasts composed of a recrystallised mosaic of albite. Thin veins of more coarsely recrystallised quartz + epidote occasionally traverse the rock and show ptygmatic folding where they cross the dominant foliation suggesting a pre-S_2 formation. No relict igneous textures are seen in the schists although the composition (see table 6) of the rock suggests an igneous origin.

Amphibole, chlorite, epidote, phengite and albite compositions from this rock type are presented in Tables 1, 2, 3, 4, 5.

Ꝑi – *Banded ironstone*

In the Atkins Range area are occasional dark grey phyllites, of high specific gravity, with specular hematite along the dominant cleavage. In thin section the dominant cleavage is seen to be a S_2 crenulation cleavage depicted by hematite alignment separating layers of fine equigranular quartz-albite mosaic. The S_1 cleavage is defined by the same minerals. Small crystals of apatite are sometimes associated with the hematite layers and minor chlorite crystals define the cleavage in places. Subsequent deformation of the S_2 crenulation cleavage has produced pinch-and-swell structures in the hematite layers and conjugate fractures. Such rocks are well seen at DN267700 and DN254706. A banded ironstone on the Gordon River at DN253725 contains large crystals of sodic amphibole of crossite composition. These

Table 1

AMPHIBOLE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA (continued)

Field No.			56					57		
Anal. No.		10	11	12	13	14	15	16	17	18
SiO_2		55.26	54.80	55.50	54.22	55.45	54.95	52.14	55.70	55.25
TiO_2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al_2O_3		2.61	2.45	2.28	2.93	1.19	2.24	4.91	2.16	3.14
Cr_2O_3		0.19	0.18	0.18	0.28	0.25	0.20	0.12	0.18	0.27
Fe_2O_3		0.00	1.03	0.00	1.82	0.00	0.00	6.10	0.00	0.17
FeO		13.40	12.80	13.63	11.13	12.43	14.61	9.15	13.12	13.04
MnO		0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.00	0.00
MgO		14.38	14.59	14.46	15.15	16.34	14.08	14.76	14.92	14.32
CaO		11.47	11.03	11.26	11.42	12.15	11.14	9.10	11.22	10.34
Na_2O		0.49	0.94	0.52	0.80	0.00	0.64	1.52	0.53	1.29
K_2O		0.10	0.08	0.07	0.07	0.00	0.07	0.11	0.08	0.07
H_2O		2.10	2.09	2.10	2.10	2.10	2.08	2.10	2.10	2.10
Structural for formulae calculated with 23 oxygens										
	Si	7.902	7.850	7.938	7.744	7.915	7.904	7.452	7.947	7.883
	Al^{+4}	0.098	0.150	0.062	0.256	0.085	0.096	0.548	0.053	0.117
	Σ	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
Oct	Al^{+8}	0.343	0.265	0.322	0.238	0.114	0.285	0.280	0.309	0.412
	Ti	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Fe^{+3}	0.000	0.111	0.000	0.195	0.000	0.000	0.656	0.000	0.019
M1-3	Cr	0.021	0.020	0.020	0.032	0.029	0.022	0.013	0.020	0.031
	Fe^{+2}	1.603	1.534	1.630	1.330	1.483	1.757	1.093	1.565	1.556
	Mn	0.000	0.000	0.000	0.011	0.011	0.000	0.000	0.000	0.000
	Mg	3.066	3.155	3.083	3.225	3.475	3.018	3.144	3.172	3.045
	Σ	5.033	5.046	5.056	5.031	5.112	5.083	5.186	5.066	5.062
X	M1-3	0.033	0.046	0.056	0.031	0.112	0.083	0.186	0.066	0.062
	Ca	1.757	1.693	1.725	1.747	1.859	1.717	1.393	1.715	1.580
M4	Na	0.137	0.261	0.145	0.222	0.000	0.178	0.421	0.147	0.357
	Σ	1.894	1.954	1.870	1.969	1.859	1.894	1.814	1.862	1.938
A	Na	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	K	0.018	0.014	0.013	0.012	0.000	0.013	0.020	0.014	0.012
	Σ	0.018	0.014	0.013	0.012	0.000	0.013	0.020	0.014	0.012
	OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000

amphibole crystals overgrow the S_2 crenulation cleavage. They show a pleochroic scheme: *X* - Prussian blue, *Y* - Violet, *Z* - Pale greenish yellow. Chlorite is associated with the amphibole.

Amphibole, chlorite and albite compositions from this rock are presented in Tables 1, 2, 5.

Ꝑg – *Black carbonaceous quartz-mica phyllite*

Dark grey to black phyllites occur at DN195676, DN197676, DN241707, DN238714, DN239719 and DN271727 but do not form extensive mappable units. They are composed of quartz, phengite and graphite with some chlorite closely associated with the mica and occasional albite. At DN241707 the dominant cleavage is an S_2 crenulation cleavage defined by layers of fine, equigranular quartz mosaic, mica and graphite. The earlier S_1 cleavage is also defined by fine layers of the quartz and mica. Minor F_3 folding of the S_2 cleavage has not resulted in a S_3 cleavage.

Ꝑp – *Blue-grey quartz-mica and mica-quartz phyllite*

The blue-grey phyllites both to the west and east of the Twelvetrees Range are composed of quartz, albite and phengite with accessory ore, tourmaline and zircon. A fine compositional banding defined by layers of quartz + albite and mica is common. At DN235717 this banding is very occasionally seen tightly folded into minor F_1 folds with the fine, equigranular quartz + albite mosaic elongated and the mica aligned axial planar to the structures. However, more commonly at this locality and elsewhere, the compositional banding and S_1 cleavage is folded into minor F_2 folds. Within the layers of quartz + albite there is a marked elongation of the fine equigranular mosaic axial planar to the F_2 folding. In the more micaceous layers this S_2 surface is seen as a pronounced crenulation cleavage. Subsequent F_3 minor open folding of the S_2 cleavage is seen but a penetrative S_3 cleavage is not developed.

In the phyllites east of the Twelvetrees Range there are areas with marked variations in composition. These phyllites are described below.

Table 1

AMPHIBOLE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA (continued)

Field No.						JG74/3				
Anal. No.		19	20	21	22	23	24	25	26	27
SiO_2		51.97	53.63	53.58	52.50	53.62	53.92	53.71	54.57	53.96
TiO_2		0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al_2O_3		5.89	5.10	6.17	8.39	7.49	6.49	6.73	6.50	6.89
Cr_2O_3		0.16	0.17	0.22	0.10	0.00	0.17	0.19	0.17	0.00
Fe_2O_3		10.29	11.76	10.52	8.10	7.44	8.63	8.50	8.26	8.11
FeO		9.34	9.66	11.90	11.15	12.48	12.89	12.06	12.45	11.20
MnO		0.16	0.00	0.20	0.00	0.00	0.06	0.06	0.06	0.08
MgO		10.17	9.09	6.84	8.41	7.98	7.37	8.00	7.65	8.79
CaO		1.59	0.67	0.55	0.53	0.35	1.05	1.37	0.61	0.92
Na_2O		8.26	7.79	7.20	8.65	8.57	7.15	7.11	7.46	7.96
K_2O		0.11	0.06	0.00	0.10	0.00	0.19	0.18	0.18	0.00
H_2O		2.07	2.08	2.08	2.09	2.08	2.08	2.08	2.09	2.09
Structural formulae calculated with 23 oxygens										
	Si	7.515	7.724	7.733	7.549	7.713	7.787	7.736	7.843	7.733
	Al^{+4}	0.485	0.276	0.267	0.451	0.287	0.213	0.264	0.157	0.267
	Σ	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
Oct	Al^{+8}	0.5200	0.590	0.886	0.970	0.984	0.892	0.879	0.944	0.897
	Ti	0.000	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Fe^{+3}	0.120	1.275	1.143	0.876	0.805	0.938	0.921	0.893	0.875
M1-3	Cr	0.018	0.020	0.025	0.011	0.000	0.020	0.022	0.020	0.000
	Fe^{+2}	1.129	1.164	1.436	1.341	1.501	1.557	1.453	1.497	1.342
	Mn	0.020	0.000	0.025	0.000	0.000	0.007	0.007	0.007	0.009
	Mg	2.193	1.952	1.471	1.801	1.710	1.586	1.717	1.639	1.876
	Σ	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
X	M1-3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ca	0.246	0.103	0.085	0.082	0.054	0.162	0.211	0.094	0.142
M4	Na	1.754	1.897	1.915	1.918	1.946	1.838	1.789	1.906	1.858
	Σ	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
A	Na	0.561	0.277	0.100	0.494	0.444	0.165	0.196	0.172	0.354
	K	0.020	0.011	0.000	0.018	0.000	0.036	0.034	0.034	0.000
	Σ	0.581	0.288	0.100	0.512	0.444	0.201	0.230	0.206	0.354
	OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000

Ꞓpe – *Epidote-chlorite-quartz-mica phyllite with albite porphyroblasts*

Along the western side of the Atkins Range quartzite at DN253707 is a zone of porphyroblastic phyllite. The dominant cleavage is an S_2 crenulation cleavage depicted by mica, chlorite, ore and strings of fine quartz mosaic. An S_1 cleavage is depicted by the same minerals. Small colourless to pale yellow crystals of epidote occur throughout the rock. Rounded porphyroblasts of albite overgrow both the S_1 and S_2 cleavages. The albites sometimes have helicitic texture enclosing ore defining the S_1 cleavage and in some places S_2 cleavage. Small green tourmaline crystals are an accessory constituent of the phyllite.

Ꞓphc – *Hematite-chlorite-quartz-mica phyllite with porphyroblasts of albite and occasional calcite*

Northwards along the strike from the area described above are similar porphyroblastic phyllites but with hematite becoming a major constituent of the phyllite.

The dominant S_2 crenulation cleavage is defined by an alignment of the mica, chlorite, ore and by elongated fine quartz mosaic. Porphyroblasts of albite overgrow the S_1 and S_2 cleavages. Small crystals of apatite appear to also overprint the S_2 crenulation cleavage. Rocks of this composition are seen at DN248741 and DN244754. At DN240750 the phyllite has porphyroblasts of calcite as well as albite overgrowing the S_2 crenulation cleavage. There is no indication that the calcite porphyroblasts are replacing an earlier mineral.

Chlorite, phengite and albite compositions from these rocks are presented in Tables 2, 4, 5. In one specimen (18, table 4) an attempt was made to distinguish between phengites belonging to the S_1 and S_2 cleavages. A histogram (fig. 2) of Si values from the structural formula, used as an indication of phengite contents of the mica, shows that the S_2 micas (Si frequency peak = 6.725) are more phengitic than the S_1 micas (Si frequency peak = 6.625). A single low Si value for a supposed S_2 mica may have been a misidentification. Measurements of Si content of micas from the Strathgordon area

Table 1

AMPHIBOLE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA (continued)

Field No.		JG74/3								
Anal. No.		28	29	30	31	32	33	34	35	36
SiO_2		54.36	53.61	53.92	55.17	55.52	54.99	56.01	54.73	55.74
TiO_2		0.00	0.00	0.00	0.15	0.00	0.12	0.00	0.00	0.00
Al_2O_3		6.97	7.08	6.83	8.45	7.40	8.06	6.84	6.95	8.27
Cr_2O_3		0.00	0.16	0.13	0.22	0.20	0.20	0.26	0.24	0.23
Fe_2O_3		5.66	8.05	7.88	7.74	8.10	7.28	6.62	10.14	6.75
FeO		12.86	12.26	12.48	9.71	11.15	11.89	13.25	9.83	10.79
MnO		0.08	0.06	0.06	0.22	0.24	0.31	0.28	0.25	0.18
MgO		8.68	7.94	7.93	8.42	7.97	7.29	7.71	8.22	8.57
CaO		0.68	0.88	1.08	0.55	0.44	0.42	0.23	0.78	0.52
Na_2O		8.62	7.82	7.49	7.16	6.86	7.35	6.69	6.75	6.76
K_2O		0.00	0.06	0.14	0.07	0.00	0.00	0.00	0.00	0.07
H_2O		2.09	2.08	2.08	2.12	2.11	2.11	2.10	2.11	2.13
Structural formulae calculated with 23 oxygens										
	Si	7.801	7.720	7.762	7.787	7.881	7.831	7.980	7.792	7.860
	Al^{+4}	0.199	0.280	0.238	0.213	0.119	0.169	0.020	0.208	0.140
	Σ	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
Oct	Al^{+8}	0.980	0.923	0.921	1.194	1.119	1.185	1.129	0.959	1.235
	Ti	0.000	0.000	0.000	0.016	0.000	0.013	0.000	0.000	0.000
	Fe^{+3}	0.611	0.873	0.854	0.822	0.866	0.780	0.710	1.086	0.716
M1-3	Cr	0.000	0.018	0.014	0.025	0.023	0.022	0.029	0.027	0.025
	Fe^{+2}	1.543	1.477	1.502	1.146	1.323	1.416	1.578	1.170	1.272
	Mn	0.009	0.007	0.007	0.027	0.028	0.037	0.034	0.030	0.021
	Mg	1.857	1.703	1.701	1.771	1.685	1.546	1.638	1.743	1.802
	Σ	5.000	5.000	5.000	5.000	5.045	5.000	5.118	5.016	5.072
X	M1-3	0.000	0.000	0.000	0.000	0.045	0.000	0.118	0.016	0.072
	Ca	0.105	0.136	0.166	0.084	0.067	0.064	0.035	0.120	0.079
M4	Na	1.895	1.864	1.834	1.916	1.888	1.936	1.847	1.865	1.849
	Σ	2.000	2.000	2.000	2.000	1.995	2.000	1.882	1.984	1.928
A	Na	0.504	0.320	0.257	0.043	0.000	0.092	0.000	0.000	0.000
	K	0.000	0.011	0.025	0.013	0.000	0.000	0.000	0.000	0.012
	Σ	0.504	0.331	0.282	0.057	0.000	0.092	0.000	0.000	0.012
	OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000

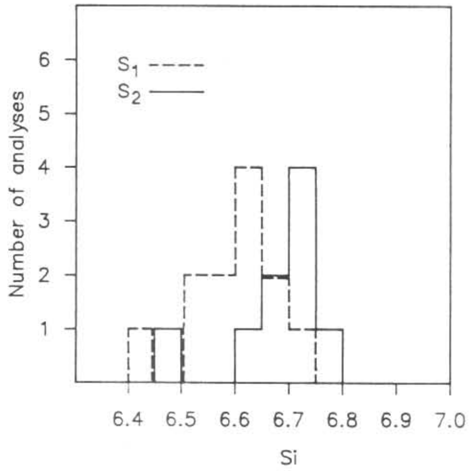


Figure 2. Histogram of Si values from phengites defining S_1 and S_2.

5 cm

by Boulter and Råheim (1974) indicated that S_1 micas had Si values 6.59–6.64, S_2 micas Si values of 6.52 and S_3 micas Si values of 6.75. These values suggest a possible correspondence between the S_2 here and their S_3 and between the S_1 here and their S_1.

Pl – *Light green-grey quartz-mica and mica-quartz phyllite*

The light green-grey phyllite west of the Twelvetrees Range is composed of quartz and a colourless to pale greenish phengite with accessory ore, tourmaline and zircon. Three cleavages are often readily discernable in thin section. The S_1 cleavage is seen in the more micaceous layers and is defined essentially by the mica separated by quartz mosaics. The S_2 cleavage, which is sometimes dominant, is seen as a crenulation cleavage defined by the mica and strings of a fine-grained, equigranular mosaic of quartz. The S_3 cleavage is developed axial planar to the minor F_3 folds and becomes dominant in places. It is a crenulation cleavage

Table 1

AMPHIBOLE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA (continued)

Field No.		JG74/3		
Anal. No.		37	38	39
SiO_2		55.34	56.20	55.16
TiO_2		0.00	0.10	0.00
Al_2O_3		7.35	7.59	6.83
Cr_2O_3		0.22	0.22	0.18
Fe_2O_3		8.31	6.84	9.15
FeO		10.11	10.77	11.20
MnO		0.00	0.22	0.31
MgO		8.64	6.85	7.85
CaO		0.50	0.39	0.42
Na_2O		7.36	6.88	6.80
K_2O		0.06	0.00	0.00
H_2O		2.12	2.13	2.10
Structural formulae calculated with 23 oxygens				
	Si	7.840	7.923	7.865
	Al^{+4}	0.160	0.077	0.135
	Σ	8.000	8.000	8.000
Oct	Al^{+8}	1.067	1.185	1.014
	Ti	0.000	0.011	0.000
	Fe^{+3}	0.886	0.726	0.982
M1-3	Cr	0.024	0.025	0.020
	Fe^{+2}	1.198	1.270	1.335
	Mn	0.000	0.026	0.037
	Mg	1.824	1.817	1.667
	Σ	5.000	5.060	5.055
X	M1-3	0.000	0.060	0.055
	Ca	0.075	0.059	0.065
M4	Na	1.925	1.880	1.880
	Σ	2.000	1.939	1.945
A	Na	0.096	0.000	0.000
	K	0.011	0.000	0.000
	Σ	0.107	0.000	0.000
	OH	2.000	2.000	2.000

defined mainly by the mica but also by strings of quartz mosaic.

Small crystals of tourmaline, zoned and pleochroic pale pink to olive green, are seen overgrowing S_1, S_2 and occasionally S_3 and are sometimes bent and fractured by deformation.

In some parts of the western and northern Pleiades [e.g. DN283777, DN300773, DN318871, DN303862, DN297857] the quartz mosaic includes abundant carbonate crystals. A sample from DN325880 contains carbonate as porphyroblasts.

Ꝑqs - *Schistose micaceous quartzite*

The micaceous quartzites show a penetrative cleavage defined by an elongation of the recrystallised quartz mosaic and by an alignment of the phengite. In some specimens albite is associated with the quartz mosaic and occasionally the phengite has altered to chlorite. Accessory minerals are ore, zircon and tourmaline. In the quartzite units within the phyllites east of the Twelvetrees Range the dominant cleavage is seen to be S_2 and in places it is folded by F_3 kink folds. Fractures with fine-grained cataclastic textures are developed in places along the kink bands.

Ꝑq - *Quartzite*

The massive quartzites are generally very pure having only very minor amounts of accessory phengite, tourmaline, zircon and ore. A fine penetrative cleavage is defined by an elongation of the large quartz crystals and an alignment of sparse thin mica flakes. The quartz crystals are surrounded by fine-grained polygonal elongated mosaics of quartz. These finer mosaics have formed by recrystallisation of the larger quartz crystals which show straining. A widely spaced parting in some specimens may be a parting along current bedding. In The Pleiades the larger quartz grains are often rimmed by fine grains of ore which when oxidised may be responsible for the pink colour of the quartzite in that area.

In the south-west area the penetrative cleavage is S_1 but in the Pleiades area the cleavage developed in the quartzites, though generally the only one evident, is considered to be S_2.

Micaceous quartzites show a penetrative cleavage defined by an elongation of the recrystallised quartz mosaic and by an alignment of the phengite. In some specimens (Ꝑqa) albite is associated with the quartz mosaic and occasionally the phengite has altered to chlorite. Accessory minerals are ore, zircon and tourmaline. In the quartzite units within the phyllites east of the Twelvetrees Range the dominant cleavage is seen to be S_2 and in places it is folded by F_3 kink folds. Fractures with fine-grained cataclastic textures are developed in places along the kink bands.

Ꝑqp - *Quartzite with interlayered phyllite*

On the western margin of The Pleiades a N-S band of quartzite occurs which contains thin layers of phyllite. A small body of this rock type also occurs in the Gordon River near Erskine Point at DN317738.

The quartzite is light grey or white and is similar to that designated elsewhere as Ꝑq. The phyllite resembles the light green-grey phyllite (Ꝑl).

Table 2

CHLORITE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA

Field No.				55				56		
Anal. No.		40	41	42	43	44	45	46	47	48
SiO_2		27.22	26.40	27.63	26.93	27.01	27.03	27.09	27.05	27.39
TiO_2		0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00
Al_2O_3		19.64	19.64	19.74	20.02	20.40	19.83	20.35	20.37	20.35
Cr_2O_3		0.14	0.35	0.11	0.00	0.13	0.17	0.09	0.00	0.14
Fe_2O_3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO		23.03	23.78	24.69	23.98	23.40	23.71	23.19	23.52	22.55
MnO		0.13	0.13	0.00	0.15	0.16	0.00	0.16	0.00	0.15
MgO		18.20	17.50	15.93	17.12	17.20	17.52	17.48	17.43	17.73
CaO		0.00	0.65	0.18	0.11	0.07	0.07	0.00	0.00	0.00
Na_2O		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K_2O		0.00	0.00	0.15	0.00	0.00	0.06	0.00	0.00	0.00
H_2O		11.64	11.54	11.56	11.58	11.62	11.60	11.64	11.63	11.68
Structural formulae calculated with 28 oxygens										
	Si	5.611	5.847	5.732	5.576	5.574	5.590	5.853	5.579	5.625
	Al^{+4}	2.389	2.513	2.268	2.424	2.426	2.410	2.417	2.421	2.375
	Σ	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.031	8.552
	Ti	0.000	0.000	0.000	0.017	0.000	0.000	0.000	0.000	0.000
	Fe^{+3}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M1-3	Cr	0.023	0.057	0.019	0.000	0.022	0.027	0.014	0.000	0.023
	Fe^{+2}	3.971	4.132	4.283	4.152	4.038	4.101	3.997	4.057	3.873
	Mn	0.023	0.023	0.000	0.026	0.028	0.000	0.028	0.000	0.026
	Mg	5.590	5.421	4.926	5.284	5.291	5.401	5.369	5.356	5.426
	Ca	0.000	0.146	0.039	0.025	0.016	0.016	0.000	0.000	0.000
M4	Na	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	K	0.000	0.000	0.040	0.000	0.000	0.016	0.000	0.000	0.000
	Σ	11.99	12.07	11.86	11.96	11.93	11.98	11.93	11.94	11.90
	OH	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00

Field No.		55	57				JG74/3			18
Anal. No.		49	50	51	52	53	54	55	56	57
SiO_2		26.67	26.77	27.23	29.27	29.04	29.45	29.11	30.52	27.09
TiO_2		0.12	0.13	0.00	0.00	0.00	0.00	0.10	0.00	0.00
Al_2O_3		18.90	19.23	19.88	18.53	18.59	17.50	19.00	19.09	22.09
Cr_2O_3		0.25	0.23	0.11	0.21	0.18	0.15	0.10	0.16	0.09
Fe_2O_3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO		25.65	25.16	23.90	15.59	15.39	17.27	15.31	16.00	15.84
MnO		0.00	0.00	0.00	0.86	0.61	1.15	0.62	0.63	0.05
MgO		16.86	16.97	17.27	23.27	24.08	22.46	23.65	21.24	22.80
CaO		0.10	0.00	0.00	0.18	0.07	0.10	0.07	0.20	0.00
Na_2O		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K_2O		0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.08	0.00
H_2O		11.47	11.51	11.61	12.01	12.04	11.91	12.05	12.07	12.04
Structural formulae calculated with 28 oxygens										
	Si	5.576	5.579	5.628	5.844	5.787	5.931	5.792	6.068	5.395
	Al^{+4}	2.424	2.241	2.372	2.156	2.213	2.069	2.208	1.932	2.605
	Σ	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
	Al^{+6}	2.236	2.304	2.472	2.206	2.154	2.086	2.248	2.543	2.579
	Ti	0.018	0.021	0.000	0.000	0.000	0.000	0.015	0.000	0.000
	Fe^{+3}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M1-3	Cr	0.041	0.038	0.019	0.033	0.028	0.025	0.015	0.025	0.014
	Fe^{+2}	4.485	4.385	4.132	2.603	2.565	2.908	2.547	2.660	2.638
	Mn	0.000	0.000	0.000	0.146	0.103	0.196	0.104	0.107	0.009
	Mg	5.253	5.272	5.318	6.924	7.150	6.742	7.013	6.766	6.491
	Ca	0.022	0.000	0.000	0.038	0.015	0.022	0.015	0.043	0.000
M4	Na	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	K	0.000	0.000	0.000	0.019	0.000	0.000	0.020	0.000	0.073
	Σ	12.05	12.01	11.94	11.96	12.01	11.97	11.95	11.69	12.00
	OH	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00

Field numbers 55 to 57 are from the chlorite-actinolite-epidote-albite schist. Whole rock analyses and grid references for these samples are presented in table 6. Field numbers JG74/3 is from a banded ironstone at DN253725. Field numbers 17 and 18 are from hematite-chlorite-quartz-mica phyllite with albite porphyroblasts at DN240750 and DN248741. Ideal H_2O content assumed and analyses normalised to 100.

Table 2

CHLORITE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA (continued)

Field No.	18		17
Anal. No.	58	59	60
SiO_2	28.23	25.87	26.07
TiO_2	0.00	0.00	0.00
Al_2O_3	22.40	19.10	21.31
Cr_2O_3	0.13	0.17	0.00
Fe_2O_3	0.00	0.00	0.00
FeO	14.73	32.94	23.19
MnO	0.07	0.04	0.04
MgO	22.03	10.80	17.76
CaO	0.00	0.00	0.00
Na_2O	0.00	0.00	0.00
K_2O	0.29	0.00	0.00
H_2O	12.13	11.08	11.63

Field No.		18		17
Anal. No.		58	59	60
Structural formulae calculated with 28 oxygens				
	Si	5.582	5.598	5.378
	Al^{+4}	2.418	2.402	2.622
	Σ	8.000	8.000	8.000
	Al^{+6}	2.803	2.471	2.560
	Ti	0.000	0.000	0.000
	Fe^{+3}	0.000	0.000	0.000
M1-3	Cr	0.021	0.029	0.000
	Fe^{+2}	2.453	5.961	4.001
	Mn	0.012	0.008	0.008
	Mg	6.491	3.482	5.461
	Ca	0.000	0.000	0.000
M4	Na	0.000	0.000	0.000
	K	0.073	0.000	0.000
	Σ	11.83	11.95	12.03
	OH	16.00	16.00	16.00

Table 3

EPIDOTE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA

Field No.				55				56		
Anal. No.		61	62	63	64	65	66	67	68	69
SiO_2		38.57	39.44	38.55	36.24	35.78	38.53	37.98	38.98	38.21
TiO_2		0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.12	0.16
Al_2O_3		27.35	24.86	27.35	24.06	22.56	27.25	23.12	26.20	24.04
Cr_2O_3		0.31	0.24	0.00	0.31	0.36	0.16	0.21	0.17	0.31
Fe_2O_3		8.00	10.22	9.56	12.85	15.19	8.60	13.53	9.85	12.75
FeO		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MnO		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MgO		0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00
CaO		23.84	23.30	22.08	24.66	24.24	23.53	23.16	22.74	22.62
Na_2O		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K_2O		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H_2O		1.94	1.93	1.94	1.89	1.87	1.94	1.90	1.94	1.91
Structural formulae calculated with 25 oxygens										
	Si	6.010	6.176	5.997	5.797	5.771	6.007	6.034	6.085	6.039
	Al^{+4}	0.000	0.000	0.003	0.203	0.229	0.000	0.000	0.000	0.000
	Σ	6.010	6.176	6.000	6.000	6.000	6.007	6.034	6.085	6.039
	Al^{+6}	5.024	4.590	5.015	4.332	4.060	5.009	4.332	4.821	4.479
	Fe^{+3}	0.938	1.205	1.119	1.546	1.844	1.009	1.618	1.157	1.516
M1-3	Cr	0.038	0.030	0.000	0.039	0.046	0.019	0.027	0.022	0.039
	Σ	6.000	5.825	6.134	5.918	5.950	6.037	5.976	5.999	6.034
	Mn	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Mg	0.000	0.000	0.119	0.000	0.000	0.000	0.000	0.000	0.000
	Ti	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.014	0.020
	Fe^{+2}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ca	3.980	3.910	3.681	4.225	4.189	3.391	3.944	3.803	3.831
M4	Na	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Σ	3.980	3.910	3.800	4.225	4.189	3.931	3.955	3.817	3.851
	OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000

Field numbers 55 to 57 are from the chlorite-actinolite-epidote-albite schists. Whole rock analsyes and grid references for these samples are presented in table 6. Ideal H_2O content assumed and analyses normalised to 100.

Table 3

EPIDOTE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA (continued)

Field No.				56				57		
Anal. No.		70	71	72	73	74	75	76	77	78
SiO_2		37.88	37.99	38.42	38.53	38.47	37.92	37.99	37.94	37.88
TiO_2		0.00	0.00	0.00	0.00	0.00	0.46	0.32	0.85	0.60
Al_2O_3		23.59	24.23	25.35	26.71	26.51	23.82	23.90	22.38	22.61
Cr_2O_3		0.25	0.24	0.17	0.27	0.15	0.22	0.17	0.22	0.22
Fe_2O_3		13.33	12.70	10.66	9.03	9.39	12.64	12.42	13.76	13.53
FeO		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MnO		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MgO		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO		23.04	22.94	23.47	23.52	23.55	23.03	23.28	22.95	23.27
Na_2O		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K_2O		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H_2O		1.90	1.91	1.92	1.93	1.93	1.91	1.91	1.90	1.90
Structural formulae calculated with 25 oxygens										
	Si	6.012	6.010	6.038	6.020	6.018	6.006	6.015	6.036	6.027
	Al^{+4}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Σ	6.012	6.010	6.038	6.020	6.018	6.006	6.015	6.036	6.027
	Al^{+8}	4.414	4.159	4.697	4.920	4.889	4.447	4.461	4.198	4.242
	Fe^{+3}	1.593	1.512	1.261	1.061	1.105	1.507	1.480	1.648	1.563
M1-3	Cr	0.032	0.030	0.022	0.034	0.018	0.028	0.022	0.028	0.028
	Σ	6.038	6.061	5.980	6.014	6.012	5.981	5.963	5.874	5.890
	Mn	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Mg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ti	0.000	0.000	0.000	0.000	0.000	0.054	0.038	0.102	0.072
	Fe^{+2}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ca	3.918	3.889	3.952	3.938	3.947	3.908	3.950	3.913	3.967
M4	Na	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Σ	3.918	3.889	3.952	3.938	3.947	3.963	3.988	4.015	4.039
	OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000

Field No.	57	
Anal. No.	79	80
SiO_2	38.03	37.93
TiO_2	0.00	0.12
Al_2O_3	23.64	23.70
Cr_2O_3	0.22	0.25
Fe_2O_3	13.10	13.05
FeO	0.00	0.00
MnO	0.00	0.00
MgO	0.00	0.00
CaO	23.10	23.04
Na_2O	0.00	0.00
K_2O	0.00	0.00
H_2O	1.91	1.91

Field No.		57	
Anal. No.		79	80
Structural formulae calculated with 25 oxygens			
	Si	6.030	6.010
	Al^{+4}	0.000	0.000
	Σ	6.030	6.014
	Al^{+8}	4.419	4.431
	Fe^{+3}	1.563	1.557
M1-3	Cr	0.028	0.032
	Σ	6.010	6.019
	Mn	0.000	0.000
	Mg	0.000	0.000
	Ti	0.000	0.014
	Fe^{+2}	0.000	0.000
	Ca	3.924	3.915
M4	Na	0.000	0.000
	K	0.000	0.000
	Σ	3.924	3.929
	OH	2.000	2.000

Table 4

PHENGITE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA

Field No.				55				56		
Anal. No.		61	62	63	64	65	66	67	68	69
SiO_2		48.05	49.32	47.99	46.91	42.59	48.58	49.49	48.47	49.34
TiO_2		0.14	0.12	0.29	0.12	0.21	0.35	0.38	0.17	0.29
Al_2O_3		27.42	33.85	27.65	33.15	27.28	29.24	27.90	30.80	28.29
Cr_2O_3		0.33	0.00	0.00	0.10	0.14	0.17	0.11	0.00	0.00
Fe_2O_3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO		5.33	2.61	5.29	4.12	8.44	4.25	4.46	3.98	4.42
MnO		0.00	0.09	0.10	0.09	0.09	0.10	0.09	0.10	0.10
MgO		3.04	1.30	4.64	3.70	9.49	2.20	2.67	1.57	2.22
CaO		0.59	0.32	0.44	0.31	0.36	0.63	0.53	0.50	0.57
Na_2O		0.00	2.73	0.00	2.28	0.00	0.00	0.00	0.00	0.00
K_2O		10.70	5.05	9.17	4.66	7.03	10.02	9.91	9.94	10.31
H_2O		4.41	4.61	4.44	4.56	4.36	4.46	4.46	4.48	4.45
Structural formulae caclualted with 22 oxygens										
	Si	6.540	6.416	6.475	6.169	5.854	6.533	6.651	6.491	6.642
	Al^{+4}	1.460	1.584	1.525	1.831	2.146	1.467	1.349	1.509	1.358
	Σ	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
	Al^{+6}	2.940	3.609	2.873	3.308	2.275	3.170	3.073	3.353	3.133
	Ti	0.015	0.012	0.029	0.012	0.022	0.036	0.039	0.017	0.029
	Fe^{+3}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M1-3	Cr	0.035	0.000	0.000	0.010	0.016	0.018	0.012	0.000	0.000
	Fe^{+2}	0.606	0.284	0.597	0.454	0.971	0.478	0.501	0.446	0.498
	Mn	0.000	0.009	0.011	0.010	0.010	0.011	0.010	0.011	0.011
	Mg	0.617	0.252	0.933	0.726	1.943	0.440	0.534	0.313	0.445
	Σ	4.213	4.167	4.444	4.520	5.236	4.153	4.168	4.140	4.115
	Ca	0.086	0.045	0.064	0.043	0.054	0.091	0.076	0.071	0.083
M4	Na	0.000	0.688	0.000	0.582	0.000	0.000	0.000	0.000	0.000
	K	1.858	0.838	1.578	0.782	1.232	1.719	1.699	1.699	1.771
	Σ	1.944	1.571	1.642	1.406	1.286	1.810	1.774	1.770	1.853
	OH	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000

Field No.			18					17		
Anal. No.		90	91	92	93	94	95	96	97	98
SiO_2		48.63	48.72	49.21	41.41	49.98	49.83	50.36	49.65	50.13
TiO_2		0.19	0.24	0.26	0.12	0.19	0.21	0.19	0.19	0.11
Al_2O_3		29.57	28.81	28.36	30.53	27.33	27.23	26.81	26.95	27.08
Cr_2O_3		0.10	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00
Fe_2O_3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO		4.15	4.54	4.18	8.21	4.52	4.80	4.32	5.15	4.89
MnO		0.11	0.11	0.11	0.09	0.11	0.10	0.11	0.11	0.11
MgO		2.11	2.28	2.96	8.21	2.72	2.58	2.91	2.74	2.80
CaO		0.59	0.57	0.54	0.30	0.50	0.51	0.53	0.54	0.51
Na_2O		0.00	0.34	0.00	0.67	0.00	0.00	0.00	0.00	0.00
K_2O		10.09	9.92	9.91	6.07	10.19	10.18	10.30	10.23	9.91
H_2O		4.46	4.45	4.47	4.39	4.46	4.45	4.46	4.44	4.46
Structural formulae calculated with 22 oxygens										
	Si	6.535	6.563	6.607	5.659	6.723	6.715	6.772	6.708	6.744
	Al^{+4}	1.465	1.437	1.393	2.341	1.277	1.285	1.228	1.292	1.256
	Σ	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
	Al^{+6}	3.218	3.139	3.095	2.576	3.058	3.041	3.022	3.001	3.038
	Ti	0.019	0.024	0.026	0.013	0.019	0.021	0.019	0.019	0.012
	Fe^{+3}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M1-3	Cr	0.010	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.000
	Fe^{+2}	0.466	0.511	0.469	0.938	0.508	0.541	0.486	0.581	0.550
	Mn	0.013	0.013	0.013	0.010	0.013	0.011	0.013	0.013	0.013
	Mg	0.423	0.458	0.593	1.672	0.546	0.518	0.584	0.552	0.561
	Σ	4.149	4.145	4.196	5.209	4.144	4.146	4.124	4.167	4.174
	Ca	0.085	0.083	0.078	0.043	0.072	0.073	0.076	0.077	0.073
M4	Na	0.000	0.090	0.000	0.177	0.000	0.000	0.000	0.000	0.000
	K	1.729	1.704	1.697	1.058	1.749	1.750	1.767	1.763	1.7
	Σ	1.815	1.877	1.775	1.279	1.821	1.823	1.843	1.841	1.773
	OH	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000

Field number 55 is from the chlorite-actinolite-epidote-albite schists. A whole rock analysis and grid reference for this sample is presented in table 6. Field numbers 17 and 18 are from hematite-chlorite-quartz-mica phyllite with albite porphyroblasts at DN240750 and DN248741. Analyses numbers 99–106 and 111–114 are from S_1 micas and analyses numbers 94–98 and 107–110 are from S_2 micas. Ideal H_2O content assumed and analyses normalised to 100.

Table 4

PHENGITE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA (continued)

Field No. / Anal. No.		99	100	101	102	17 / 103	104	105	106	107
SiO_2		48.29	49.19	49.38	49.93	48.58	48.63	47.76	48.89	49.47
TiO_2		0.29	0.29	0.19	0.21	0.22	0.32	0.24	0.29	0.16
Al_2O_3		28.16	28.12	28.09	27.19	29.45	28.72	30.36	28.74	27.22
Cr_2O_3		0.12	0.00	0.00	0.00	0.00	0.12	0.10	0.00	0.11
Fe_2O_3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO		5.57	4.82	4.95	4.84	4.60	4.92	4.63	4.69	5.11
MnO		0.11	0.10	0.11	0.10	0.09	0.10	0.10	0.11	0.10
MgO		2.38	2.38	2.31	2.71	2.00	2.12	1.74	2.26	2.63
CaO		0.61	0.57	0.54	0.56	0.56	0.54	0.44	0.51	0.63
Na_2O		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K_2O		10.05	10.08	9.69	9.99	10.05	10.08	10.20	10.06	10.13
H_2O		4.42	4.45	4.45	4.45	4.46	4.44	4.45	4.45	4.44
Structural formulae calculated with 22 oxygens										
	Si	6.546	6.630	6.651	6.722	6.538	6.561	6.439	6.583	6.683
	Al^{+4}	1.454	1.370	1.349	1.278	1.462	1.439	1.561	1.417	1.317
	Σ	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
	Al^{+8}	3.045	3.097	3.111	3.038	3.210	3.131	3.263	3.145	3.017
	Ti	0.029	0.029	0.019	0.021	0.022	0.032	0.024	0.029	0.017
	Fe^{+3}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M1-3	Cr	0.013	0.000	0.000	0.000	0.000	0.013	0.010	0.000	0.012
	Fe^{+2}	0.632	0.543	0.558	0.545	0.517	0.555	0.522	0.528	0.578
	Mn	0.011	0.011	0.013	0.011	0.010	0.011	0.011	0.013	0.011
	Mg	0.481	0.478	0.464	0.544	0.400	0.427	0.349	0.454	0.529
	Σ	4.211	4.158	4.166	4.159	4.160	4.169	4.179	4.170	4.163
	Ca	0.089	0.083	0.079	0.081	0.081	0.079	0.064	0.073	0.091
M4	Na	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	K	1.739	1.734	1.711	1.716	1.726	1.735	1.754	1.728	1.746
	Σ	1.827	1.816	1.789	1.798	1.807	1.814	1.817	1.801	1.837
	OH	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000

Field No. / Anal. No.		108	109	110	17 / 111	112	113	114
SiO_2		49.59	48.98	48.13	49.27	49.43	49.25	49.13
TiO_2		0.22	0.14	0.31	0.22	0.19	0.22	0.19
Al_2O_3		27.41	27.87	29.48	27.77	27.77	27.79	27.56
Cr_2O_3		0.00	0.00	0.00	0.11	0.14	0.12	0.00
Fe_2O_3		0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO		4.92	5.41	4.66	4.98	4.82	5.27	4.76
MnO		0.10	0.11	0.10	0.10	0.10	0.09	0.09
MgO		2.53	2.38	2.00	2.63	2.39	2.34	2.80
CaO		0.59	0.66	0.57	0.61	0.63	0.54	0.56
Na_2O		0.00	0.00	0.00	0.00	0.00	0.00	0.40
K_2O		10.20	10.01	10.31	9.86	10.08	9.94	10.07
H_2O		4.45	4.43	4.44	4.45	4.45	4.44	4.44
Structural formulae calculated with 22 oxygens								
	Si	6.690	6.622	6.496	6.640	6.663	6.646	6.634
	Al^{+4}	1.310	1.378	1.504	1.360	1.337	1.354	1.366
	Σ	8.000	8.000	8.000	8.000	8.000	8.000	8.000
	Al^{+8}	3.048	3.064	3.187	3.054	3.077	3.068	3.021
	Ti	0.022	0.015	0.031	0.022	0.019	0.022	0.019
	Fe^{+3}	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M1-3	Cr	0.000	0.000	0.000	0.012	0.015	0.013	0.000
	Fe^{+2}	0.555	0.612	0.526	0.561	0.543	0.594	0.538
	Mn	0.011	0.013	0.011	0.011	0.011	0.010	0.010
	Mg	0.509	0.479	0.402	0.528	0.480	0.471	0.564
	Σ	4.146	4.183	4.157	4.188	4.145	4.179	4.151
	Ca	0.086	0.096	0.083	0.088	0.091	0.079	0.082
M4	Na	0.000	0.000	0.000	0.000	0.000	0.000	0.105
	K	1.755	1.727	1.775	1.696	1.734	1.711	1.736
	Σ	1.840	1.823	1.858	1.784	1.825	1.790	1.922
	OH	4.000	4.000	4.000	4.000	4.000	4.000	4.000

Table 5

PLAGIOCLASE COMPOSITIONS FROM ROCKS OF THE STRATHGORDON AREA

Field No.			18					17		
Anal. No.		90	91	92	93	94	95	96	97	98
SiO_2		66.50	66.54	67.22	69.52	68.15	68.31	67.18	69.08	69.09
TiO_2		0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00
Al_2O_3		20.09	20.01	20.27	19.91	19.64	19.69	19.67	20.02	19.89
Cr_2O_3		0.00	0.00	0.00	0.00	0.09	0.13	0.10	0.19	0.20
Fe_2O_3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO		0.18	0.19	0.00	0.21	0.00	0.00	0.13	0.23	0.18
MnO		0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00
MgO		0.18	0.15	0.00	0.00	0.00	0.00	0.17	0.00	0.00
CaO		0.13	0.15	0.07	0.21	0.08	0.13	0.34	0.10	0.07
Na_2O		12.79	12.87	12.21	10.15	11.94	11.67	12.12	10.32	10.58
K_2O		0.13	0.10	0.11	0.00	0.10	0.07	0.19	0.06	0.00
H_2O		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Structural formulae calculated with 32 oxygens										
	Si	11.72	11.72	11.78	12.05	11.92	11.93	11.81	12.00	12.01
	Al	4.175	4.158	4.192	4.071	4.051	4.058	4.079	4.101	4.076
	Fe^{+3}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M1-3	Cr	0.000	0.000	0.000	0.000	0.012	0.018	0.014	0.026	0.027
	Ti	0.000	0.000	0.016	0.000	0.000	0.000	0.000	0.000	0.000
	Mg	0.047	0.039	0.000	0.000	0.000	0.000	0.045	0.000	0.000
	Fe^{+2}	0.027	0.028	0.000	0.030	0.000	0.000	0.019	0.033	0.026
	Mn	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.000
M4	Na	4.371	4.398	4.153	3.415	4.053	3.955	4.134	3.478	3.565
	Ca	0.025	0.028	0.013	0.039	0.015	0.024	0.064	0.016	0.014
	K	0.029	0.022	0.025	0.000	0.022	0.016	0.043	0.014	0.000
	Σ	20.39	20.40	20.18	19.61	20.08	20.00	20.22	19.67	19.71

Field No.		99	100	101	102
Anal. No.					
SiO_2		68.94	65.89	66.43	67.16
TiO_2		0.00	0.00	0.08	0.15
Al_2O_3		19.50	19.65	19.56	19.82
Cr_2O_3		0.13	0.00	0.10	0.00
Fe_2O_3		0.00	0.00	0.00	0.00
FeO		0.63	0.51	0.28	0.18
MnO		0.08	0.09	0.09	0.10
MgO		0.00	0.00	0.00	0.00
CaO		0.15	0.38	0.10	0.08
Na_2O		10.34	13.36	13.24	12.44
K_2O		0.24	0.12	0.11	0.07
H_2O		0.00	0.00	0.00	0.00
Structural formulae caluclated with 32 oxygens					
	Si	12.02	11.68	11.74	11.80
	Al	4.010	4.100	4.070	4.100
	Fe^{+3}	0.000	0.000	0.000	0.000
M1-3	Cr	0.018	0.000	0.014	0.000
	Ti	0.000	0.000	0.011	0.020
	Mg	0.000	0.000	0.000	0.000
	Fe^{+2}	0.092	0.076	0.041	0.026
	Mn	0.012	0.014	0.013	0.015
M4	Na	3.497	4.593	4.539	4.241
	Ca	0.028	0.072	0.019	0.015
	K	0.053	0.027	0.025	0.016
	Σ	19.73	20.57	20.48	20.24

Field numbers 55 to 56 are from the chlorite-actinolite-epidote-albite schist. Whole rock analyses and grid references for these samples are presented in table 6. Field numbers JG74/3 is from a banded ironstone at DN253725. Field numbers 17 and 18 are from hematite-chlorite-quartz-mica phyllite with albite porphyroblasts at DN240750 and DN248741. Analyses normalised to 100.

Table 6

WHOLE ROCK ANALYSES OF SAMPLES FROM THE CHLORITE-ACTINOLITE-EPIDOTE-ALBITE-SCHIST

		55	56	57
Field No.		55	56	57
Anal. No.		762724	762725	762726
Grid Ref.		DN248680	DN249679	DN249678
SiO_2		49.60	47.90	49.10
TiO_2		1.00	1.10	1.10
Al_2O_3		14.90	14.20	13.90
Fe_2O_3		4.60	3.90	4.60
FeO		6.20	7.60	6.20
MnO		0.19	0.19	0.17
MgO		6.10	7.40	5.60
CaO		11.10	11.00	13.00
Na_2O		3.00	2.80	2.10
K_2O		0.09	0.02	0.07
P_2O_5		0.11	0.16	0.16
SO_3		0.07	0.19	0.12
CO_2		<0.05	0.45	1.60
H_2O^+		2.20	2.60	2.20
H_2O^-		0.42	0.38	0.25
F		0.01	0.01	0.02
Total		99.59	99.90	100.19
Trace elements (ppm)				
	Zr	51	56	55
	Y	28	29	30
	Sr	60	84	81
M1-3	Rb	<4	<4	<4
	Ba	<25	<25	<25
	Zn	289	124	134
	Cu	82	92	79
	Ni	<4	109	82
M4	Co	45	45	34
	Nb	17	<7	<7
	V	299	307	316
	Cr	618	405	354
	Li	12	10	12

JUNCTION RANGE (WEST) AND DENISON PLAIN

N. J. Turner

Ꝑqp - *Quartzite with interlayered phyllite*

On the western ridge of Junction Range [DN288686] the Precambrian sequence consists of bands of quartzite and phyllite which are too thin to be shown on the map individually. They are therefore shown under the collective designation Ꝑqp.

The quartzite bands range in thickness up to several tens of metres. They consist of fairly massive to very well foliated quartzite varieties which are similar to types designated elsewhere as Ꝑq, Ꝑqc and Ꝑqs. For the most part the quartzite is white but in some bands pigments (?Fe compounds) in the cement impart purple or pink colours. An unusual feature in places is the presence of a small (less than one per cent by volume) but conspicuous proportion of bright red grains of chert.

The micaceous rocks interbanded with the quartzite comprise very well foliated, fine-grained phyllite. The phyllite ranges in composition from quartz-dominant to subordinate mica-dominant and from pale green to dark greenish-grey in colour. The varieties resemble types that are shown as Ꝑl in other areas. Rocks equivalent to Ꝑp may be present. In thin section the rocks are seen to be completely recrystallised with well aligned muscovite (?phengite), chlorite, fine-grained quartz and accessory opaque minerals, tourmaline and zircon. Relatively large, composite grains consisting of alternating, parallel, cleavage flakes of muscovite and chlorite may be present and appear to have formed before the main cleavage (?S_2).

Ꝑq - *Quartzite and* Ꝑu - *Undifferentiated Precambrian*

Prior to the filling of Lake Gordon quartzite cropped out south-east of Erskine Point around DN335710. The quartzite was coarse to medium grained, white weathering and well cleaved. It contained even-grained, white and minor pink quartz grains of high sphericity and it displayed large-scale, simple cross-lamination in units about 300 mm thick. Similarity with quartzites designated as Ꝑq and Ꝑqc was marked.

Surrounding the quartzite outcrops was an area of sparsely scattered rubble of quartzite and minor, very fine-grained phyllite. The latter rock type contained at least two well-developed cleavages but was considerably finer grained and less glossy than phyllite typical of the Precambrian terrane to the west. However, its mineralogy was similar, comprising mainly quartz and muscovite (?phengite) with accessory opaque minerals and zircon together with common, relatively large grains (?porphyroblasts) of muscovite, chlorite, and interleaved muscovite and chlorite. This similarity of pelite composition and fabric combined with the character of the associated quartzite indicates that the rocks around DN335710 were part of the same sedimentary sequence as the undisputed Precambrian rocks further west but were of rather lower metamorphic grade. At DN337694 in the area of scattered rubble there were fragments of pale- to medium-grey cherty silica with agate-like texture and vughs. Similar material elsewhere in Tasmania (e.g. Corinna district) is known to be derived from silicified dolomite.

Further to the east around DN350705 there was another area of scattered quartzite rubble. A single thin-section of the quartzite showed it to be very pure, consisting of very well rounded, high sphericity, clastic quartz grains with authigenic overgrowths. The rock had been compacted such that solution along grain interfaces had given rise to suturing. No matrix consisting of fine-grained, recrystallised quartz such as occurs in most rock designated as Ꝑq

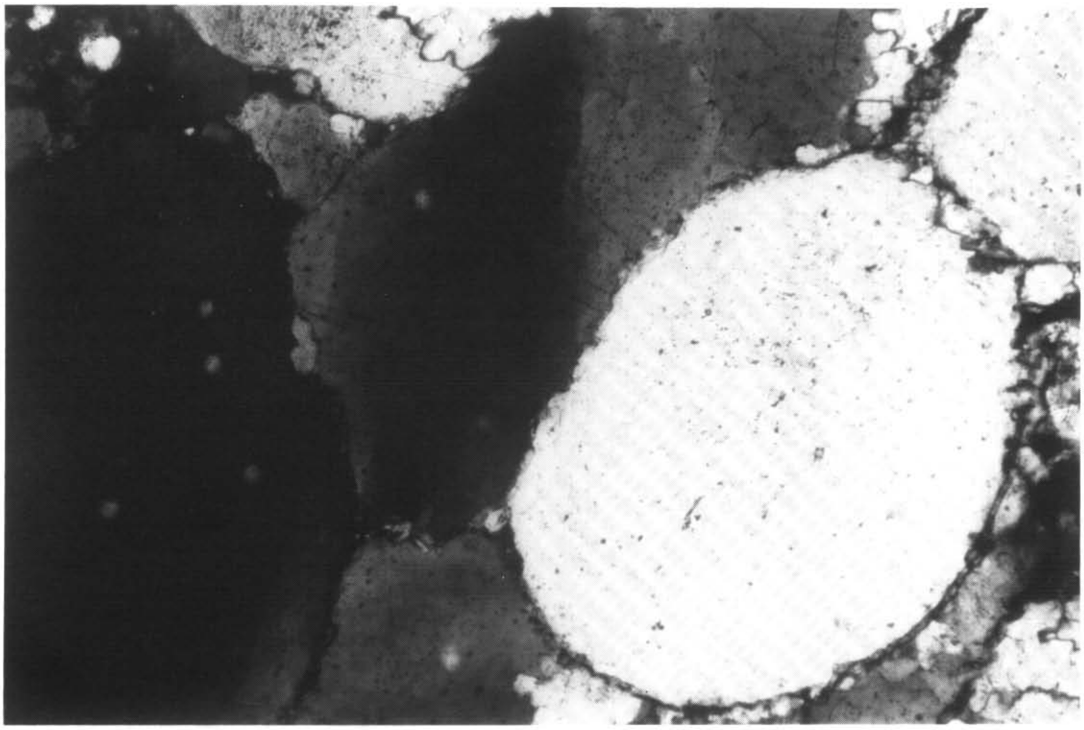


Plate 1. Photomicrograph of a quartz arenite (orthoquartzite) of Precambrian age in which there is relatively little metamorphic recrystallisation. Field of view 1.7 x 1.1 mm.

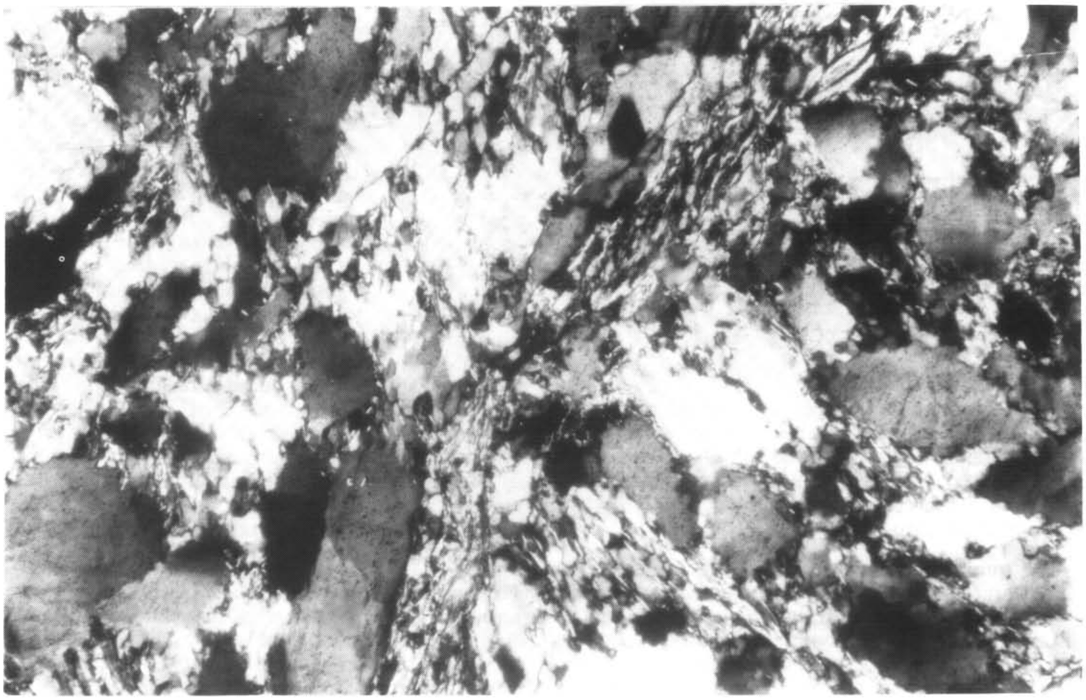


Plate 2. Photomicrograph of a quartz arenite of Precambrian age in which there has been extensive metamorphic recrystallisation. Production of the mortar texture in this example and the associated alignment of matric quartz and mica flakes was a D_1 phenomena whereas the generation of the seam of mica and distortion of the early fabric occurred during D_2. Crossed nicols. Field of view 1.7 x 1.1 mm.

5 cm

was present and no cleavage was discerned in hand specimen. However, the area has been classed as Precambrian undifferentiated (Ꝑu) on the basis of the quartzite being the same type of sediment as the Precambrian quartzite.

At DN326701 and DN320696 there were isolated outcrops of a foliated, white, medium-grained siliceous sandstone-like rock which was friable due to extensive leaching that had created 20-30% void space. Possibly the rock originally contained a high proportion of carbonate. Both outcrops have been classed as possibly Precambrian quartzite.

SHINING MOUNTAIN - DENISON GAP

N. J. Turner

The Precambrian sequences in the northern part of Huntley Quadrangle consist of lithologies similar to those in the sequences further south except that carbonate rocks become prominent.

Ꝑq - *Quartzite*

Areas designated as Ꝑq consist of medium- to coarse-grained, pure to slightly micaceous quartzite with minor phyllite. The quartzite generally weathers to a white colour but in places it is pink or purplish due to pigmentation of its cement. Variations in colour, grain size and mica-content define planar banding which is confirmed as bedding in many places by the presence of simple, large-scale cross lamination and symmetrical ripple-marks. Cross-laminated beds are commonly 100–300 mm thick with cross laminae about 5 mm thick which entirely transect the beds. Cross-lamination of herring-bone style is occasionally present. A planar parting may be parallel to both bedding and cross-lamination and is thought to reflect a sedimentary or diagenetic fabric.

In hand specimen the quartzite may be even-grained but commonly the grain size distribution is bimodal with even-grained, coarse- to medium-sand (0.3–1.5 mm), contained in a silt (0.05 mm) matrix. The matrix generally comprises less than 25% (volume estimate) of the rock but may comprise up to 50%. In thin section the two populations of grains form a mortar texture. The coarser grains in the mortar texture consist predominantly of monocrystalline quartz with minor chert and metamorphic quartzite. Quartz grains have undulose extinction and are frequently in contact with one another along curved, occasionally sutured, boundaries. Removal of parts of the grains in the process of forming these boundaries is sometimes demonstrated by the partial preservation within the grains sharing the boundary of clastic grain-shapes with authigenic overgrowths. These clastic grain-shapes are very well rounded and of moderate to high sphericity.

The fine grains of silt that form the mortar or matrix in the quartzite consist of quartz in pure quartzite and quartz, muscovite and/or colourless chlorite in impure quartzite. The quartz grains may either be equant or elongate and aligned. Their origin is probably varied. In even-grained, pure quartzite with only a few per cent by volume of matrix it can be seen that the small grains formed by recrystallisation of the strained, coarser grains either along fractures or around margins (plate 1). Possibly such recrystallisation was extensive in some purer quartzite thus accounting for high proportions of matrix. However, in impure quartzite the phyllosilicates mixed with quartz in the fine fraction (plate 2) indicate at least partial derivation from clay and thus, from original matrix. Lack of substantial recrystallisation of the large quartz grains in these rocks seems to be indicated by the apparent near-preservation of their original clastic grain-shapes (rounded, high sphericity) although recrystallisation of authigenic overgrowths on the large grains may have contributed to the matrix.

As well as being disseminated as small flakes in the matrix of quartzite, muscovite also occurs as fairly continuous, thin stringers which are often relatively rich in fine-grained opaque minerals. These stringers may define one or more of the tectonic surfaces in the quartzite. Accessory minerals in the quartzite include tourmaline, zircon and granular and fine-grained, dusty, opaque minerals. In a number of examples tourmaline grains were found to consist of very well rounded, clastic cores of high sphericity that are surrounded by overgrowths. A few feldspar grains of a similar nature were observed.

A quantitative assessment of the relative contributions to quartzite matrix made by recrystallisation of coarse clastic grains with authigenic overgrowths and by metamorphism of original matrix was not accomplished. However, in rocks with a large proportion of micaceous matrix there was probably a high proportion of original matrix and thus the texture of the parent sediment may have been bimodal. This texture is a feature of some orthoquartzite or quartz arenite and may reflect the effect of aeolian winnowing in the genesis of the sediment (Pettijohn *et al.*, 1972, p. 218). The generally very high degree of rounding and the high sphericity of original clastic grains in the Precambrian quartzite also suggest an aeolian history. However, the bedding, cross lamination and ripple marking demonstrate that the final phase of transport and deposition was by water which was probably shallow and subject to wave action.

Ꝑl - *Quartz-mica and mica-quartz phyllite*

Quartz-dominant phyllite is usually pale to medium green but may uncommonly be reddish. Mica-dominant phyllite is darker in colour, usually a greenish grey. In contrast to mica-dominant phyllite the siliceous component in quartz-dominant phyllite is obvious in hand specimen and metamorphic differentiation associated with tectonic surfaces is generally more pronounced than in either mica-dominant phyllite or quartzite. Both types of phyllite differ from quartzite in their fine grain size and by having finely foliate texture with generally smooth, lustrous surfaces. Quartz veins are particularly common in quartz-dominant phyllite and in almost all cases they show the effects of very tight folding and boudinage. Compositional interbanding is a ubiquitous feature of the phyllitic rocks and ranges from differentiation laminae with thicknesses of the order of one millimetre to lithological units with thicknesses of one metre or more. No evidence confirming any of the compositional banding in the phyllitic rocks as bedding was found. There is a small, isolated occurrence of fairly pure, recrystallised chert near DN327899.

In thin section both types of phyllite are completely recrystallised with no relict clastic textures. They consist of green-tinted muscovite (?phengite) and quartz with accessory dusty opaque minerals (?carbonaceous), granular opaque mineral(s), tourmaline and zircon. Minor chlorite may be present but it is not a common mineral and no interlaminated chlorite/muscovite grains such as occur in phyllite on Junction Range were found. Minor carbonate is present in some rocks.

Ꝑqpc – *Interlayered quartzite, phyllite and carbonate rock*

Between Mt Curley and Shining Mountain the Precambrian sequence consists predominantly of quartz- and mica-dominant phyllite with thin interbands of cross-bedded orthoquartzite and rare carbonate rocks. The sequence closely resembles the sequence on the western ridge of Junction Range with which it is continuous.

Ꝑg – *Black carbonaceous mica phyllite*

A distinctive unit of phyllite occurs along the eastern flanks of North Star and the northern Pleiades. It consists mainly of black to dark grey phyllite in which there are compositional bands ranging in thickness from a few millimetres to a few metres. These bands reflect varying proportions of opaque mineral, quartz and carbonate and may be either lighter or darker than the common rock type. No specific evidence of original bedding was found.

In thin section the mica phyllite is very fine grained, consisting predominantly of green-tinted metamorphic muscovite (?phengite) and recrystallised quartz. Opaque mineral grains may be abundant. The finer of these are probably carbonaceous (graphitic) whereas iron sulphide (?entirely pyrite) and possibly oxides form coarser grains. Accessory green tourmaline and zircon are generally present.

In some bands of dark-coloured mica phyllite there are disseminated composite grains consisting of interlaminated cleavage flakes of muscovite and chlorite (plate 3). These grains are large relative to the surrounding quartz and mica grains, ranging up to about 120 μm across. They comprise only a small part of the total rock volume, generally less than one per cent. Their formation preceded the development of the main seamed cleavage because the cleavage is deflected around them and beards have formed on either side of individual grains in the cleavage direction. A high degree of preferred orientation of their internal chlorite/muscovite laminae exists and in a sample from DN361877 the surface thus defined is at a high angle to both compositional banding (?S_0) and the main cleavage (?S_2). The surface therefore seems to record a kinematic event (?D_1) rather than mimetic growth on a primary bedding fabric (*cf.* Craig *et al.*, 1982).

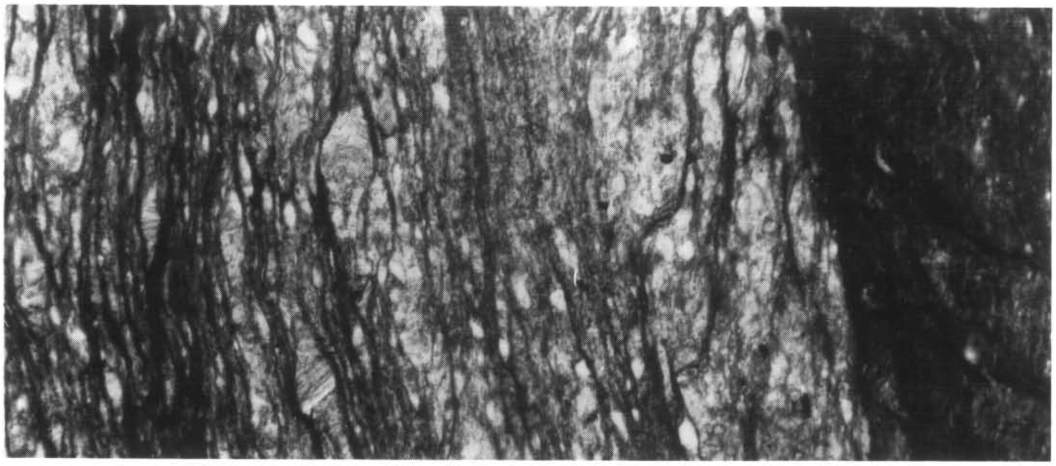


Plate 3 Photomicrograph of a phyllite from Ꝑg, east of the northern Pleiades, showing compositional banding and a strong oblique cleavage (?S_2). Preferred orientation of the crystallographic cleavage in chlorite/mica porphyroblasts possibly defines S_1. Field of view 4.33 x 2.80 mm.

5 cm

The mineralogy, very fine grain size and tectonic fabric of the dark-coloured phyllite in Ꝑg resemble those of the phyllite occurring in rubble (Ꝑu) south-east of Erskine Point near DN387913 (see earlier discussion). This similarity supports the assignment of the latter material to the Precambrian rock association because no structural or stratigraphic break was recognised between Ꝑg and quartzite of undisputed Precambrian age which caps The Pleiades. The apparent decrease in metamorphic rank displayed by the rocks in both areas suggests a cautious approach should be adopted to the use of degree of deformation and metamorphism as criteria for assigning relative age to rock sequences in this belt of country.

Ꝑc – *Interlayered carbonate rock and phyllite*

Carbonate rocks outcrop in valleys east and west of the northern Pleiades and north of North Star. Outcrop is generally poor: the best section is in the creek east of North Star near DN379903 where phyllitic rocks comprise a large part of the sequence. Elsewhere phyllite is also interbanded with carbonate. Because of its generally slow reaction with acid the carbonate is assumed to be mostly dolomite.

The dolomite lithologies comprise massive dolomite and thinly laminated dolomite and phyllite. Massive dolomite is fine-grained and grey to cream or, uncommonly, pink in colour. Weathered surfaces are usually a distinctive yellow-orange. The dolomite occurs in units up to about 500 mm thick that are interbanded with phyllite. These units probably correspond to original beds although little evidence was found of sedimentary structures. Ripple marks were observed in one locality (near DN364943) on the surface of a massive carbonate unit. Cross-bedding of the type present in the orthoquartzite was observed in a dolomitic quartzite near DN367917. Unlike the massive dolomite, the thinly laminated dolomite contains a high proportion of mica. Typically it comprises 5–20 mm thick lenticules of cream, medium-grained dolomite separated by anastomosing folia of green mica that are 0.5–2 mm thick. The resulting lamination may be oblique to thicker compositional bands (e.g. DN389932) and is thus regarded as a metamorphic differentiation fabric related to cleavage (S_2) rather than as a bedding-related fabric.

In thin section the massive dolomite is very fine-grained (0.05 mm) with small, irregularly-shaped patches of coarser grain size. Thin veins consisting of quartz, muscovite and opaque minerals are common as are stylolites in which black, ?carbonaceous residue is concentrated. Fine-grained flakes of mica may be disseminated in the carbonate and patches of very fine-grained quartz may be present. No sedimentary or biogenic (stromatolitic) textures were identified.

Dolomitic lithologies occur north of Shining Mountain but they are very impure. Commonly dolomite in this area occurs with recrystallised quartz in thin lenses 30 mm or so thick. These lenses are enclosed by mica folia a few millimetres thick which, despite their quite rich green colour, do not contain significant chlorite. Dusty and granular opaque minerals occur as accessories along with green tourmaline which may be euhedral. The lenticular fabric of the rocks is probably a structurally related feature similar to the lamination elsewhere rather than an original sedimentary feature.

Near DN380897 in the lower part of Kindling Creek there is a sequence of phyllite and interbanded phyllite and dolomite that is unusual in that it contains scattered blocks of massive dolomite ranging in size from about 20 mm to about 500 mm. Although the blocks commonly have angular boundaries and do not show pinch-and-swell morphology, they may be a consequence of boudinage during folding since the foliation in the surrounding material wraps tightly around them. Alternatively they may reflect syndepositional or immediately post-depositional disruption of the sequence. A little further north at DN385908 there is similar material and nearby at DN387913 there are highly foliated fragmental rocks associated with thinly interbanded carbonate and phyllite. In this latter locality the fragmental rocks are diamictite breccias containing angular fragments of very fine-grained pelite, quartzose pelite, micaceous psammite and carbonate. The sequence has been classed as part of Ꝑc on the basis of the presence of interbanded carbonate and phyllite. However, the extent of metamorphic recrystallisation seems to be relatively low and the sequence may belong in the unit that is designated 'schistose pebbly sandstone and conglomerate (€ep)'.

THE SPIRES – PRINCE OF WALES RANGE

N. J. Turner

Geological coverage of the remote north-western part of Huntley map was obtained by aerial photograph interpretation and by helicopter over-flying and landings at four localities. Rocks similar to those occurring between the Twelvetrees Range, The Pleiades and North Star extend at least as far as Prince of Wales Range.

Metamorphosed quartz arenite occurs near DN198943 on Prince of Wales Range and near DN205868 on the eastern side of the Denison River. In both localities the rocks consist of even-grained monocrystalline, detrital quartz grains contained invariable amounts of microcrystalline matrix consisting of metamorphic quartz and minor muscovite. On Prince of Wales Range grain alignment, particularly in the matrix, defines early cleavage whereas spaced, anastomosing seams of muscovite with opaque mineral define a later cleavage. East of the Denison River the matrix is more coarsely recrystallised and the fabric relationships less clear. No pelitic material was collected in either locality.

Near the northern edge of the map at approximately DN244940 an isolated outcrop of dolomite occurs in the bed of the Denison River. It is pale grey, massive and even grained. It consists of recrystallised carbonate with minor, disseminated, recrystallised quartz. Thin planar veinlets of quartz are common. The rock resembles the more massive dolomite of the Shining Mountain - Denison Gap area.

At the northern edge of the map on The Spires there is red, fine-grained, siliceous arenite of uncertain affiliation. The arenite appears to be thickly bedded and gently dipping. It consists of angular, fairly well sorted, monocrystalline quartz with minor muscovite and accessory green tourmaline. Some of the larger muscovite grains appear to be detrital. The red colour is imparted by a strong and abundant cement consisting of extremely fine-grained iron mineral(s). There is little evidence of preferred orientation of grains in thin section and there is no evidence of quartz recrystallisation. Possibly the arenite is of Palaeozoic age.

MIDDLE POKANA RIVER AREA

A. V. Brown

In the upper reaches of the Pokana River and along the lower slopes of the Northern Pleiades to the west, there are small areas of outcrop of three different sequences, shown by other workers (NJT and MPMcC) to belong to the Precambrian successions which make up The Pleiades.

These consist of:

(1) two small hills of Ꝑqs at DN329826 and DN336849;

(2) an area of Ꝑgg, at DN345862;

(3) an almost continuous section of carbonate, Ꝑc, along the upper reaches of the Pokana River between DN345846 and DN361874.

Ꝑqs - *Schistose micaceous quartzite*

The hillocks consists of interbedded quartzite and indurated quartzwacke. (contains $>15\%$ original matrix component, thin section estimate) In thin section the quartzite units contain 0.35–0.45 mm grains of deformed, sub-angular quartz grains and minor chert fragments. Grain boundary overgrowth and muscovitic beards between grains occur throughout the specimens. The quartzwacke units contain 0.15–0.34 mm angular to elongate grains of deformed quartz and chert and consist of 0.25 mm zones of recrystallised muscovite alternating with 1.5–2 mm wide zones of clastic quartz and chert grains. Some grain boundaries show overgrowth and most grains have muscovitic beards.

Ꝑgg - *Black carbonaceous mica phyllite with cream and green phyllite*

Cropping out in a creek bed on the eastern slopes of The Pleiades (around DN345860) are small sporadic outcrops of a dominantly black phyllite. This phyllite or carbonaceous muddy siltstone, is dominantly black in colour but also contains minor dull red, yellow-green or grey units. In thin section the samples contain a planar foliation parallel or sub-parallel to compositional banding; a crenulation cleavage perpendicular to the planar cleavage; and a spaced cleavage or kink band set at approximately 65° to compositional banding.

Ꝑc - *Interlayered fine-grained carbonate rock (dolomitic and calcareous), with interbedded quartz-mica phyllite and mica-quartz phyllite* (Ꝑd)

Outcrops of the carbonate succession along the Pokana river have a light brown weathering surface. When fresh, the carbonate varies from greyish-white to pink or green. The succession consists of dominantly recrystallised, fine-grained, massive or schistose dolomite with minor indurated siltstone. Some areas contain brecciated carbonate with a siliceous matrix, and other samples contain albite porphyroclasts. Minor thin (120–150 mm) units of interbedded phyllite occur within the succession. In the areas where phyllite occurs, the carbonate units are usually 5–8 mm thick, and contains 1–2 mm interbeds(?) of dark grey to black, silvery-grey, whitish-green or yellow phyllite, or zones of interbedded grey (50 mm) and/or black (120 mm) siltstone.

Within the massive carbonate, foliation surfaces have a clayey selvage, usually after green muscovite, or solution seams of residue and muscovite. In other places the carbonate contains fine sand grade quartz grains aligned with recrystallised fine-grained muscovite. When the succession is followed west of the Pokana River (up a tributary creek to the west, as far as DN344863), a 30 m thick zone of interbedded siliceous sandstone (5–8 mm) and whitish-green phyllite (1–2 mm) occurs. This is followed to the west by a further sequence of interbedded carbonate (2–5 mm) and phyllite (1–2 mm).

Tectonic deformation has produced a compositional banding in the massive carbonate, defined by an anastomosing cleavage, or two separate cleavages up to 30° apart. Pull apart cavities and veins are filled by recrystallised quartz. At a high angle (70–80°) across this compositional banding is a crenulation, or spaced cleavage with kink bands.

In thin section, the rocks consist of either fine-grained and/or recrystallised dolomite, or very fine-grained quartz clastic dolomite units. Most specimens show brecciation and contain pull-apart textures. All fractures and cracks are filled with recrystallised quarts and minor carbonate, with late stage quartz and calcite infillings of veins. Three foliations, defined by muscovite laths are common to most sections, one parallel to sub-parallel with compositional banding, another at 65–70° to compositional banding is either a spaced cleavage or a kink band system.

Interbedded phyllite samples have a compositional banding with a planar cleavage 10–15° away, and a crenulation cleavage perpendicular to the planar cleavage.

Eocambrian? - Early Cambrian

DENISON PLAIN - DENISON GAP REGION [DN360855]

DENISON GAP AREA

N. J. Turner

€ep - *Schistose pebbly sandstone and conglomerate;* €ecp - *Interbedded mica phyllite and minor chert*

Strongly deformed, poorly sorted conglomerate (€ep) crops out in a small area around DN394939, north-west of Denison Range. Similar material occurs in a phyllite–minor chert sequence (€ecp) about one kilometre to the east and also in a small area about 2 km to the south. The grouping of the conglomerate in these areas with conglomerate near South Star is speculative since no continuity has been established. Lack of established continuity also makes the relationship of the phyllite–chert sequence to other chert-bearing sequences further south uncertain. Two chert-bearing sequences (€ec/€el, €la) have been mapped to the south and of these €ec extends to within close proximity of the northern area. However, the distinctive, readily-weathered micaceous labile sandstone that is associated with the chert in both €ec and €la is not present in the northern area. Additionally, the apparent metamorphic rank of €la and much of €ec is lower than the rank of the northern phyllite although this may reflect a regional transitional variation.

At DN390937 rocks classed as €ep overlie upward-facing Precambrian quartzite at an angular unconformity (plates 4–5). The unconformity surface is quite irregular over an area of several square metres with a relief of about one metre. Its angular discordance with bedding in the underlying quartzite is about 90°. Resting on the unconformity surface is breccia consisting of angular fragments of quartzite up to about 200 mm across. The quartzite is similar to quartzite in the underlying sequence.

There is little matrix in the breccia at DN390937. However, medium to dark grey matrix is a major constituent of nearby outcrops classed as €ep and may exceed 20% (volume estimate of outcrop). It has a phyllitic texture and consists largely of fine-grained metamorphic mica and quartz with dusty and granular opaque minerals. Green chlorite of metamorphic origin is sometimes present. Sand and silt consisting of monocrystalline quartz and sparse rock fragments comprise the clastic part of the matrix.

Larger clasts in all exposures of €ep consist of massive, fairly pure, white or sometimes, pink quartzite of the type designated Ꝑq in the underlying sequence. Micaceous quartzite and quartz are also generally present. Although the shapes of the clasts have been modified by flattening, some appear to have been well-rounded prior to deformation. The clasts commonly range up to 100–250 mm across but boulders up to about 700 mm across are present at DN390913. In this locality carbonate (?dolomite) comprises some of the clasts.

No measurements of bedding were made in the conglomerate nor were other original sedimentary structures identified. This reflects the small and scattered nature of outcrop and means that the genesis of the conglomerate is unknown. Possibly it is tillite (see Jago *in* Hambrey and Harland, 1981) but no dropstones or faceted or striated clasts were observed and the unconformity surface at DN390937 is not smoothed. Alternatively, the conglomerate may be a density flow product.

In the various areas underlain by rocks that have been grouped together as €ecp the dominant lithology is dark grey or, less commonly, green phyllite except at DN394928 where the pelitic rocks are khaki shales. The chert that is present in all areas is generally either creamy white or dark grey. It is recrystallised and may be brecciated such that blocks several centimetres across containing uniformly oriented bands relatively rich in dusty opaque (?carbonaceous) minerals are juxtaposed with blocks in which the banding is strongly oblique. A small amount of very fine-grained mica may be present and opaque mineral is sometimes concentrated in stylolitic seams. At DN401942 there is a small occurrence of banded iron formation consisting of hematite (after ?magnetite) and recrystallised chert in thin (less than 1–3 mm) bands that are alternatively oxide-rich (90%) and oxide-poor (10%).

CENTRE STAR - DENISON PLAIN AREA

A. V. Brown

Introduction

The area of low ridges and high peaks between the Precambrian successions of The Pleiades and the fossiliferous Middle Cambrian successions on Trial Ridge, contains nine

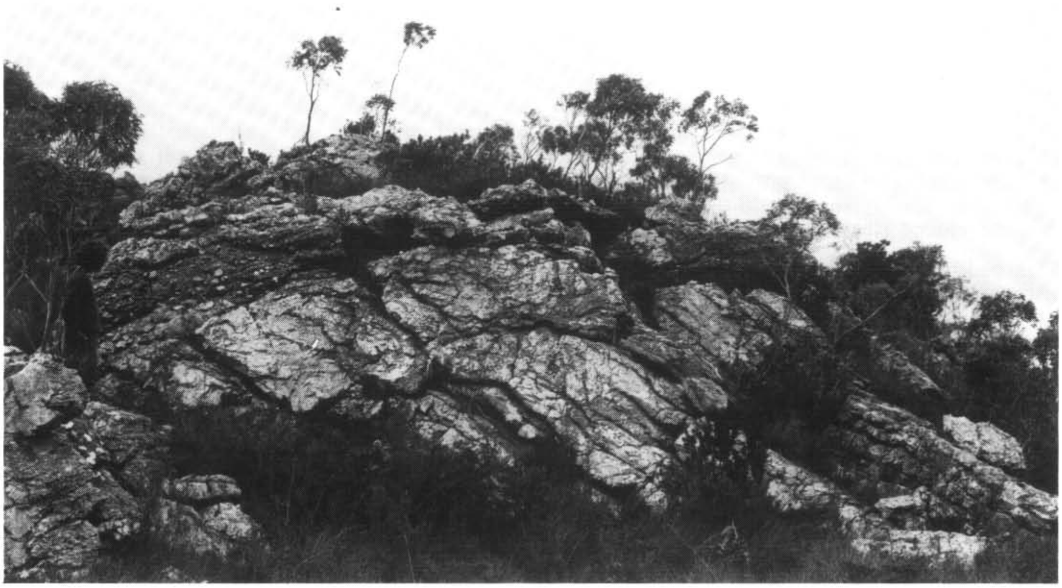


Plate 4. Unconformity between Precambrian quartzite (Ꝑq) and the overlying Cambrian basal breccia (Ꞓap) at DN390937 north-west of the Denison Range.

Plate 5. Close-up of same exposure as Plate 4.

5 cm

different lithological successions. Each succession has an irregularly shaped outcrop distribution but in general is elongate N-S and dips steeply to the east. Boundary relationships between these sequences are faulted. Although the successions have faulted contacts are unfossiliferous and the original stratigraphic relationships are unknown, a tentative grouping of the units has been made on structural criteria into a western foliated group and an eastern unfoliated group. On structural and lithological grounds an angular unconformity is inferred between the two groups. Spatially, the west to east stacking of the successions added to their structural and lithological character suggests a package of stacked, thrust fault slices.

The age of the nine rock successions to the east of the fault line (between DN345845 and DN363876) is unknown, but they are all older than the middle Middle Cambrian Trial Ridge Beds and younger than the metamorphosed Precambrian successions on The Pleiades.

From the west, the successions are:

Two interrelated sequences:

€eq/€er - Schistose micaceous quartzite with minor phyllite / Schistoseindurated siltstone

€ep - Schistose pebbly sandstone and conglomerate

Two interrelated sequences:

€ec/€el - Chert predominant / Lithic sandstone predominant.

Implied unconformity

€lm - Mixtite with angular clasts and sandstone lenses

Two interrelated sequences:

€lr/€lw - Red siltstone and mudstone, with interbedded sandstone layersindicated (€lrs) / Massive quartz sandstone, notably quartz-rich(Wings Sandstone)

€la - Interbedded chert, lithic sandstone, siltstone, pyritic mudstone,horizons of dominantly banded chert (-€lac); dominantly pyriticmudstone in zone of cataclasis (€lap).

Implied unconformity

€eq/€er - *Schistose micaceous quartzite with minor phyllite / schistose indurated siltstone*

€eq: The schistose micaceous quartzite with minor phyllite consists of irregularly alternating units of thinly interbedded muscovitic quartzwacke, friable siliceous sandstone, sometimes with basal ripple marks, and indurated siltstone. The muscovitic quartzwacke (>15% original matrix, thin section estimate) has a well formed anastomosing cleavage parallel to compositional banding/bedding. Elongation of clastic grains and recrystallised quartz with beards, is parallel to this cleavage. Minor calcareous quartzwacke contains both recrystallised carbonate grains as well as a clastic components and has a foliation defined by elongation of muscovite laths. The sandstone is clean and siliceous with some secondary overgrowth on the clastic grains.

In thin section, quartzwacke units are composed of medium- to coarse-grained (0.22–0.91 mm), angular to semi-rounded sand grains of predominantly quartz, with undulose extinction, and minor grains of quartzite. The matrix fraction is recrystallised to quartz and mica producing a very strong tectonic fabric. In some specimens, clasts up to 1.5 mm across of well-rounded quartz, in a matrix of 0.09–0.14 mm occur. Throughout the succession minor small grains of tourmaline (0.0725 mm), leucoxene and hematite also occur.

€er: The schistose indurated siltstone consists of purple, dull red, green and grey indurated muscovitic siltstone. Original bedding was not observed, but a compositional banding, which is probably due to an early transposition cleavage is easily recognised in outcrop. Thin quartz veins occur throughout the sequence parallel to this banding. In thin section, grain size ranges from silt to fine sand grade (0.05–0.09 mm), which is recrystallised to a quartz-mica mosaic.

€ep - *Schistose pebbly sandstone and conglomerate*

This succession was tectonically derived from what appears to have originally been a turbiditic sequence of interbedded (100–200 mm) siltstone, sandstone, wacke, and conglomerate. Graded and truncated bedding has been observed in a remnant area of the original sequence, which remained undeformed, within this otherwise tectonised sequence (around DN364833). Outcrop characteristics are very varied, ranging from nearly all clasts to nearly all matrix in a distance of less than 2 m, obviously reflecting variations in original bedding.

Clasts range in size from <5 mm fragments of siltstone and mudstone up to Precambrian quartzite boulders (350 × 150 × 100 mm) (plate 6). Pebble, cobble and boulder clasts are of dominantly foliated and massive quartzite with minor dolomite and mudstone. The foliation within the quartzite clasts is a penetrative cleavage formed prior to deposition in this succession, and is discordant to the cleavage in the surrounding matrix. The overall proportion of clasts is approximately 80% quartzite, 15% carbonate, 5% sandstone/mudstone. Dolomite clasts range in quantity from approximately 15% in some areas to 5% in other places. In the

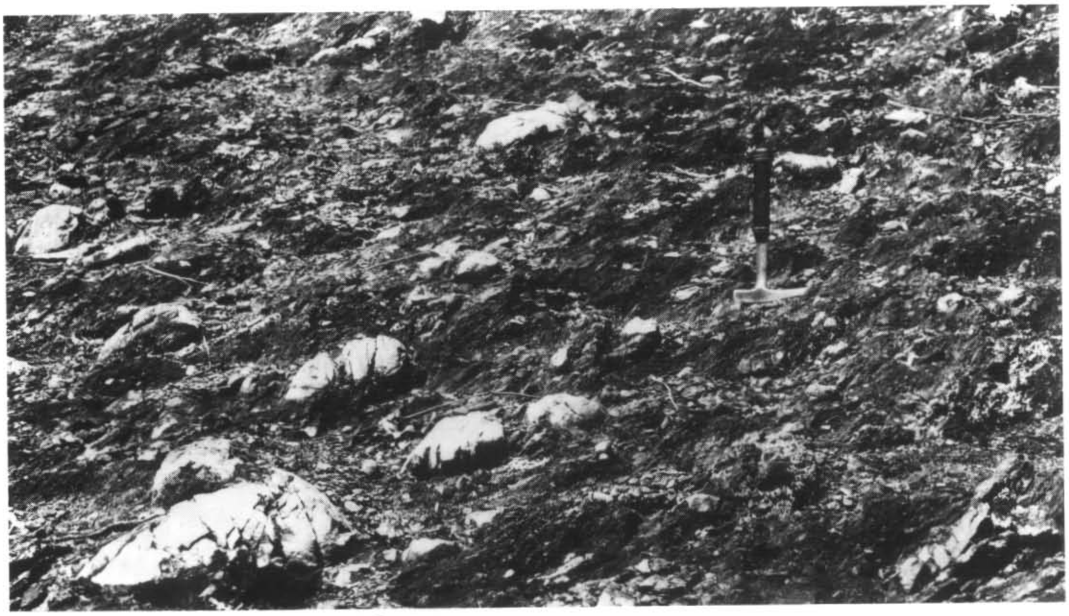


Plate 6. Schistose conglomerate (Ꞓep).

central area, where tectonism is most severe, the schistose conglomerate has clasts of quartzite up to 350 mm long, carbonate to 250 mm, and mudstone up to 250 mm. The matrix consists of grey silt and sand grade material derived both from original fine-grained material and, from thin section study, by tectonic breakdown of larger grains, and is best described as being a cataclasite.

The tectonic deformation was such that the clasts have been rotated from their original depositional position, such that the long axis of the clasts is parallel to the dominant deformation foliation. This foliation wraps around the larger clasts, and while it was not observed cutting the clasts, some of the larger quartzite boulders have been boudinaged perpendicular to the direction of the main disruption foliation. The angle between the original bedding and the tectonic banding is approximately 40°, but it ranges in some samples up to as much as 60°. In the finer sediments S_2 offsets S_1.

Within this succession is an area of original bedded material (around DN364833), which survived the main deformation. The tectonic event which produced the transposition in the rest of the succession, only produced a crenulation cleavage in this part of the sequence. The original succession consisted of a turbiditic sequence of interbedded quartzite and dolomite cobble conglomerate, pebbly lithic sandstone, sandstone and siltstone.

A reconstruction of the original sedimentary sequence, starting from the southernmost outcrops around DN352820, show that they consisted of chert or siliceous carbonate with interstitial clastic quartz grains, associated with siltstone, quartzwacke, which is sometimes calcareous, and conglomerate. In the north, minor purple and red mudstone occurs within a sequence dominated by siltstone and quartzwacke. Overall the mixtite is graded from the south-westernmost outcrop (around DN352820), where the largest clasts are only 10–20 mm, to the centre of the outcrop area, where the clasts are up to 500 mm and were possibly greater before being broken up, to the north-eastern outcrop area [DN364836], where the average of the coarse clasts is approximately 200 mm.

Areas of similar tectonic mixtite occurs to the north of the area of scree (Qqsc) on the lower western slope of South Star, [DN367850], and to the north-west of Centre Star (around DN369874). In tectonic and general appearance these areas appear to be similar to the southern areas, but the clasts are smaller and consist of labile sandstone, green siltstone and silver-grey and red mudstone. Outcrop of single blocks of red mudstone, up to 8 m by 5 m occur within the mixtite area. Whether these outcrops are isolated blocks of part of an original interbedded sequence or part of another succession was not determined, but the mudstone has a similar and continuous tectonic fabric to the surrounding mixtite. Actual contact of the two rocks was not observed due to soil and scree cover.

In thin section, the units consist of similar material to that which formed the indurated quartzwacke and siltstone successions. The dominant foliation is again a transposition surface. In some samples a later spaced crenulation surface at approximately 45° to the transposition surface is present.

€ec/€el – *Two interrelated successions: €ec – Chert dominant; €el – Lithic sandstone predominant.*

€ec: The chert sequence is massive, monotonously uniform and crypto-crystalline. It is predominantly off-white with minor black, grey, green and purple bands. The succession contains two surfaces, the first, a platy parting with green pelitic selvages, which occurs parallel to the colour banding and possibly represents original bedding, but so far direct proof is lacking. This surface consists of a parallel parting ranging from less than one millimetre up to 50 mm separation. In thin section this surface is represented by a strong alignment of fine sericitic muscovite laths. Cross cutting this surface at approximately 40°, is a crenulation cleavage which in outcrop has a constant parting of less than a millimetre. In outcrop only one fold has been observed, this being in an area of purple-green banded material. Undulations in cleavage directions from the area suggests large scale folding.

In the areas of €el to the south of the Gordon River the succession contains a large amount of recrystallised quartz as irregularly shaped patches and veins, which in places can be taken in outcrop for quartzite. Generally, the irregularly shaped patches have been effected by the two cleavages, but the majority of veining has not. The second cleavage forms as kink bands in the areas of recrystallised quartz rather than a crenulation cleavage. Chert units in this area are dominantly white (brownish greyish white on a freshly broken surface) with minor thin black bands parallel to the platy cleavage. As with the outcrops to the north of the Gordon River, the chert units in the southern area have two cleavages, the first platy and the second penetrative crenulation.

In samples in which bedding is apparent, i.e. where thin siltstone laminae occur within the chert, the main penetrative cleavage has a similar morphology to the transposition surface in the schistose pebbly sandstone and conglomerate (€ep) and earlier successions. In some samples, a later cross-cutting surface is observed at approximately 45° to the main cleavage, and appears as a spaced crenulation.

€el: Regionally associated with, and at times interbedded with the chert is a sequence of dominantly foliated muscovitic greywacke, with minor interbedded siltstone and multicolour mudstone. The term greywacke is used for a the coarser grained muscovitic-feldspathic-lithic quartzwacke units. Within this sequence minor units of angular to subrounded brecciated chert and siltstone clasts in a coarse-grained wacke matrix also occur, but the succession is dominantly composed of detritus from a metamorphosed Precambrian terrain, similar to the €ep and €eq/€er successions, and the degree of recrystallisation of the groundmass is similar to the rocks within these successions. Lithic fragments are from fine- to coarse-grained quartzite as well as chlorite-mica schist. The greywacke unit contain a good planar cleavage, outlined by the alignment of muscovite, sub-parallel to bedding and a second crenulation cleavage, at 35–40° from the planar cleavage, similar to that formed in the chert sequence.

In finer grained samples a later foliation can been seen to produce a marked crenulation surface across the crenulation surface observed within the greywacke.

€lm – *Mixtite with angular clasts and sandstone lenses.*

To the north of the northern extent of the Wings Sandstone, on the south western slopes of South Star, an unfoliated mixtite of sedimentary origin occurs. This rock consists of rounded to angular clasts, ranging in size from 5 mm to 100 mm, of dominantly purple mudstone (70%) and quartz-quartzite (20%) with minor amounts of red and green mudstone and chert (cleaved and rotated banded and massive) in a green to greenish-brown siliceous matrix. Throughout this sequence lenses of pebbly sandstone, sandstone and siltstone occur in an otherwise dominantly massive sequence. These lenses are usually graded and normally have the same colour and consist of similar material to the matrix of the surrounding mixtite. Except for the lenses no bedding or other structures of a sedimentary nature were observed.

The matrix is of coarse-grained sand and contains grains of Precambrian quartzite and phyllite in addition to grains of the earlier described sequences. Throughout this unit lenses and laminations of pebbly lithicwacke, lithicwacke and siltstone occur. The lenses are usually graded and consist of similar material to the matrix of the surrounding mixtite. Except for the lenses no larger scale bedding has so far been observed but a crude alignment of the larger clasts exist sub-parallel to the bedding. Although no actual contact with the surrounding units outcrop, the contact zones are sharp and have no influence on topography.

The presence of this unfoliated mixtite led to the inference of an angular unconformity between successions €eq, €er, €ep, €ec, and €el, to the west; and the rest of the Eocambrian successions to the east. The latter successions only exhibit one measurable tectonic surface in some areas.

It is possible that a sequence of interbedded purple mudstone underlies the mixtite. This possibility is based on the percentage of purple mudstone clasts in the mixtite and the fact that a low hill to the west of the mixtite contains rubble of a similar purple mudstone and no other rock type, however no outcrop was observed. This mudstone was not been found anywhere else in the area mapped and the true relationship with the mixtite in unknown.

€lr/€lw – *Two interrelated successions which are known to pass conformably from one to the other:* €lr – *Red siltstone and mudstone, with interbedded sandstone layers indicated* (€lrs); €lw – *Massive quartz sandstone, notably quartz-rich*

€lr: This succession consists of dull-red, graded sandstone, siltstone and mudstone units with minor units of lithicwacke and grit. Fine conglomerate units composed of sandstone clasts in a matrix of red pervaded silt occur in the interbedded part (€lrs) of the sequence. The red nature of the sandstone and siltstone is caused by pervasive secondary iron oxide minerals, and not due to deposition as a classical 'red bed' deposit.

Due to fault displacement of the succession in at least four places along its length, the overall stratigraphic thickness is unknown, but the succession can be divided into two parts, €lr and €lrs, which, although now juxtaposed by faulting, were obviously originally gradational.

The lower part of the succession consists only of red sand- and silt-grade units with an occasional white quartzite cobble (up to 200 mm by 140mm in cross section). In the few examples observed the long axes of the cobbles are vertical with respect to bedding.

The upper part consists of red hematitic sandstone and siltstone units with interbedded white siliceous sandstone. The hematitic units dominate the succession with the white siliceous sandstone units increasing in proportion up through the succession. The first appearance of the siliceous sandstone within the succession is as thin units (2–3 mm wide) with a wide stratigraphic separation (10–20 m). This separation decreases up through the succession as the white siliceous sandstone units become more frequent and thicker (up to 5 m) and a corresponding decrease in thickness and frequency of the red sandstone and siltstone units occurs. The interbedded sequence is well exposed to the south and south-west of Wings Lookout and part of it occurs on the first ridge on this line to the north of the Gordon River. Between these two areas the interbedded sequence is missing. Although the sequence can be shown to be conformable and gradational into the Wings Sandstone [DN364781], thin section examination of specimens of sandstone from the two successions are different.

Within this mixed part of the succession, numerous apparent cycles of white siliceous sandstone, red sandstone-siltstone-mudstone, to red mudstone with pebble to boulders of quartzite occur. In other parts of the sequence minor thin reddish-grey lithicwacke and granule conglomerate units, consisting of haematite pervaded sand/silt grade matrix with quartzite fragments. The sandstone beds are mainly medium grained (0.23–0.68 mm), and consist of well-rounded grains of dominantly quartz with minor sub-angular chert grains. Overgrowth has occurred along most grain boundaries, resulting in places to some triple-junction textures. The pebbles in the hematitic mudstone-siltstone beds are composed of similar grain size, quartz rich material with the same degree of grain-boundary overgrowth as found in samples from the interbedded siliceous sandstone units.

Along the faulted contact of €lr with €lw, a fault breccia, 1–2 m wide, consisting of irregularly shaped clasts of both succession re-cemented by secondary quartz occurs to the south-east of Wings Lookout [DN385728].

€lw: Massive quartz sandstone, notably quartz-rich – this succession is informally defined as 'Wings Sandstone'. It cannot be formally defined as both the eastern and western margins are faulted, and the thickness of the sequence is unknown. The succession consists of white, massive, mature quartz sandstone which is highly jointed and has an uneven fracture but no penetrative cleavage. The succession crops out from south of Wings Lookout, along the line of ridges to the north, to south of South Star. As well as thickness, the internal structure of this sequence is also not known as no foliation readings were obtained, and the only definite bedding reading recorded, was from a one metre thick clay band within otherwise massive quartz sandstone [DN367763]. In most outcrops joints are the only recognisable tectonic feature.

In thin section the larger quartz grains are closely packed in an interlocking mosaic. Some pressure solution overgrowths occur. Many grains exhibit sweeping extinction or deformation lamellae, but due to the random orientation, the deformation is considered to have occurred before deposition of this unit. Grain size is the same as in the interbedded sequence beneath (0.23-0.68 mm), and all samples observed are clean, well sorted sandstones with the minor percentage of matrix having recrystallised around grain boundaries. Some samples have a small amount of hematitic mud-silt grade material, others occasional green tourmaline grains (0.07–0.08 mm).

€la – *Interbedded chert, lithic sandstone, siltstone, pyritic mudstone, horizons of dominantly banded chert* (-€lac); *Dominantly pyritic mudstone in zone of cataclasis* (€lap)

To the south of the Gordon River, between the eastern slope of Wings Lookout and the western slope of Clear Hill, a dominantly lithic sandstone-quartzwacke succession with minor limestone, black and grey pyritic mudstone and chert units occurs. Progressing south, towards the Adams Falls along the southern side of

Clear Hill, red-brown mudstone becomes dominant but minor limestone, chert and lithicwacke still occur. A mélange zone through the saddle between Clear Hill and Wings Lookout has sheared and intermixed mudstone, limestone and lithicwacke. To the west of this, dominantly pyritic mudstone occurs. On the south-western slopes of Clear Hill, ridges of chert are associated with red and green mudstone and minor lithicwacke.

The labile sandstone-greywacke is the most variable unit and appears to have been a dark blue-grey when fresh, and weathers to a bright orange-yellow. Grain size and variety of constituent minerals and rock fragments vary considerably from place to place. The red and green mudstone and black and grey shale appear to be of almost uniform composition, but vary in the thickness and frequency of occurrence throughout the area.

Chert beds range from 10–50 mm in thickness, when interbedded with mudstone and sandstone, to over 50 m in thickness. The thicker sections now form ridges. Usually the chert is colour banded, ranging from white to grey, green, red or orange and have a good foliation parallel to the banding. In some areas the chert occurs as fractured blue-grey lenses. Over most of any chert ridge only small undulations in the foliation is evident but occasionally areas of kink bands and small folds occur. These range is size from a few centimetres to 1–2 m across. The overall structural and lithological character of this succession is vastly different to that of the Cec/Cel successions to the west, which have a gross lithologically similarity, but are far more structurally complex.

Within this succession bedding is easily recognised and is folded on a regional scale. The overall folding pattern was not unravelled but the folding occurred before deposition of the unconformably overlying correlate of the Upper Cambrian Singing Creek Formation (Ol). The succession is considered to be a stratigraphic correlate of the fossiliferous Middle Cambrian Trail Ridge Beds, which, although siliceous in character to the north of the Gordon River, correlates to the south, covered by the Pedder 1:50 000 Sheet (Turner *et al.*, 1985), have a similar lithology and contain faunas of late Middle Cambrian age.

RAGGED RANGE - DENISON PLAIN AREA

N. J. Turner

Ꞓleu/Ꞓleuc - *Micaceous sandstone, shale and chert*

From Ragged Range westwards to near DN340690 there are two areas which are underlain by chert-bearing sequences designated Ꞓleu/Ꞓleuc. The sequence in the western area is not well-exposed. It contains lithologies similar to those in the eastern area and to those west of Wings Lookout which are designated Ꞓec/Ꞓel. Rocks in the eastern area are continuous with rocks designated as Ꞓla north of the Adams River. They also contain the same range of lithologies and display a similar style of disruption to the Ꞓec/Ꞓel sequence west of Wings Lookout. No sedimentary facings have been found in either the eastern or western areas so the thickness of the unit or units is unknown.

Lithologies in the eastern area comprise shaly mudstone and siltstone, chert and very deeply weathered, compositionally unusual sandstone. The chert is highly fractured and occurs in discontinuous bands ranging in thickness from a few tens of millimetres to several tens of metres. Weathered surfaces are commonly white or light grey but fresh surfaces may be pale green, pale pink or dark grey. Colour banding at scales of 1–10 mm in thickness is common and there is usually a close-spaced, planar parting either parallel or subparallel to the colour banding. In thin section the chert consists of quartz, rare muscovite and fine-grained opaque minerals. Sometimes pale green non-fissile, siliceous mudstone is interbanded with the chert. The chert is variably recrystallised. Most consists of very fine (<7 μm), equant quartz grains but in thin section there may be patches that are coarser grained.

Weathering of the Ꞓleu/Ꞓleuc sequence has been very extensive and thus it is doubtful that colours displayed by the shales are original. However, the shales may be subdivided into a khaki to orange-yellow type and a chocolate-brown type. The former type occurs as very common, this (<1 m) units in sandstone whereas chocolate-brown shale occurs less frequently and in units ranging in thickness from one to many metres. Thinly banded dark brown chert may occur in these latter units and there may be very dark coloured manganiferous materials with fracture surfaces on which dendrites occur. Bedding in both shale types and in shale/sandstone sequences is often indiscernible, even in good exposures (e.g. road cuts). Interfaces between shale and sandstone are commonly irregular and may correspond to polished shear surfaces. The irregularity of contact relationships is well displayed in exposure along the shore of Lake Gordon near [DN418684] (plate 7). Very irregularly shaped patches of chocolate brown shale ranging in size from less than one metre across to several metres across are isolated in sandstone that contains minor lenses of khaki to orange-yellow shale. This distribution pattern is attributed to very extensive disruption of the original sequence. To what extent the rocks were lithified at the time of disruption is unclear but the widespread occurrence of polished and slickensided surfaces suggests that at least part of the disruption occurred after the rocks were well consolidated.

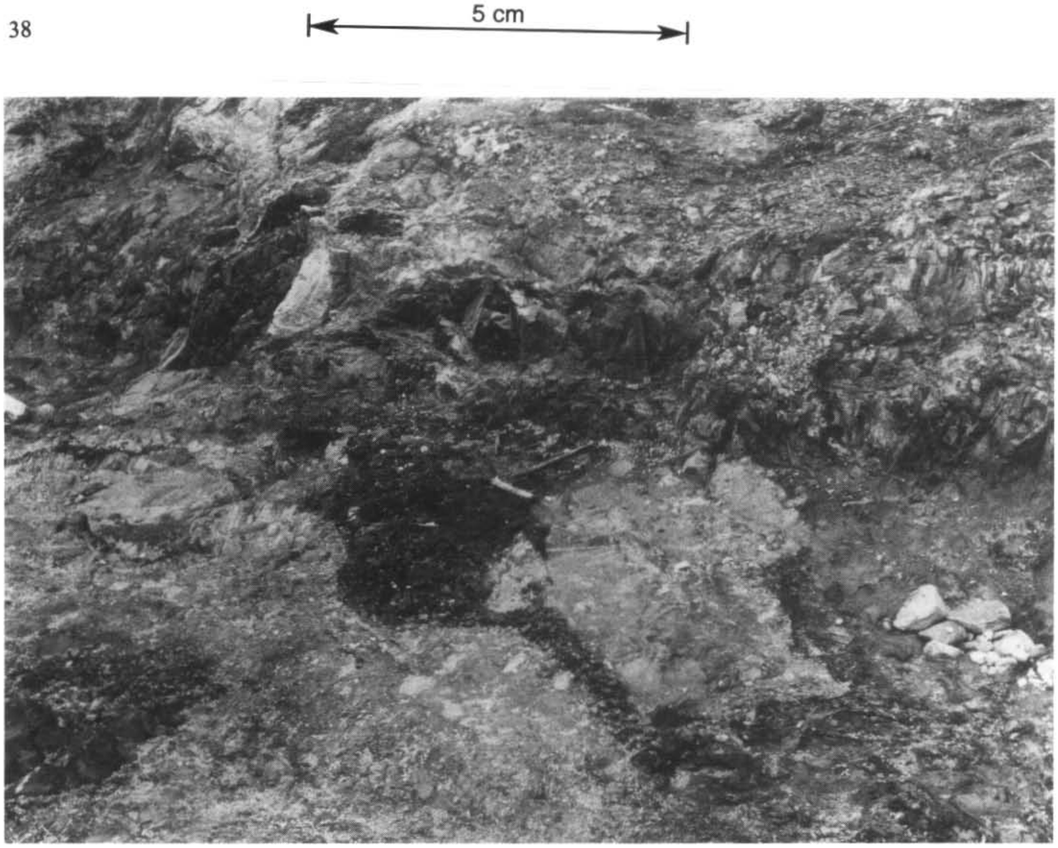


Plate 7. An irregularly-shaped patch of chocolate-brown shale in micaceous labile sandstone. Foreshore exposure at DN418684. Field of view about 3 m wide.

The effect of deep weathering is particularly evident in sandstone. Usually the sandstone is very soft and has a brownish to orange colour due to the presence of a high proportion of clay and limonitic material. These latter frequently display relict sandy texture. Of the original clastic constituents only quartz and muscovite are generally recognisable. The muscovite is a particularly distinctive feature of the sandstone being generally abundant, mostly coarse-grained and having strong preferred orientation. Quartz grains are sometimes unusually well-rounded. Unweathered sandstone was only collected near DN423694 in the Adams River, below Adams Falls, a locality now flooded by Lake Gordon. The rock is medium-grained, dark green and poorly sorted. It contains about 30% (by volume, estimated from thin section) angular, medium-grained quartz, about 15% muscovite, about 25% biotite and chlorite and a few grains of feldspar with rare grains of garnet. The remainder of the rock consists of fine-grained, indeterminate matrix. Biotite and muscovite occur as flakes which may be relatively large and which share a well-defined, preferred orientation. Biotite flakes may be partly or completely altered to green chlorite but some chlorite occurs as finer, more equant grains and may be after a mineral other than biotite.

Of the western area underlain by rocks classed as €leu/€leuc, the only part not inundated by Lake Gordon is what is now known as New Moon Island at DN465670. The island is a narrow strike ridge formed by interbanded chert and shale. The chert is dark grey or pale greyish green when fresh but weathered surfaces are white or pale grey. Pale green non-fissile mudstone is interbanded with the chert. Commonly shales are weathered and are yellowish or reddish brown in colour although some fairly fresh, dark purplish-brown and greenish shales are present. On the flooded ridge north east of New Moon Island there was outcrop of pale pink and pale green, banded chert whilst white to pale grey chert outcropped on ridges NNW of the island. Exposure in other parts of the area was limited to sparse rubble. At DN355704 there was rubble of greyish-black chert and small-pebble breccia consisting of deeply weathered, fawn to brown, angular, labile fragments in a soft, greenish, medium-grained groundmass. The breccia contained sparse, rounded fragments of chert and quartzite. Nearby there was rubble of brown weathering, micaceous siltstone and deeply weathered, coarse-grained sandstone rich in decomposed labile minerals.

Chert outcrops NNW of New Moon Island showed in places a distinctive fine banding related to new crystal growth. Similar banding also occurs in chert in the eastern area. Although anastomosing the banding is generally planar and commonly apparent only in parts of outcrops rather than throughout. It is not related to colour banding, being characterised instead by a greater translucence in the bands of new crystal growth when compared with the milky opacity of the interbanded finer grained chert. It is also characterised by consistency of band spacing and thickness, both being about 1.5 mm. In thin section bands of new growth can be seen to be healed tension fractures in which there have been several growth phases. The most prominent of these phases involved the growth of fibrous fans of quartz from discrete nucleation points on opposing walls of the fractures such that the fans generally meet in a comb structure along the median line of the fracture.

Єes - *Lithic sandstone and breccia*

Prior to flooding by Lake Gordon there was a small, isolated patch of outcrop at DN384668. Lithologies exposed in the area included green, shaly siltstone; greenish, siliceous, lithic sandstone; and greyish, siliceous pebble breccia. Similar rocks cropped out about one kilometre to the north. The sandstone and breccia consisted predominantly of elongate, angular, chert grains oriented parallel to bedding. The remainder of the sandstone was made up of angular grains of monocrystalline and rare polycrystalline quartz with a few angular fragments of fine-grained pelite. As well as quartz grains, the breccia contained fragments of orthoquartzite.

How the rocks classed as Єes are related to adjacent rocks is unknown. There are no exposed contacts and no comparable rocks were found in either the eastern or western areas of Єleu/Єleuc. However, rocks classed as Єec which occur near DN363810, south-west of Menkar, are very similar in that they consist mainly of strongly oriented, elongate, angular fragments of chert together with a large component of apparently clastic grains of angular monocrystalline and minor polycrystalline quartz.

NEEDLES AREA

C. R. Calver

Introduction

P. G. Lennox and P. R. Williams mapped the Eocambrian rocks in the Needles region, in the south-east corner of the map sheet, in the 1976-1977 field season. Selected traverses by C. R. Calver were recently done to compare these rocks with similar sequences on the Pedder Quadrangle (Turner *et al.*, 1985). This uncovered some new sedimentological and stratigraphic information (see Calver, in prep.)

The Eocambrian rocks are folded into a steeply NW-plunging major anticline whose axis crosses the summit of The Needles [DN548685]. On the eastern limb a prominent strike ridge is developed on the Needles Quartzite, and this unit (Єens) is conformably overlain by an argillaceous dolomite-mudstone-chert sequence (Єenf, Єend, Єend, Єenm). The stratigraphic relationship of these rocks to the dolomite (Єenq) cropping out on the south face of Tim Shea [DN563702] is uncertain.

The Eocambrian sequence is unconformably overlain by the Denison Subgroup to the north, and faulted against Cambrian lithicwacke to the south (Turner *et al.*, 1985). A lithologically similar, W-facing sequence north of Mt Mueller, on the Pedder Quadrangle, is probably the faulted western limb of the needles anticline *(ibid.)*.

These rocks are considered to be Eocambrian primarily on the basis of their very low tectonic and metamorphic grade.

Previous work

Lewis (1940) described the area but misinterpreted the relationships of the major rock units. A brief but more accurate account is given in Carey and Banks (1954), who applied the names Needles Quartzite, Stephens Dolomite and Humboldt Slate to the Eocambrian rocks, which they interpreted as a single conformable sequence, the Clark Group (see their fig. 3). Spry (1957) briefly described the sequence, and Spry (1962) gave the succession as:

Top:	Stevens *(sic.)* Dolomite	> 4000 ft [>1200 m]
	Humboldt Slate and Dolomite	1800 ft [540 m]
	Needles Quartzite	1500 ft [450 m]
	Laminated Quartzite	150 ft [45 m]
	Laminated Grey Dolomite	150 ft [45 m]
Base:	Green Greywacke Sandstone	> 500 ft [>150 m]

A correlation of the Stephens Dolomite with other thick late Precambrian dolomite successions (Jane Dolomite, Smithton Dolomite) was suggested by Spry.

Єens - *Quartz sandstone; mudstone with sandstone at lower horizons*

As shown on the map, this unit includes the Needles Quartzite and underlying rocks. The succession beneath the Needles Quartzite was not differentiated, but is given by Spry (see above). At DN557678, outcrops of thin-bedded black mudstone and well-bedded orthoquartzite were observed.

The Needles Quartzite, comprising the upper part of Єens, is an abundantly cross-bedded, texturally and compositionally supermature, fine-to medium-grained orthoquartzite about 500 m in thickness. Cross-bedding is planar, in places herring-bone, with sets 100–150 mm thick. There are minor thin beds of laminated silty sandstone.

In thin section (77/245, 77/401–404), syntaxial overgrowths are well-developed, and grain boundaries are commonly sutured. Where original grain boundaries are visible, they show well-rounded, well-sorted grains, usually 0.2–0.5 mm in diameter, almost entirely monocrystalline and commonly with undulose extinction. Chert grains (*c.* 1%) and rare accessory tourmaline are present. In some samples grain elongation (up to 2:1) defines a cleavage.

The top of the Needles Quartzite is exposed in a creek at DN573673. There is a gradation over 0.5 m into the overlying fine-grained dolomite and black pyritic mudstone.

Ꞓenf – *Fine-grained dolomite and black pyritic mudstone*

This unit is well-exposed in cuttings along the Gordon Road east of Humboldt divide [DN553693]. These exposures consist of leached yellow-brown dolomitic mudstone and yellow-brown to pinkish, very fine-grained dolomite with possible mudcracks on one or two horizons, passing up into red, green and predominantly black shaly micaceous mudstones, occasionally pyritic and with minor thin beds of quartz siltstone and fine-grained dolomite.

Dolomite layers are commonly boudinaged, and the sequence is abundantly folded between DN557682 and DN563690. Bedding planes commonly show slickensides and the rocks are usually well-jointed.

In thin section (77/234, 77/28, 77/31) the dolomites are very finely crystalline (5–30 μm) and slightly impure (fine quartz silt, pyrite and phyllosilicates are present). Weak lamination is defined by slight grain size variation. 77/33 is a coarsely crystalline dolomite with the recrystallised grain boundaries outlined by brownish opaques. Most thin-sections are cut by at least two generations of quartz- and carbonate- present in few samples. In the minor arenaceous rocks, quartz grains are predominantly monocrystalline with only minor chert or polycrystalline grains (c. 1–2%), and display undulose extinction and sutured grain boundaries.

Ꞓend – *Coarse-grained dolomite and mudstone with hackly fracture*

This unit dominantly consists of coarsely-crystalline grey dolomite and mudstone, usually black, with a shaly to hackly fracture. Rare chert beds are present. Leached dolomitic mudstones crop out on the Gordon Road [DN563690]. In the Tyenna River at DN565691, and just east of the map sheet boundary in a roadside quarry at DN591672, this unit includes very fine-grained, impure thin-bedded carbonate and black shale.

Some fine-grained dolomite beds contain rosettes of wedge-shaped sparry carbonate bodies. These are probably pseudomorphs after an evaporite mineral (Calver, in prep.).

Ꞓenc – *Interbedded chert and mudstone*

This unit consists of chert interbedded with thin, wispy mudstone layers. At the base the chert is interbedded with thin dolomite beds. Low-angle lenticularity of beds is common.

Ꞓenm – *Massive mudstone with hackly fracture*

This unit crops out well in cuttings on the Gordon Road. It consists of dominantly massive, uniform, reddish to khaki to greenish-grey mudstone or argillite, with a hackly, less commonly shaly, fracture. In places, thin siltstone laminae are present. Soft-sediment slumping and load casting may be developed, No carbonate rocks were observed but minor puggy (leached dolomitic?) mudstones occur.

Ꞓenq – *Dolomite*

This is a white to pale grey, relatively pure 'clean' fine-grained dolomite cropping out on the south slope of Tim Shea. It is dominantly massive or faintly laminated, but high exposures (e.g. around DN564701) are well-bedded. Here, some beds have a coarser primary texture and are partly silicified, weathering out prominently. These grainstone layers often display trough cross-bedding, with sets 100–200 mm thick. The beds dip steeply north and are right-way-up.

Middle Cambrian

Ꞓmu –TRIAL RIDGE BEDS

A. V. Brown
N. J. Turner

Introduction

The term 'Trial Ridge Beds' was first used by Corbett (1970, 1975) for a succession of sedimentary rock ' ... on Trial Ridge just west of the Denison Range'. He described the succession (1975) as having, ' ... a maximum thickness of at least 500 m, and consists largely of siliceous conglomerate and cross-bedded sandstone in the lower part and of interbedded lithic-quartzwacke and siltstone, with lesser conglomerate, in the upper part. Some of the sandstone beds in the upper part show graded bedding and erosional sole marks, and may be turbidites'.

In the course of mapping the Huntley Sheet the sequence on Trial Ridge was re-mapped in greater detail than previously and rocks in several isolated areas south and north of Trial Ridge were correlated with the sequence.

On Trial Ridge the rocks were subdivided into three members, of which the upper (€mh) and lower (€ml) members are characterised by boldly outcropping conglomerate. An intervening zone contains sparse outcrop of finer grained, less resistant strata, and is designated the middle member (€mm).

Minimum thicknesses for the lower, middle and upper members are 170 m, 300 m and 650 m respectively. The thickness of the middle member is a measure of the original thickness but the value given for the lower member may be less than original, as the lower contact against the ultramafic rocks is probably a faulted contact. The calculated thickness of the upper member is less than the original thickness due to truncation by the unconformably overlying Singing Creek Formation.

NORTHERN TRIAL RIDGE–DENISON GAP AREA

N. J. Turner

€ml - *Lower Member - dominantly granule to cobble conglomerate and sandstone*

On the northern part of Trial Ridge the lower member forms the crest and western flank of the ridge. The member dips and faces to the east, away from the ultramafic rocks on the lower western flank of the ridge. The contact with the ultramafic rocks was not found in outcrop but evidence from elsewhere (AVB) indicates that the ultramafic rocks were emplaced along faults which disrupt the Trial Ridge Beds. Corbett (1975) recorded the presence of crenulated, black, pyritic phyllite or quartz schist adjacent to the unexposed western contact of the beds in Kindling Creek near DN391893 and inferred an unconformity. This contact was not relocated but a sample of crenulated material collected by Corbett is the same as phyllite that occurs in Pg. The phyllite is part of a small body because ultramafic rocks occur downstream in Kindling Creek and no phyllite occurs either in the next creek to the north near DN393896 or to the south on the flank of Trial Ridge near DN387885. The phyllite may be a tectonic lens incorporated with the ultramafic rocks and thus its contact with the Trial Ridge Beds may be a fault. Whatever the precise nature of the contact in Kindling Creek, there is no doubt that the sequences designated €ep, €ecp, Ꝑg, etc. are more highly deformed than the Trial Ridge Beds.

Near the contact in Kindling Creek the lower member consists of well-bedded, moderately sorted conglomerate. Cobble conglomerate with occasional boulders is interbedded with pebble conglomerate, each type forming beds up to about one metre thick. Along the crest of Trial Ridge the beds are stratigraphically higher and finer grained. They mainly comprise coarse sandstone and granule conglomerate which are frequently pebbly. Rare, thin (<100 mm) beds of poorly sorted, medium-grained sandstone occur and are the only rocks in the lower member that contain a significant component of fine-grained material. Moderately sorted, cobbly or pebbly granule conglomerate occurs in scattered beds.

On unweathered surfaces the rocks in the lower member are usually pale green. They have a siliceous cement which appears to bind some beds more strongly than others. Rounding of sand grains and granules is poor but coarser clasts are generally well rounded. Clasts of all sizes comprise quartz and quartzite similar to variably foliated types occurring in Ꝑq and Ꝑqs. The long axes of clasts in conglomerate in the upper part of the member generally exhibit preferred orientation parallel to bedding which may either be plane- or cross-stratified. Large scale cross lamination may occur in coarse sandstone beds.

Well bedded conglomeratic rocks outcrop to the north of Trial Ridge near DN395920 and occur again as rubble around DN400934. A few clasts of carbonate similar to material in Ꝑc were found in the former locality but virtually all clasts in both areas are quartz and quartzite. No contact relationships were established in either area but the rocks are thought to be fault-bounded correlates of probably the lower member of the Trial Ridge Beds or possibly the upper member.

Cmm - *Middle member - lithic sandstone turbidite and fossiliferous siltstone*

On the highest part of Trial Ridge near DN389883 there is sparse rubble and exposure of khaki, fissile, micaceous siltstone which contains agnostid trilobites of Late Middle Cambrian age (J. Jago, pers. comm., see Palaeontology - €mm). Nearby, on the eastern flank of the ridge, there is rubble of red, coarse- and medium-grained poorly sorted wacke. About 0.5 km south near the crest of the ridge there are graded, density-current deposits (K. D. Corbett, pers. comm.). There is very little other exposure in the northern part of the middle member of the Trial Ridge Beds.

€mh - *Upper member - dominantly thickly bedded siliceous granule conglomerate and siliceous sandstone*

The upper member is well-exposed on the eastern slopes of the northern part of Trial Ridge where it comprises mainly moderately sorted, siliceous, granule conglomerate containing negligible silt and clay. Pebbles and cobbles are abundant, causing variations from sparsely pebbly or cobbly, granule conglomerate to pebble or cobble conglomerate. These variations produce a well-bedded sequence in which beds usually range up to about one metre in thickness.

Coarser clasts are generally well-rounded throughout the member but granules and sand are angular. Most clasts consist of quartz and massive to foliated quartzite similar to types in Ꝑq and Ꝑqs. Generally the quartzite is white but pink and grey varieties are present. There may be up to about 10% (by volume) of dolomite clasts that are similar to dolomite in Ꝑc. Rare fragments of indurated metasiltstone (?dolomitic) are present also there are a few fragments of foliated conglomerate similar to €ep.

Cobbles and pebbles are often either completely isolated in a matrix of granules and sand or they may be scattered along particular horizons within a bed of granule conglomerate. Clasts showing the latter pattern of distribution are interpreted as lag remaining after current reworking of the deposits. Current reworking is demonstrated in places by the presence of scours and is also reflected in the commonly lenticular nature of bedding. The long axes of clasts in pebble and cobble conglomerate generally exhibit preferred orientation which may be either parallel to plane bedding or to cross-stratification. Simple, large scale, cross lamination may be present in coarse grained sandstone lenses.

SOUTHERN TRIAL RIDGE–BOYES RIVER VALLEY AREA

A. V. Brown

On the southern end of Trial Ridge the three members have a stratigraphic thickness in excess of 750 m. Due to an actual contact with older successions not being observed, the basal angular unconformity is still only inferred, but with regional structural evidence, the inference has a high probability. The unconformable relationship with the overlying Singing Creek Formation was traced over 5 km to the south of the area recorded by Corbett (1975), and angular discordances of up to 55° [DN402839] were measured.

€ml – *Dominantly thickly-bedded siliceous granule-conglomerate and siliceous sandstone*

The basal member consists of siliceous pebble to cobble conglomerate with occasional boulder size clasts. The clasts are dominantly massive quartz and massive and foliated quartzite, with minor amounts of red mudstone in the lower units. No elongation of the long axis of the clast component was observed. The conglomerate units progressively becomes finer in grain size up through the sequence. The matrix consists of sand grade material. Within conglomerate units lenses of siliceous sandstone and pebbly sandstone occur. Towards the top of the sequence the coarse-grained units are granule to pebble conglomerate with cross-laminations, interbedded with pebbly sandstone.

€mm – *Lithic sandstone turbidite and fossiliferous mudstone*

The middle member of the 'Trial Ridge Beds' consists of thinly and monotonously interbedded light to dark grey sandstone and fossiliferous siltstone. In some siltstone units muscovite is present in distinguishable quantities, in other places the siltstone has a sand-grade component. Most siltstone units contains multiple truncated cross bedding, with some of the interbedded sandstone units having silt-grade basal flame structures.

€mh – *Interbedded lithic conglomerate, lithic sandstone, siliceous sandstone and siltstone*

The upper member consists of an irregularly interbedded sequence of granule to cobble conglomerate, pebbly sandstone, and siltstone (plates 8–10). The majority of the clasts in the sequence are red, grey and white massive quartzite, grey and white foliated quartzite, green-grey foliated phyllite and up to 10% dolomite. The cobbles are up to 240 mm in length. Some conglomerate units have intercalated sandstone lenses (plates 8–9, 11) which are up to 500 mm thick and between 0.5 and 2 m in width. Numerous conglomerate units have a bimodal grain size distribution suggesting reworking and multiple depositional events.

Many of the granule conglomerate units have isolated cobble grade clasts whose long axis is parallel to bedding (plate 10). Sandstone beds usually contain cross-bedding, which, in some units, is truncated by the overlying conglomerate unit. In the parts of the sequence where conglomerate units are interbedded with numerous sandstone units, they range in thickness from 300–500 mm to 1–2 m, and contain infilled scour and channel deposits of sand-grade material. Minor interbedded sandstone and siltstone zones show load casting and flame structures.

DEPOSITIONAL ENVIRONMENT OF THE TRIAL RIDGE BEDS

N. J. Turner

The 170 m thickness (approximate) of the lower member of the Trial Ridge Beds on Trial Ridge is a fining upwards sequence of siliceous, conglomeratic strata in which no evidence of Bouma-type, density-current deposits has been found. Density-current deposits have been reported near the boundary between the lower and middle members of the Trial Ridge Beds (Corbett, pers.comm.) but the 300 m thick middle member outcrops poorly and little direct evidence relating to its depositional environment has been obtained. Fossils indicate marine conditions and the member is almost certainly much finer-grained generally than the upper and lower members.

Plate 8. Interbedded conglomerate and sandstone, Upper Member, Trial Ridge Beds (Єmh).

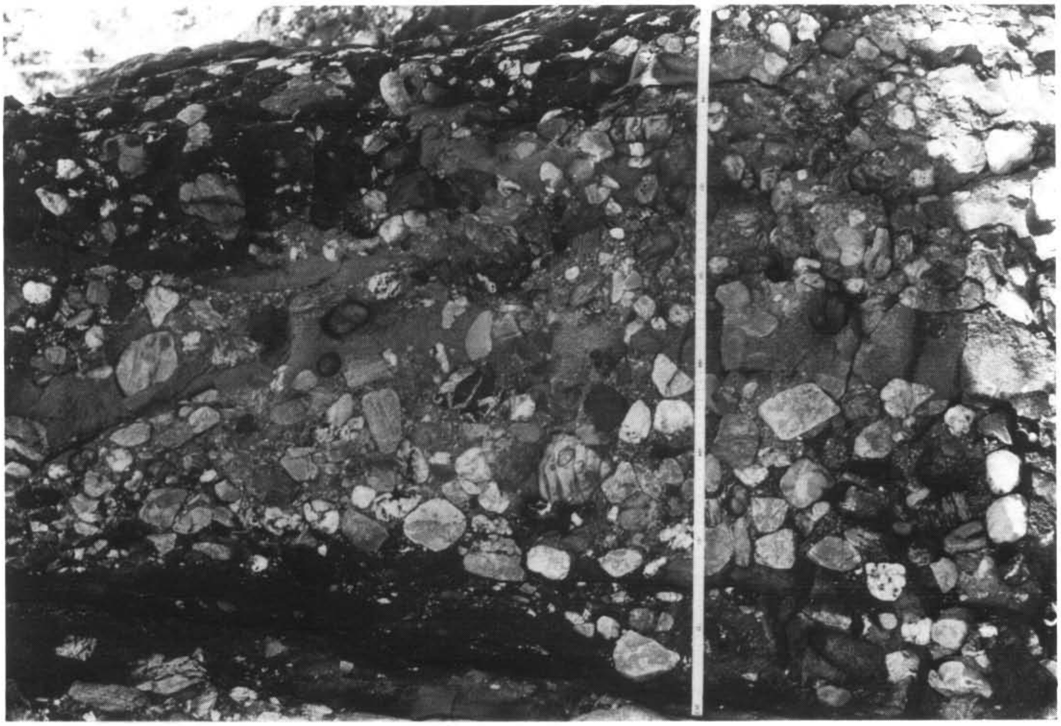


Plate 9. Coarse conglomerate with minor interbedded sandstone, Upper Member, Trial Ridge Beds (Єmh).

5 cm

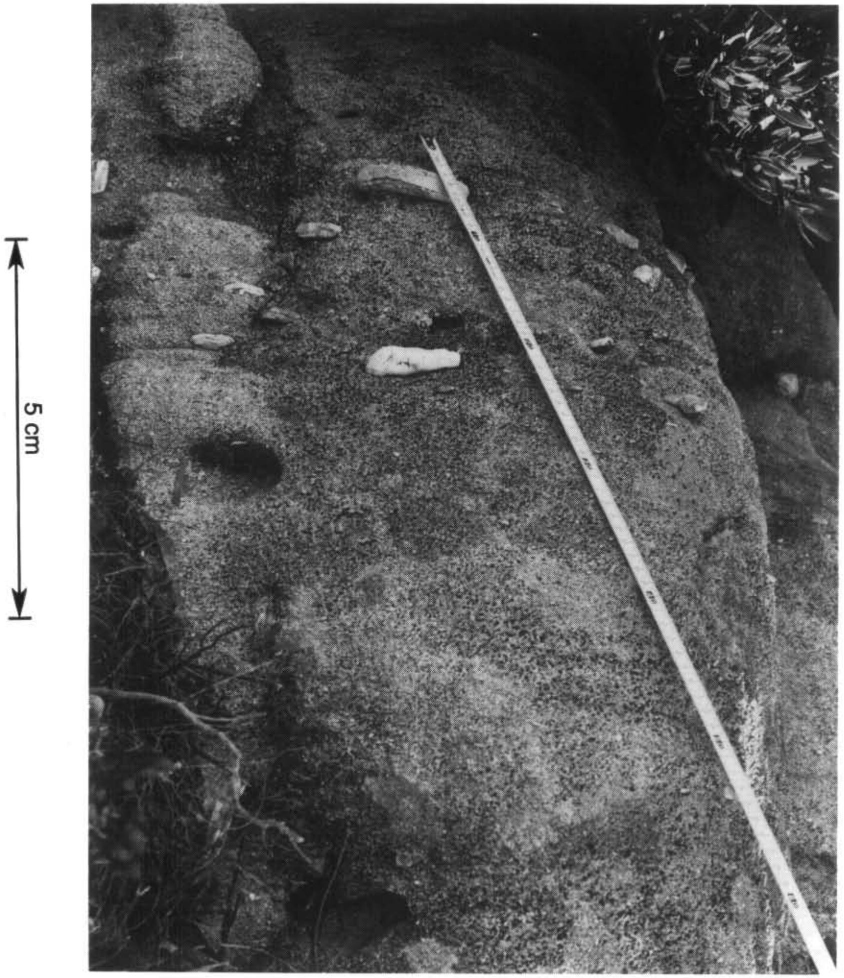


Plate 10. Cobbles aligned parallel to bedding, occurring isolated in granite conglomerate, Upper Member, Trial Ridge Beds (€mh).

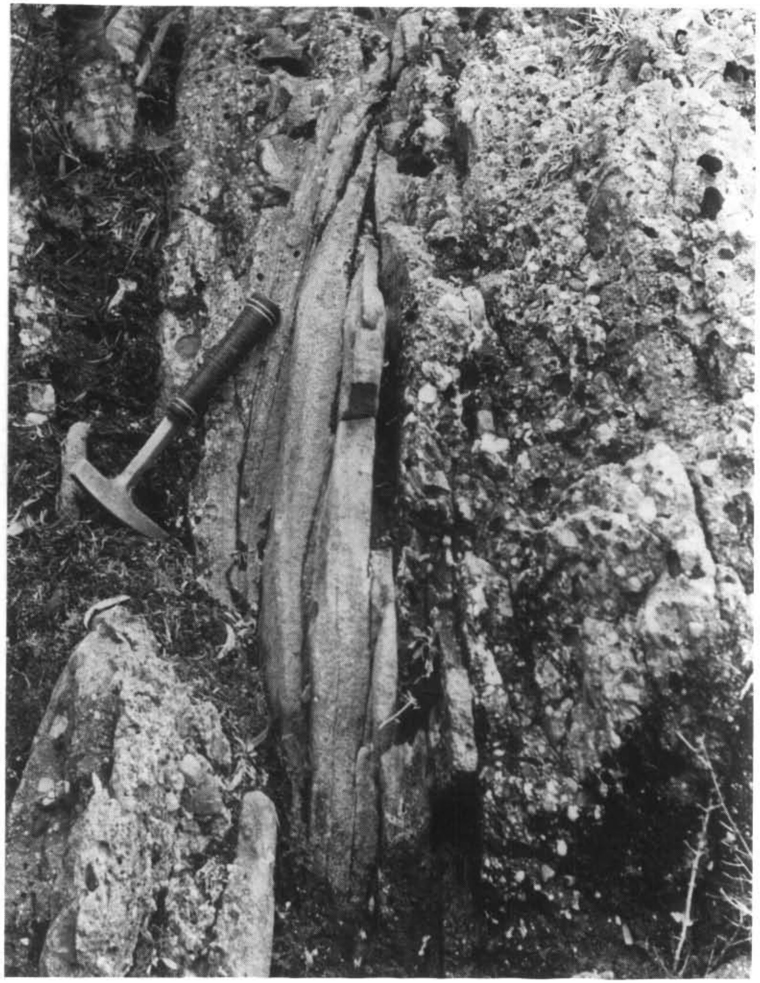


Plate 11. Cross-laminated sandstone lens in conglomerate, Upper Member, (€mh).

Sedimentological features of the well-exposed upper member of the Trial Ridge Beds are much better known. The member is a thick (650 m) accumulation of well-stratified, granule- to cobble-conglomerate (plates 8–9). It differs from the lower member primarily by being much thicker, by showing no substantial change with stratigraphic height and by containing a considerable proportion of dolomitic detritus in addition to the dominant, siliceous detritus. Individual beds and packets of beds are commonly lenticular and may display basal scours. Pebbles and cobbles are often scattered along particular horizons in finer grained rocks (plate 10) and such distributions are interpreted as lag remaining after extensive current reworking (winnowing) of the deposits. Relatively large clasts are frequently totally isolated in finer grained material and this probably implies that there was a variety of mechanisms by which materials were transported, including rolling and saltation.

Cross lamination is usually a feature of the relatively uncommon sand lenses in the upper member (plate 11) whereas both plane- and cross-stratification are features of the conglomeratic rocks. Preferred orientation of clasts parallel to plane- and cross-stratification is ubiquitous and no clear examples were found of imbrication of clasts. A few examples of grading in pebbly, granule conglomerate were recognised but, in general, grading is rare and no Bouma-type units were recognised in the sandstone. No beds of structureless conglomerate of possible debris-flow origin were recognised.

A transgression from proximal alluvial fan conditions to medial submarine fan conditions may be represented by the lower and middle members of the Trial Ridge Beds although the turbiditic character of the middle member is poorly established. A dramatically rapid return to alluvial fan conditions is indicated by the upper member. The small amount of sand and finer material in the upper and lower members is taken to indicate particularly high energy (proximal) conditions whilst the general absence from these members of density flow phenomena is thought to indicate an alluvial fan environment rather than deposition on a submarine fan.

PALAEONTOLOGY (€mm)

During mapping of the Trial Ridge area fossil faunas were found in two locations within the middle lithic sandstone and fossiliferous mudstone (€mm) member of the 'Trial Ridge Beds'.

The southern locality (found at [DN385867] by AVB), yielded a fauna which contained abundant *Ptychagnostus (Goniagnostus)* cf. *nathorsti* an effaced agnostoid, one pygidium of *Clavagnostus*, several cephala of what may be *Tasagnostus*, a few small inarticulate brachiopods, an undetermined polymeroid and trilobite tracks. There is a very high percentage of complete agnostoids in this fauna which has a late Middle Cambrian age of *Lejopyge laevigata* Zone, possibly *L. laevigata* II or III (J. Jago, pers. comm., 1977).

The northern locality (found at [DN389883] by NJT), contains a similar, but more restricted fauna, than the first locality. It contains the same undetermined polymeroid as the southern locality, numerous examples of *Tasagnostus*, an effaced agnostoid species, and *Hypagnostus*, and is the same age as the southern fauna (J. Jago, pers. comm., 1975).

The deformation event which occurred just after the deposition and consolidation of the Middle Cambrian Trial Ridge Beds and correlates, caused underlying ultramafic rocks to be squeezed onto the floor of the basin of deposition, where they then became available for erosion and now appear as units within the fossiliferous Upper Cambrian succession in the Adamsfield area, (Adamsfield Beds, DN455704).

Late Cambrian–?Early Devonian

(Wurawina Supergroup)

INTRODUCTION

Most of the eastern half of the Huntley map sheet is underlain by a folded sequence of conformable strata ranging in age from Late Cambrian to probably Early Devonian. The sequence comprises three major stratigraphic units and their correlates, namely, the Denison Group (Corbett, 1975), Gordon Group (Corbett and Banks, 1974), and Tiger Range Group (Baillie, 1979). The stratigraphic nomenclature of the Denison and Gordon Groups has been revised from the original Subgroup status by (Burrett *et al.*, 1984) and Banks and Williams (1986), propose that the three groups be incorporated into the Wurawina Supergroup.

The change in terminology for the Late Cambrian to ?Early Devonian strata have occurred since the Huntley map was published in 1982. There are therefore discrepancies between nomenclature used in the map legend and the nomenclature used in this report. The revised nomenclature is employed throughout this report.

PREVIOUS STUDIES

P. W. Baillie

Twelvetrees (1908) in his exploration of the route of the proposed Great Western Railway recognised the synclinal structure in the limestone joining the Florentine and Rasselas Valley. He noted the occurrence of what are now known as Parmeener Super-Group rocks, and dolerite, on Wherretts Lookout.

Nye (1929) recognised the major stratigraphic units of the area, but the most important pioneer work is that of Lewis (1940) in which he set up the 'Junee Series' in a study of the geology of the Tyenna Valley.

Palaeontological studies had been undertaken by Etheridge (1904) and Kobayashi (1936, 1940) on Early Ordovician faunas belonging to what is now known as the Florentine Valley Formation.

The problem of the Lower Palaeozoic succession in Tasmania was reviewed and discussed by Thomas (1947). Öpik (1951) briefly mentions the geology and palaeontology of the area. Carey and Banks (1954) described the unconformity at Tim Shea. The present mapped area was mapped on a regional scale by Jennings (1956) and in more detail by Corbett (1963, 1970).

The Junee Series was re-defined by Corbett and Banks (1974) and following discussion (Brown *et al.*, 1975; Corbett and Banks, 1975) the Junee Group was modified into a siliciclastic unit (Denison Subgroup) and an essentially limestone unit (Gordon Subgroup) by Corbett (1975).

Stratigraphic aspects of the Early Ordovician Florentine Valley Mudstone were discussed by Stait and Laurie (1980). Banks and Burrett (1980) erected a preliminary Ordovician biostratigraphy of Tasmania, based largely on the sections described herein. Webby (1979) described the oldest Ordovician stromatoporoids of Australia from the Cashions Creek Limestone, one of the constituent formations of the Gordon Subgroup.

The Late Ordovician to ?Early Devonian siliciclastic sequence overlying the limestone was described by Baillie (1980) and various palaeontological aspects considered by Baillie *et al.* (1978); Sheehan and Baillie (1981); Gell and Baillie (1984).

Od, Ol – DENISON GROUP AND CORRELATES – PREVIOUSLY DENISON SUBGROUP

This group of mainly siliceous sandstone and conglomerate forms the belt of mountains which extends southwards from Denison Range, through Stepped Hills–Mt Wright, Clear Hill–Thumbs, to the Sawback and Ragged Ranges. A correlate of the group crops out on Tim Shea in the south-eastern part of the map sheet. In the following description of the Denison Group and correlates, the various major regions are treated separately.

One of the aims of the Huntley mapping programme was to identify and delineate lithostratigraphic units. The relationship between the lithostratigraphic units and previously established stratigraphic names are given in the discussion of the Denison Range and the Tim Shea–Florentine Valley regions.

Data obtained during the programme has shown that the base of the Denison Group is an angular unconformity with formations lensing out to the south of Denison Range in the Clear Hill–Ragged Range area.

DENISON RANGE AREA

P. W. Baillie
N. J. Turner

The central part of Denison Range from Diamond Lake to Poinya Tarn has been mapped (Corbett, 1970) in considerably greater detail than was attempted in the Huntley programme and is the type area of the Denison Group (Denison Subgroup of Corbett, 1975). Four formations were distinguished within the Denison Group, namely, the Singing Creek Formation (base), Great Dome Sandstone, Reeds Conglomerate and Squirrel Creek Formation. Re-mapping of the central part of the Denison Range has delineated boundaries in much the same positions as the previous mapping (see fig. 1 of Corbett, 1975). Two additional lithostratigraphic subdivisions have been made but no modification of the existing stratigraphic nomenclature is proposed.

Ols – *Siliceous turbidite quartzwacke, calcareous sandstone and siltstone;* Olsb – *Basal siliceous conglomerate – Singing Creek Formation*

N. J. Turner

The Singing Creek Formation 'comprises some 720 m of interbedded quartzwacke sandstone, laminated micaceous siltstone, siliceous conglomerate and slump sheets. The base is the unconformity on the Trial Ridge Beds, and the top is a conformable gradation into Great Dome sandstone exposed at Staircase Rocks' (Corbett, 1975, p. 114) near DN401891.

In the course of mapping Huntley sheet the basal part of the formation was locally distinguished as a mappable unit (Olsb). It contrasts with the upper part by having hard, siliceous cement and a generally pink colour also there is an absence of slump features. The lowermost part of Olsb generally comprises moderately sorted pebble to boulder conglomerate a few metres thick in which the clasts are rounded to angular and show good alignment parallel to bedding. Thin lenses of red, moderately sorted, fissile, micaceous sandstone may be present in the conglomerate. The upper part of Olsb consists of thinly bedded, moderately sorted, siliceous sandstone in which small angular pebbles are common. Clasts throughout Olsb consist of quartz and quartzite similar to types occurring in Ꝑq and Ꝑqs.

The main part of the Singing Creek Formation consists of interbedded, medium-grained, light grey, poorly sorted, siliceous sandstone and fine-grained, dark grey to olive micaceous sandstone and siltstone.

Fossiliferous siltstone and fine sandstone occur widely. Just above the top of Olsb near DN394889 a brachiopod *(Billingsella)* of probably Late Cambrian age is present and between Flagstone Knoll and the upper contact of the formation there are several horizons containing fossils which include *Proceratopyge* of Late Cambrian age (J. Jago, pers.comm., see Palaeontology Section). Other lithologies in the formation include distinctive white-weathering flaggy, coarse-grained, quartz arenite which forms a prominent band at Flagstone Knoll. Rocks outcropping around DN406939 near Denison Gap comprise sandy and silty, siliceous, clastic carbonate (limestone and ?dolomite). They are correlated with the Singing Creek Formation on the basis that they represent an along-strike extension of the beds on the western slope of Denison Range.

Open-cast slump structures are a feature of the main part of the Singing Creek Formation (Corbett, 1973) and are well exposed west of Flagstone Knoll. Thicknesses of up to about one metre of beds show deformation ranging from gentle to extreme. Such intervals are underlain at décollements by relatively undeformed beds and they are overlain at erosional (channelled) interfaces by undeformed beds. Within the deformed intervals beds of light grey quartzwacke act as competent units within a matrix formed by dark grey, micaceous siltstones and fine-grained sandstones. The quartzwacke beds form folds ranging from open, disharmonic, asymmetrical types with little thinning in their limbs to isoclinal types in which the cores have been pinched off and float free in the matrix. A second type of material that is probably also slumped consists of fine sandstone and siltstone similar to those associated with the quartzwacke but containing a few per cent by volume of pebbles. The fissility in these units is typically contorted which contrasts with the bedding-parallel fissility in plane bedded rocks. The units were probably produced by mixing during slumping of the fine sediments with pebbles derived originally from discrete pebble bands.

Corbett (1970) has interpreted the Singing Creek Formation as a submarine fan complex partly made up of channel deposits. He found current directions indicating a provenance to the north-west which is consistent with the abundance of detritus that is similar to Precambrian lithologies such as Ꝑq, Ꝑqs, etc.

Odl - *Lower marine shallow-water quartz sandstone);* Ods - *Siliceous sandstone, pebbly sandstone and conglomerate - Great Dome Sandstone*

N. J. Turner

Corbett (1975, p. 115–117) reports that the Great Dome Sandstone comprises some 510 m of grey quartzose sandstone, conglomeratic sandstone, fine-grained conglomerate and micaceous siltstone exposed on the west flank of the Denison Range between Staircase Rocks and Reeds Peak. The lower part of the formation shows a characteristic alternation of white, coarse sandstone units up to 6 m thick and thin bedded siltstone units up to 15 m thick. Large scale trough cross-bedding and channelled bases are typical of the sandstone. Rare gastropods (including ?*Kobayashiella*) and small articulate brachiopods occur at some horizons in the formation and may indicate a Late Cambrian age. Worm casts are abundant in many sandstone beds.

North of Great Dome the upper part of the formation is distinguished as a separate lithostratigraphic unit (Ods) on Huntley map. It consists of interbedded quartz sandstone, pebbly sandstone and pebble conglomerate containing quartz and quartzite (Ꝑq, Ꝑqs) clasts. Much of the unit is pink and north of Bonds Craig its western or basal boundary corresponds to a concordant change from pale grey rocks of the lower Great Dome Sandstone to pink rocks. At DN405914 there is a very thin (50 mm) transitional interval in which pink and white sandstone are interlaminated.

The upper boundary of the formation with the Reeds Conglomerate (Odc) is marked by a sudden increase in the proportion of conglomerate in the sequence such that it becomes dominant. There is also an increase in bed thickness and in the size of clasts in the conglomerate.

Corbett (1970) regarded the lower part of the Great Dome Sandstone as a tidally-influenced delta-platform deposit. He interpreted the upper part as a delta floodplain deposit with minor marine influence.

Odc, Ods - *Reeds Conglomerate*

P. W. Baillie

The formation was defined by Corbett and Banks (1974) as 'the formation of quartzose conglomerate and conglomeratic sandstone, usually red to purplish in colour, occurring on the crest and eastern slopes of the Denison Range'.

Corbett (1975) recognised an 'Upper Sandstone Member . . . along the lower eastern slopes of the (Denison) range . . . a sequence of grey to pale pink quartzose sandstone, granule conglomerate and pebble conglomerate . . . '. In general, massive conglomerate (Reeds Conglomerate *sensu stricto*) is shown on the map as Odc and sandstones, pebbly or conglomeratic sandstones etc. (including the Upper Sandstone Member) as Ods.

In the area immediately to the south of Denison Gap [DN417932] the massive conglomerate (Odc) is dominantly pebble or cobble grade, although some boulder conglomerates are present, and occur in beds of less than one metre to several metres in thickness. Occasional beds of sandstone and conglomeratic sandstone may be present. The conglomerate is generally structureless although sometimes the clasts have an imbricate fabric.

Near Lake Rhona [DN420880] the massive conglomerate facies consists of massive coarse pebble or cobble conglomerate with rare cross-bedded sandstone lenses. The rock has an overall reddish colour and the generally well-rounded clasts are composed of quartzite, vein quartz and foliated quartzite. Clast sphericity is dependent on structure, i.e. foliated quartzite generally is low sphericity; massive quartzite usually has high sphericity. Beds are up to several metres in thickness.

The massive conglomerate is similar in the vicinity of the Thumbs [DN469750]. To the south, on the Packers Spur [DN477715] the conglomerate dramatically lenses out along a strike distance of approximately 2 km.

At the northern end of the Saw Back Range [DN466675] Odc is dominantly grey coloured and consists of thick-bedded, massive cobble and boulder conglomerate.

In the above areas the massive conglomerate (Odc) is overlain by sandstone, pebbly or conglomerate sandstone and minor conglomerate (Ods). The upwards change from Odc to Ods is generally gradational over about 6 m stratigraphically in that the conglomerate rapidly becomes finer and thinner-bedded and sandstone becomes more abundant.

The change however was readily mappable, from the top of the sheet near Denison Group [DN417938], to the southern edge of the sheet near Stacey Lookout in the Saw Back Range [DN468679]. With the exception of the Saw Back Range the stratigraphic boundary is marked by a colour change from pink/red (Odc) to white/grey (Ods).

In the northern part of the Denison Range [DN423937] Ods (which is equivalent to the Upper Sandstone Member of the Reeds Conglomerate) is a highly variable sequence of interbedded usually pebbly very-coarse sandstone to granule conglomerate, conglomeratic sandstone and pebble to cobble conglomerate. The sandstones are very often cross-bedded in either trough or planar-tabular style. Using the classification of Miall (1978) lithofacies present include Gm, Gt, St, Sp (massive or crudely bedded gravel with horizontal bedding or imbrication; gravel sratified with trough crossbeds; sand, medium to very coarse, may be pebbly, with solitary or grouped trough crossbeds; sand, medium to very coarse, may be pebbly, with solitary or grouped planar crossbeds).

These lithofacies represent fluvial deposition in longitudinal bars, linguoid bars and minor channel fills for the coarser deposits and from sand dunes or sand waves for the sandier beds (Miall 1978, 1981). The overall pattern suggests that deposition was in a 'Donjek type' low-sinuosity environment (Miall, 1981), i.e. deposition under the following conditions: (1) braided rivers with well-defined, active channels; (2) bed load consisting of abundant sand and gravel.

Clast composition is the same as that in Odc, i.e. quartzite, vein quartz, foliated quartzite. These rock are typical of the Precambrian rocks which crop out to the west.

Palaeocurrents from the north Denison Range area, determined in Odc and Ods combined, indicate that the sediments were deposited from east-flowing currents (Corbett, 1970).

In the other areas where it was mapped Ods was similar to the north Denison Range sequence.

Odh, Odf – *Squirrel Creek Formation*

P. W. Baillie

The change from pebbly rocks (Ods) to well-sorted, flaggy, bioturbated, fine-grained quartz sandstone (Odh) is quite sharp, and occurs within a stratigraphic thickness of less than one metre. In all cases observed the first appearance of bioturbated sandstone marked the disappearance of pebbles. The sandstone is about 150 m in thickness (Corbett, 1975) and often contains flat, planispiral gastropods with a maximum diameter of 400 mm. This unit is the lower sandstone member of the Squirrel Creek Formation of Corbett, 1975. The sequence shown as Odf on the lower eastern slopes of the Denison Range, extending from DN426924 to DN425938, should have been shown as Odh.

The bioturbated sandstone is overlain by siltstone, sometimes with ovoid nodules of fine-grained carbonate, with minor interbedded green-brown very-fine sandstone (Odf). The sequence is about 150 m thick and is a lithostratigraphic and biostratigraphic correlate of the Florentine Valley Formation (Mt Field Siltstone Member) at the Gap [DN578707] in the Florentine Valley (Corbett, 1975).

A characteristic sandstone unit overlies the above sequence and was considered sufficiently diagnostic to be indicated separately on the map (Odfs). The unit consists of well-sorted, brown/green (weathers to white), cross-bedded medium- to coarse-grained quartz sandstone. The most characteristic feature is the cross-bedding, which consists of stacks of cross-bedded troughs 300–500 mm across (pi cross-stratification of Allen, 1963). This rock unit has prominent positive topographic expression and forms Timbs Ridge [DN431935]. Although not depicted on the map the unit also crops out in Squirrel Creek [DN429943] where it consists of cross-bedded, medium- to coarse-grained greenish quartz sandstone. The greenish colour, both at this locality, and on Timbs Ridge is due to the presence of glauconite. Correlates of the Florentine Valley Formation are present in Reeds Creek [DN447842] where they are faulted against pebbly quartzose sandstone (Ods). Stratigraphic relationships are obscured by folding in the area but the dominant lithologies are interbedded grey micaceous siltstone, grey impure modular limestone and very fine sandstone. Siltstone often has a characteristic 'holey' appearance, presumably where carbonate nodules have been dissolved out.

Interbedded bioturbated sandstone, flat-bedded fine-grained sandstone and grey siltstone crops out at DN444841 and is overlain by grey micaceous siltstone containing abundant planispiral gastropods up to 300 mm in diameter. It is possible that this is Odh (correlate of the lower sandstone member of the Squirrel Creek Formation) passing upwards into Odf (correlate of the siltstone-limestone member of the Squirrel Creek Formation), but structural complications and overall poor outcrop do not allow the rocks to be differentiated with complete certainty.

SAW BACK RANGE

A very similar sequence was mapped at the southern edge of the sheet, on the eastern side of the Saw Back Range [DN470670].

South of the Adamsfield Track pebbly sandstone (Ods) is overlain by thin-bedded, flaggy, well-sorted, bioturbated quartz sandstone which often contains flat, planispiral gastropods (Odh). North of this point the unit appears to be absent and the pebbly sandstone is directly overlain by siltstone with interbedded fine- to very-fine sandstone. The bioturbated sandstone also appears to thin in a southerly direction; from about 125 m [DN472693] to about 25 m [DN470680] near the southern edge of the map sheet.

Some 600 m east of Staceys Lookout [DN472669] is a low strike ridge comprised of well-laminated, cross-bedded fine- to very-fine quartz sandstone or quartzite that is similar in stratigraphic position and sedimentary aspects to the rock of Timbs Ridge in the north Rasselas Valley [DN431935].

STEPPED HILLS - MT WRIGHT - CLEAR HILL AREA

A. V. Brown

Ol/Od - *Fossiliferous Upper Cambrian - Lower Ordovician successions (Denison Subgroup and correlates)*

Along Clear Hill, Stepped Hills, Mt Wright and the southern end of the Denison Range, the Denison Subgroup correlates consist of six mappable units, one of which , Ods, does not always occur in the stratigraphic position found in the type area.

Ol - Fossiliferous calcareous sandstone and mudstone (Singing Creek Formation correlate)

Odl - Lower marine shallow-water quartz sandstone (Great Dome sandstone correlate)

Odc - Terrestrial and shallow-water thickly bedded siliceous cobble conglomerate (correlate of the coarse conglomerate part of the Reeds Conglomerate)

Ods - Siliceous sandstone, pebbly sandstone and conglomerate (upper sandstone member of the Reeds Conglomerate)

Odh - Upper marine shallow-water quartz sandstone (does not occur in the type area)

Odf - Fossiliferous calcareous sandstone, mudstone with occasional chert beds (correlate of the Florentine Valley Mudstone (Banks, 1962*b*); lower part of the Florentine Valley Formation (Corbett and Banks (1974); correlate of the Squirrel Creek Formation (Corbett, 1975).

Ol - *Fossiliferous, dominantly calcareous sandstone and mudstone with minor conglomerate, limestone, siliceous quartzite etc.*

[Note:- Ola, Ols, Olsb, Olt, symbols were left off the map inadvertently but localities are listed on the map]

Along the southern part of the Denison Range, in the upper part of the Boyes River, the extension of the Singing Creek Formation continues to unconformably overly the 'Trial Ridge Beds'. Further to the south, along the western slope of Stepped Hills, the correlate of the Singing Creek Formation is virtually completely covered by Tertiary scree and talus deposits. Along the western slope of Clear Hill the sequence is far thinner than in the type area, unconformable overlies the Eocambrian chert, sandstone mudstone sequence (€la), and lenses out around DN402736.

Where ever the angular unconformity at the base of this member was observed the lowermost units were conglomeratic. The nature of the conglomerate varies from a fine chert clast conglomerate with minor red and green mudstone clasts, along the northern slopes of Clear Hill, to very coarse, cobble to boulder, siliceous conglomerate, in the upper reaches of the Boyes River.

The thin succession along the western slope of Clear Hill grades upwards from the a basal conglomeratic zone, into interbedded sandy limestone-calcareous sandstone, sandstone, siltstone and mudstone units. The sequence gradationally becomes thicker, coarser, and more siliceous in a northerly direction, along the western slope of Stepped Hills up to the western slope of the Denison Range.

Fossils have so far been obtained from sandy limestone beds (along with pyrite nodules), calcareous sandstone beds and mudstone beds, in two localities along the western faces of Clear Hill [DN401739, DN403773]; and Stepped Hills [DN404795, DN401805]; and from a east-west section along the spur from Great Dome, due west through Flagstone Knoll, towards Trial Ridge.

On the southern end of the Denison Range the section exposed in a tributary creek to the east of the Boyes River between DN413832 and DN419838, contains a basal zone consisting of siliceous pebble to granule conglomerate; pink and white siliceous pebbly sandstone; siliceous sandstone with cross-bedding and minor siltstone. Progressing up through the sequence the coarser grained beds decrease and the sequence alternates between different proportions of interbedded siltstone (150–300 mm thick zones), minor pebbly granule conglomerate (300–900 mm thick zones) and siliceous sandstone (100–150 mm). Sandstone units have basal sedimentary structures with load enhanced siltstone flames.

In the upper reaches of the Boyes River, between DN395854 and DN392870, the basal conglomerate is a cobble to boulder grade and the overall sequence is more siliceous than to the south. The larger clasts are composed of massive and foliated quartzite, the largest measured had b-c axes of 260 and 300 mm respectively. The matrix is of a medium to coarse sand grade and has a mixed siliceous and labile component composition. In some conglomerate units there is a very strong sedimentary alignment of the long axes of the pebble and cobble grade clasts. Overall the basal conglomerate units are massive, some containing lenses of sandstone or lithicwacke. In the pebbly sandstone units cross-bedding is common and zones of thinly bedded (5–50 mm) friable and siliceous sandstone interbeds occur higher in the sequence.

Siltstone is the dominant rock type throughout the succession, with the coarser units ranging in thickness and proportion throughout. The shallow-water nature of the succession and the deepening of the basin to the north is also evident throughout. Apart from an uniform dip to the east, this rock sequence exhibits very little evidence of tectonic deformation, as there is no obvious minor or small scale folding and no cleavage was noted in the field.

Palaeontology of the Upper Cambrian fossiliferous succession (Ol)

During mapping of the Huntley sheet, six new fossil locations were found within correlates of the Singing Creek Formation in the Clear Hill, Stepped Hills and Adamsfield areas.

The southernmost fauna on Clear Hill [DN401739], is dominated by the brachiopod *Billingsella*. Other fossils present include the trilobite *Prochuangia*. A second locality [DN403773], contains the brachiopod *Eoorthis*(?) plus the trilobites *Prochuangia* and *Toxotis*(?); the greater abundance of articulate brachiopods in the southern locality suggests that it is of slightly shallower water origin than the northern fauna (J. B. Jago, pers. comm. 1977).

The shallower water indication is in keeping with the stratigraphic evidence, as the first locality occurs just before the sequence lenses out against the underlying succession (€la). As the Denison Subgroup correlate is followed along the Clear Hill–Ragged Range area, the basal units change as sequences thin and lense out, indicating that the basal angular unconformity had a continuous onlap relationship with the palaeo-basin floor. The deepest part of the palaeo-basin, with the thickest sections of each formation of the Subgroup, is in the central Denison Range area around Flagstone Knoll, the type area of the Singing Creek Formation, as well as the Great Dome Sandstone and Reeds Conglomerate (J. B. Jago, pers. comm.).

The two faunas along Stepped Hills are poorly preserved. The southernmost fauna [DN404795], contains a high percentage of complete agnostoid specimens as well as a dendroid, indicating very quiet water deposition. Due to the poor preservation it was not possible to identify the various agnostoids. There is also at least one polymeroid trilobite, a member of the Ceratopygidae, and one inarticulate brachiopod, possibly *Lingulella*. The second fauna along Stepped Hills [DN401805], only contains an acrotretid brachiopod and 1977) but due to all the other faunas in this sequence being Idamean in age, the former age is now not considered likely. By comparison with the faunas from Flagstaff Knoll, noted below, the Stepped Hills faunas are presumably of Idamean age.

When compared with the faunas found at Flagstaff Knoll, (Corbett, 1975; Jago, in prep.; pers. comm., 1986), those along the western slopes of Clear Hill and Stepped Hills are similar, but have shallower water affinity. The faunas at Flagstone Knoll occur in three separate stratigraphic levels. The brachiopods are listed in Corbett (1975) and the trilobites are described by Jago (in prep.; pers. comm., 1986).

The lowest fauna was collected from between 185 and 240 m above the base of the succession and have been described by Jago (in prep.; pers. comm.) as contains the trilobites: *Micragnostus, Pseudagnostus idalis, Eugonocare, Proceratopyge*, and a dokimocephalid, and the brachiopods: *Lingulella(?), Billingsella*, and an acrotretid. The middle fauna was collected between 410 and 430 m above the base and contains a new genus and species of agnostoids: *Aphelaspis, Proceratopyge, Pseudoyuepingia* and trilobite tracks. Brachiopods present include

Lingulella(?) and *Obolus(?)*. The top fauna was collected between 540 and 610 m above the base and contains the trilobites: *Micragnostus, Pseudagnostus idalis, Aphelaspis, Proceratopyge*, the same new genus of agnostoids as in the middle fauna, a leiostegiacean and other varieties. The brachiopods include: *Billingsella, Obolus(?)*, and an acrotretid.

All these faunas, as well as those along Clear Hill and Stepped Hills, are now considered to be of Idamean age (J. Jago, pers. comm., 1986), and to fall within the range of the top three Idamean zones, i.e. the *Proceratopyge cryptica, Erixanium sentum* and *Stigmatoa diloma* Zones.

At Adamsfield, the southernmost of three new faunas [DN470700], was found approximately 500 m north of the fauna found near the old mine workings (Öpik in Banks, 1962*b*). The new fauna contains at least three poorly preserved polymeroid trilobite species including *cf. Dunderbergia*, as well as *Eoorthis* and *Billingsella* (J. Jago, pers comm, 1977). The original fauna was described by Öpik (1951; and in Banks, 1962*b*), who stated that the fauna contained, among other specimens, *Eoorthis, Billingsella* and a new genus of nepeid trilobite, and that the sequence was Upper Dresbachian to Lower Franconian in Age (i.e. Idamean to post-Idamean).

The second fauna, obtained 500 m north of the new location at DN369705, only contained deformed specimens of *Billingsella*. The third locality, a further 1150 m north, [DN368716], contains a poorly preserved fauna which includes *Pseudagnostus* and one other agnostoid; polymeroid trilobites including *Pagodia(?)*, an aphelaspid, and a possible asaphiscid (J. Jago, pers. comm, 1977). The age indicated by all faunas in the Adamsfield area is Idamean, and is consistent with that obtained in the Clear Hill-Denison Range area.

Transition between Ol *and* Odl

The transition between the dominantly fossiliferous siltstone succession, Ol (Singing Creek Formation and correlates), and the lower marine shallow-water quartz sandstone, Odl (lower part of the Great Dome Sandstone and correlates), is fairly sharp. The dominantly grey siltstone of the underlying succession being replaced by greyish white, friable and siliceous sandstone (20–150 mm thick) with thin (1–2 mm) silvery green siltstone or mudstone partings, over an interval of approximately 10 m on the southern end of the Denison Range, and 3 m on Clear Hill.

Odl – *Lower marine shallow-water sandstone*

To the south, along Stepped Hills and Clear Hill this succession is composed of white and pink sandstone, green muscovitic siltstone and mudstone, pebbly sandstone and fine conglomerate units. The sandstone beds range from 50 mm to 60 mm in thickness whilst the mudstone units range in thickness from 10–20 mm to 150–200 mm. Pebbly sandstone and fine conglomerate beds occur up to 300mm in thickness. Progressing up through the sequence the frequency and thickness of sandstone and shale beds varies considerably but the pebbly bands within the sandstone and conglomerate beds retain an approximately uniform thickness throughout.

Sandstone beds are commonly graded, contain ripple marks and mudstone pellets, exhibit cross-bedding, and minor undulations of the bedding with an amplitude of 300 to 500 mm and wavelength of 3 m, the direction of the wavelength being along strike. The sandstone units are usually separated by thin green muscovitic parting surfaces (<1 mm). Clasts in the pebbly sandstone are usually rounded white quartz, being angular to subangular and up to 10 mm long. Towards the base of this member the conglomerate beds have angular chert clasts whereas higher up in the sequence quartz clasts are the norm. Only one to two beds have been observed with a quartz-chert clast mix.

Worm casts and gastropods are common in the middle and upper portions, especially along a ridge which protrudes from the northwest face of Clear Hill. Along the southwest face of Clear Hill, where this member unconformably overlies the Eocambrian chert-sandstone-mudstone sequence, no worm casts or gastropods were observed, but further south along Ragged Range one fossil fauna was recovered (N.J.T.).

Contact between Odl *and* Odc

Along the south western slope of Clear Hill the road gives a section through the contact which is gradational but sharp. In one part of this section [DN405736] a distance of only 3 m elapses from the occurrence of the first clast in the top sandstone bed, to the first full bed of coarse conglomerate.

Odc – *Terrestrial and shallow-water thickly bedded siliceous cobble conglomerate (correlate of part of the Reeds Conglomerate)*

Along the southern end of the Denison Range, south of Diamond lake [DN413862], Odc consists of interbedded granule to fine pebble conglomerate with up to 1m thick interbedded sandstone units with cross-bedding. The sandstone occurs both as individual beds between conglomerate units and lenses down to 50 mm wide. Minor pebbly micaceous, pink and white sandstone units, with multiple truncated crossbedding also occurs in the sequence.

On the northern end of Stepped Hills Odc is covered by Tertiary scree deposits (Qqsc).

Further south along this area, where the Odc sequence crops out, it is only 50–60 m thick, and consists of dominantly pebble conglomerate with minor fine cobble conglomerate interbedded with thin cross-bedded pink sandstone units. Clasts in the conglomerate are of white and pink quartzite and foliated quartzite and have a matrix of siliceous coarse sand-grade material.

Although the sequence thickens to the south, it is still of an overall pebble to fine conglomerate grade, the coarse cobble to boulder beds found on the Denison Range, to the north, and Clear Hill, to the south, are missing. Within the pebble conglomerate pink sandstone lenses, up to 2 m, contain multiple truncated crossbedding, and scour channels are infilled by laminated pink and purple siliceous sand-grade material. The clasts are mainly white, cream or minor grey quartzite, they are mostly well rounded, but tabular clasts are common. Interbedded pebble and granule sandstone beds are up to 3 m thick.

On Clear Hill there is a large variation in the grain size of the conglomerate units. In the lower 20 or so metres of this succession clasts range in size and density every 'few feet'. Continuing up sequence the next 60–70 m consists of coarse cobble to boulder grade conglomerate, and then the sequence alternates, with a gradually fining, every 20–30m, over the next 150 m up to the summit, between zones of pebble to fine cobble clasts and coarse cobble to boulder grade clasts. Interbedded with the conglomerate units are cross-bedded sandstone and fine pebbly sandstone lenses. These are up to 50 m wide and a metre thick. The sand-grade material within these lenses is similar in grain size and texture to the matrix of the surrounding conglomerate.

Clasts consist of pink, white or grey Precambrian quartzite, both foliated and massive; white quartz and siliceous phyllite. No chert clasts were observed. All the clasts have a good alignment, usually the long axis being parallel to sub-parallel with bedding. Most of the conglomerate consists of thick beds with clasts of 100–150 mm. The coarse conglomerate consists of beds, of up to 500 mm, thick containing 20–30 mm clasts. At the summit of Clear Hill the average size of clasts is 30–50 mm.

Contact between Odc *and* Odh–Ods

In the description of the Reeds Conglomerate, Corbett (1975) included an Upper Sandstone Member; ' ... a sequence of grey to pale pink quartzose sandstone, granule conglomerate and pebble conglomerate ... ', which is transitional with the underlying coarse conglomerate along the lower eastern slope of the Denison Range to the east of Hanging lake. This sequence is missing along Stepped Hills and Clear Hill, here the coarse conglomerate (Odc) is rapidly gradational to an upper, fossiliferous, friable and siliceous, shallow-water quartz sandstone sequence (Odh).

To the south of the Denison Range, areas of Ods (interbedded quartz sandstone, granule and pebble conglomerate), were found to occur as zones within the coarse conglomerate (Odc) (e.g. DN413750), forming a thick sequence on Mt Wright [DN454808], as well as conformably following the coarse conglomerate on the southern end of the Denison Range. On the northern and southern ends of Mt Wright, Ods passes transitionally upwards into Odh, indicating lensing of sequences within the Denison Subgroup, disconformities, and the presence of sequences, not present in the type area, in the southern extension of the Subgroup.

Contact between Odc and Odh – *Stepped Hills and Clear Hill area*

The contact between these two successions appears to be gradational between the topmost conglomerate unit and the first the friable white bioturbated sandstone. The transition distance is variable, but was observed to be as sharp as one metre,in some areas, up to 10 m in other areas. The intervening part of the sequence consisted of pebbly sandstone and sandstone beds with hand specimen features similar to that of the conglomerate matrix, but it was too thin to map as a separate sequence.

Odh – *Upper marine shallow-water quartz sandstone*

This sequence is dominated by pink and white friable and siliceous sandstone with minor pebbly sandstone. In the friable sandstone beds worm casts and gastropod imprints are common, with worm casts both covering bedding surfaces as well as going vertically through the sandstone beds.

The pink and white colouration occurs both in separate beds as well as in cross-bedded channel infillings within beds. Both planar and multiply truncated cross-bedded sandstone units, up to 500 mm thick, occur, as well as planar units with channels and lenses of cross-bedded sandstone.

Contact between Ods *and* Odf – *Stepped Hills–Clear Hill area*

As with transition between other sequences in this succession, the transition from the clean quartzose sandstones into calcareous and muddy sandstone, siltstone and limestone is relatively sharp.

Odf – *Fossiliferous calcareous sandstone, siltstone, mudstone and limestone (Florentine Valley Mudstone)*

On the northern end of Stepped Hills, the area of Odf around [DN430825], contains a sequence of grey bioturbated micaceous silty mudstone, grey siliceous sandstone with worm and gastropod casts, calcareous silty sandstone, highly fossiliferous (gastropods) silty sandstone, and glauconitic silty sandstone. Bedding is irregular and lensoidal and varies from 2-3 mm to 20-30 mm in thickness.

On the south-eastern end of Clear Hill, to the north of Adams Falls [DN424700], the sequence consists of interbedded, fossiliferous, limestone, sandy limestone, mud-pellet limestone, glauconitic and calcareous sandstone and finely laminated grey siltstone. In some places (e.g. over 20 m north of the Adams Falls bridge on the Clear Hill Road), the sandstone is interbedded with calcareous sandstone and mudstone beds which contain minor sulphide mineralisation (calcareous sandstone) and fossils (mudstone). The fossils are of Lower Ordovician age (pers. comm., M. J. Clarke, 1973).

RAGGED RANGE AREA

N. J. Turner

From Clear Hill to Adams Falls the Denison Group thins very substantially. South of Adams Falls along Ragged Range it thickens again but not very greatly. No lithological correlate of the Singing Creek Formation is present on Ragged Range and the sequence commences with rocks that have been classed as siliceous sandstone, pebbly sandstone and conglomerate (Ods). This unit is overlain by cobbly conglomerate, fine conglomerate and sandstone (Odc, Odh) and thence by argillaceous rocks (Odf).

The basal Ods unit rests with angular unconformity on a chert-bearing sequence (€leu/€leuc) of Cambrian or older age. Where the unconformity is exposed near the southern edge of the map at DN436668 the lowermost 0.5-1 m of Ods comprises moderately sorted conglomerate containing rounded pebbles and cobbles of quartz and quartzite similar to Pq and Pqs, also angular boulders of chert similar to €leuc. This conglomerate is overlain by fine conglomerate interbedded with pebbly sandstone and sandstone. Chert is a prominent clastic constituent in the lowermost few metres of beds but quartz and quartzite quickly become predominant. Sandstone makes up an increasing proportion of the sequence with increasing height above the basal contact and south of DN436668 in Pedder Quadrangle the sequence contains quartz sandstone with only basal conglomerate. It is therefore classed as Odl whereas the more conglomeratic sequence north of DN436668 in Huntley quadrangle is classed as Ods. Sandstone and conglomerate low in the unit are white or pale grey whereas sandstone higher in the unit may be pink. Interbeds of dark-coloured, fine-grained, micaceous sandstone and siltstone are present and at DN425685 the brachiopod *Billingsella* (M. J. Clarke, pers.comm.) of ?Late Cambrian age occurs in fine sandstone. Correlation of the lower lithostratigraphic subdivision of the Denison Group on Ragged Range with Corbett's (1975) stratigraphic subdivisions on Denison Range is indirect. The lower part of the Great Dome Sandstone on Denison Range with its well-bedded, cross-bedded, bioturbated sandstone resembles the Odl sequence south of DN36668 in Pedder Quadrangle which is laterally equivalent to the basal Ods sequence in Huntley quadrangle. The higher proportion of conglomerate in the basal sequence on the northern part of Ragged Range may be an effect of proximity to a basement high. Thinning of the Denison Group at Adams Falls suggests that this area may have been such a high.

Thickly bedded pink, pebble and cobble conglomerate with rare boulders and thin, coarse sand lenses overlies Ods on Ragged Range. It is a lithological correlate of the lower part (Odc) of the Reeds Conglomerate and passes upward into interbedded, coarse, pink and pale grey sandstone, pebbly sandstone and fine conglomerate similar to the upper sandstone member of the Reeds Conglomerate on Denison Range. These finer-grained, higher beds have been grouped with Odc on Ragged Range but would be categorised more accurately as Ods. They are overlain by pale-grey or white, occasionally glauconitic, siliceous, flaggy sandstone classed as Odh and thence by deeply weathered argillaceous rocks classed as Odf. The flaggy sandstone may contain abundant worm casts and burrows, also gastropods may be present. At least in large part it is a correlate of the lower sandstone member of the Squirrel Creek Formation on Denison Range.

Outcrop of Odf is poor and comprises mainly sparse rubble on the low rises at the eastern foot of Ragged Range. The rubble is of mainly deeply leached, iron stained, clayey material which was probably originally calcareous sandstone and siltstone. Glauconite may be present and the rocks contain brachiopods and trilobites. Less weathered, fossiliferous argillaceous rocks are exposed in road cuttings near Adams Falls. Odf at Ragged Range is a lithological correlate of probably the middle member of the Squirrel Creek Formation on Denison Range. The upper member of the Squirrel Creek Formation may also be present but may outcrop too poorly to have been recognised. The entire Denison Group sequence is overlain by poorly outcropping Gordon Group limestone.

TIM SHEA - FLORENTINE VALLEY AREA

Ods - *Tim Shea Sandstone*

P. W. Baillie
P. R. Williams
P. G. Lennox

The Tim Shea Sandstone (Corbett and Banks, 1974) consists of quartzose sandstone with minor conglomerate and siltstone, and rests unconformably on Precambrian rocks in the Tim Shea area [DN562702]. This unconformity is the Tyennan Unconformity of Carey and Banks (1954), and is very irregular, with one 60 m channel recorded (Corbett and Banks, 1974).

At Tim Shea the lower part of the formation consists of dolomitic breccia and dolomitic sandstone overlain by 12 m of red sandstone containing abundant small tube-like structures (Carey and Banks, 1954; Corbett and Banks, 1974).

The bulk of the formation at Tim Shea consists of alternating zones of red cross-bedded sandstone and grey flat-bedded bioturbated sandstone. The cross-bedding is generally trough-type, although planar-tabular cross bedding is also present. U-shaped worm casts parallel to bedding occur throughout the grey sandstone. Chert fragments are a common component of the rocks which occur in beds which vary in thickness from 20 to 300 mm. Occasionally thin mudstone beds occur.

Corbett and Banks (1974) associate the colour changes from grey to red with a variation from marine conditions (grey) to non-marine (red). Analysis of restored palaeocurrents (Corbett and Banks, 1974) indicates that sediment-bearing currents were derived from the north and west.

The lower part of the formation is exposed along the Gordon River Road on the western side of the Humboldt Divide and consist of interbedded quartzose sandstone and conglomeratic sandstone with lesser pebble conglomerate. The road section consists of coarse-grained quartzose lithic arenite, minor quartzose lithic conglomerate and abundant pink quart-arenite in massive, thickly-bedded (<1.5 m) units.

The postulated depositional environment of the Tim Shea Sandstone is a flat coastal plain at the seaward edge of a major alluvial fan complex, with shallow marine conditions alternating with alluvial flood plain deposition (Corbett and Banks, 1974). The common occurrence of chromite and (?)fuchsite suggests that material derived from ultramafic rocks were present as a sediment source.

GORDON ROAD – FLORENTINE VALLEY AREA

Odh, Odf, Odfs – *Marine Sequences below the Gordon Group*

P. W. Baillie

A major marine transgression is recorded in rocks above Ods. The terminology of stratigraphic use is summarised in Table 7. It can be seen from Table 7 that the statement on the legend of Huntley Sheet that Odf is the Florentine Valley Mudstone and correlates is incorrect. The Florentine Valley Formation in fact includes both Odf and Odh. The type section of the Churchill Sandstone Member, the lowest recognised member of the Florentine Valley Formation, occurs along the Gordon Road between DN539698 and DN535694 (Stait and Laurie, 1980) in rocks mapped on Huntley Sheet as Odf-stated to be Florentine Valley Mudstone and correlates. Rocks mapped as Odh to the east of the Saw Back Range [DN471691] and in the northern end of the Denison Range* [DN425932] (which include the type section of Corbett's Squirrel Creek Formation) are identified with the Churchill Sandstone Member and are clearly part of the Florentine Valley Formation correlate.

Corbett and Banks (1974) defined the Florentine Valley Formation as 'that formation of sandstone and siltstone with lesser limestone and chert which conformably overlies the Tim Shea Sandstone and Reeds Conglomerate and underlies the Gordon Subgroup'. No type section was designated but sequences at the Gap, the Gordon Road and the northern part of the Rasselas Valley were described.

Stait and Laurie (1980) subdivided the formation into three members based on sections on the Gordon Road and the Gap, and recognised seven faunal assemblages based on trilobites and brachiopods.

On the Gordon Road the basal section of the formation is obscured by till. The lowest exposed unit is a pale grey, thickly-bedded, bioturbated quartz sandstone containing rare planispiral gastropods (Churchill Sandstone Member of Stait and Laurie, 1980; shown incorrectly as Odf on Huntley Map). The sandstone grades up into 30 m of highly bioturbated siltstone overlain by 10 m of white, highly weathered bioturbated mudstone containing abundant inarticulate brachiopods. Overlying this unit is 75 m of massive, well-cleaved, nodular calcareous siltstone and impure limestone which is part obscured by a veneer of till. This is followed by 75 m of fine-grained impure limestone containing some horizons with abundant pyrite. At the top of the road section there is at least 30 m of well-jointed, grey siltstone with minor chert.

Some of the siltstone contains augen-shaped white quartzite pebbles. Stait and Laurie (1980) termed this finer grained sequence the Pontoon Hill Siltstone Member and gave a thickness of 260 m.

The uppermost member of the Florentine Valley Formation crops out at the Gap and is known as the Mt Field Siltstone Member (Stait and Laurie, 1980). It consists of interbedded siltstone and fine sandstone and is 55 m thick. It contains a diverse fauna of brachiopods, trilobites, gastropods and graptolites.

* These rocks are incorrectly shown on the map as Odf. Rocks mapped as Odh extend from DN426924 to DN425938.

Table 7.

SUBDIVISIONS OF THE GORDON LIMESTONE SUBGROUP

		HUNTLEY MAP SHEET		STAIT AND LAURIE, 1980 (Florentine Valley)		CORBETT, 1975 (Denison Range)	
		GORDON LIMESTONE SUBGROUP					
Marine	Dominantly argillaceous	Odf	Odfs	Florentine Valley Formation (410 m)	Mt Field Siltstone Member (75 m)	Squirrel Creek Formation (600 m)	Upper sandstone member (300 m)
Marine	Dominantly argillaceous	Odf		Florentine Valley Formation (410 m)	Pontoon Hill Siltstone Member (260 m)	Squirrel Creek Formation (600 m)	Siltstone-limestone member (150 m)
Marine	Dominantly quartzose	Odh		Florentine Valley Formation (410 m)	Churchill Sandstone Member (75 m)	Squirrel Creek Formation (600 m)	Lower sandstone member (150 m)
Terrestrial	Dominantly quartzose	Ods, Odc		Tim Shea Sandstone		Reeds Conglomerate with Upper Sandstone Member	

Palaeontological aspects of the Florentine Valley Formation have been studied for many years. Trilobites from the Gap were first described by Etheridge (1904). Quilty (1971) identified the *Lancefieldia* graptolite *Clonograptus rigidus* from the Pontoon Hill Siltstone Member on the Gordon Road. Corbett and Banks (1974) illustrated a number of trilobites from the Gap and other areas. Stait and Laurie (1980) identified faunas found in the sequence on the Gordon Road. Laurie (1980) described brachiopods from both the Gordon Road and Gap sections. *Psigraptus jacksoni* was described from the Gordon Road section by Rickards and Stait (1984) and is the first example known in which graptolite zooids have been found preserved in three dimensions. Trilobites have been described by Jell and Stait (1985).

Og - GORDON GROUP - PREVIOUSLY THE GORDON LIMESTONE SUBGROUP AND THE GORDON SUBGROUP

FLORENTINE VALLEY - RASSELAS VALLEY AREA

P. W. Baillie

The Gordon Group is that sequence of peritidal limestone with lesser siltstone and sandstone lying conformably between the Florentine Valley Formation and its correlates and the Tiger Range Group above (Corbett and Banks, 1974; Baillie, 1979). The thickness reaches a maximum of 2100 m in the north Rasselas Valley [DN442935], and is 1200-1800 m in the Florentine Valley (Corbett and Banks, 1974). The Group spans a continuous range extending from Late Arenigian to earliest Llandovery (Banks and Burrett, 1980; Sheehan and Baillie, 1981).

It should be pointed out that sections mapped and described by Corbett and Banks (1974) had deteriorated, either by weathering or regrowth, to such an extent as to be of little use during the current mapping programme (1975-1977). However excellent new sections had been opened up further north in the Florentine Valley in areas less accessible to Corbett and Banks and these merely confirmed that earlier work.

Ogk - *Karmberg Limestone*

This formation consists of impure limestone and chert-rich limestone lying between the Florentine Valley Formation below and the Cashions Creek limestone above (Corbett and Banks, 1974). In outcrop the rock generally has a characteristic nodular appearance with ovoid or rhomb-shaped nodules of micrite in a 'chicken-wire' lattice of very dark-grey silty material that may be dolomitic. The formation is about 450 m thick, and shelly faunas and rare graptolites suggest a Whiterockian (Late Arenigian) age (Banks and Burrett, 1980).

Corbett and Banks (1974) recognised an upper member of the Karmberg Limestone - the Wherretts Chert Member. This was not found to be a mappable unit; however, Quaternary lag of cherty material is indicated on the map (Oghq) in certain parts of the Florentine Valley, where it forms low strike ridges.

Weldon (1974) considered that the Karmberg Limestone was deposited as beds of lime mud interbedded with thin clastic beds under quiet water conditions, and that differential compaction of the lime and silt beds produced the nodules. In some places it is clear that the nodular appearance has been enhanced by tectonic flattening and associated cleavage development.

Ogo - *Cashions Creek Limestone*

This formation consists of thick-bedded limestones characterised by the ubiquitous presence of numerous sub-spherical to ovoid oncolites 15-20 mm in diameter. They give the rock a diagnostic spotted appearance, and indeed this formation is the key to mapping the limestones in the Florentine Valley. Once it is recognised and followed, mapping of the other limestone formations becomes very simple.

The formation often forms relatively prominent strike ridges and is of the order of 150 m thick (Corbett and Banks, 1974). It contains a shelly fauna, including large number of the flat-bottomed gastropod Maclurites, which indicates a Chazyan age (Corbett and Banks, 1974; Banks and Burrett, 1980).

The postulated depositional environment is offshore from a carbonate tidal flat sequence where strong current action continually eroded algal mats which were then transported and deposited in agitated waters (Weldon, 1974).

Ogb - *Benjamin Limestone*

This uppermost limestone sequence was subdivided into upper and lower limestone members separated by a siltstone member (Corbett and Banks, 1974). Detailed mapping showed that although the siltstone was present at Florentine Bridge [DN545850] and near the Settlement [DN542884] it could not be mapped over any distance, and so no subdivision of the Benjamin Limestone was attempted.

The formation contains a wide variety of lithotypes, from coarse grained bioclastic limestone to interbedded micrite and dolosiltite. It is of the order of 900-1200 m thick and in places contains a rich coralline macrofauna. The age of the formation extends from Blackriverian to Maysvillian (Corbett and Banks, 1974; Banks and Burrett, 1980).

The postulated environment of deposition varies from supra-tidal to sub-tidal, with silt locally present (Weldon, 1974). Shallowing-upwards cyclicity has been recognised (Calver, 1980).

Lithostratigraphic correlates of the limestone formations of the Gordon Subgroup were mapped in the Vale of Rasselas. Rocks identical with the Karmberg Limestone crop out near Gordon Bend [DN493781] and in Reeds Creek [DN460841]. Correlates of the Benjamin Limestone crop out sporadically in the Gordon River south of Richea Creek [DN487802] to east of Reeds Creek [DN473860]. Although no Cashions Creek correlates were mapped this is not considered to be significant due to the very poor outcrop of limestone in this valley.

A thick unit of coarse quartzose sandstone occurs in the middle part of the limestone sequence at the north end of the Rasselas Valley [DN442936] (Corbett, 1970) but was not observed during mapping of the Huntley Sheet because of time constraints. This unit forms a strong topographic ridge.

Sa - *Arndell Sandstone*

This formation incorporates the 'Westfield Beds' of Corbett and Banks (1974) and is the uppermost formation of the Gordon Subgroup. It contains diverse shelly and graptolite faunas at several horizons (Baillie, 1979; Baillie *et al.*, 1978), including the earliest strophic brachiopod (Sheehan and Baillie, 1981). The formation ranges in age from Ashgillian to earliest Silurian (Banks and Burrett, 1980; Sheehan and Baillie, 1981).

Thickness of the formation is about 250 m and it consists of interbedded buff-coloured siltstone and very fine-grained sandstone (Baillie, 1980).

ADAMSFIELD AREA

P. W. Baillie
N. J. Turner

Several small outcrops of limestone occur west of Adamsfield and east of Ragged Range [DN437690]. In this area an Late Canadian cephalopod fauna includes Manchuroceras, and is the oldest known Ordovician limestone sequence in Tasmania (Teichert and Glenister, 1953; Banks and Burrett, 1980).

FLORENTINE VALLEY AREA

P. G. Lennox

Og - *Gordon Limestone Subgroup*

There were no outcrops of Karmberg Limestone (Ogk) located in the southern part of the sheet, although abundant chert fragments along Tims Track ridge were assumed to indicate the presence of Karmberg Limestone.

The Cashions Creek Limestone (Ogo) is an oncolitic limestone and outcrops both along the Adamsfield Track [DN527721, DN522706] and in a tributary of the Florentine River immediately upstream of McGillan, Griffin Creek junction [DN486697].

The majority of the Florentine River drainage basin is underlain by Benjamin Limestone consisting of interbedded microcrystalline limestone and dolomite of silt size grade. In hand specimen these rocks range from the skeletal, stylolised dolobiomicrite with abundant birds-eyes to irregularly arranged blebs in *en echelon* veins of sparry calcite in birds-eye-rich micrite.

Hand specimen 77/29 [DN517705] consist of an extremely well stylolised, sparry calcite containing dolosiltite and micrite. The sparry calcite forms veinlets and blebs throughout the specimen. In thin section it consists of very fine, light brown transluscent dolomite with sparry calcite (up to 0.5 mm across) replaced by crystalline fine-grained calcite scalenohedron. The dolosiltite layers are aligned sub-parallel to the black wavy (up to 1 mm thick) stylolites. The algae and ostracods in this specimen show no visible distortion parallel to the stylolite traces.

Specimen N19 located at the intersection of a tributary 500 m upstream of the Florentine River bridge contains a Tetradium, whilst specimen N39 [DN508683] displays planar, wavy stylolites (about 0.1 mm thick) and contains numerous tiny ribbed-gastropods.

Su - TIGER RANGE GROUP

P. W. Baillie

The Tiger Range Group (Baillie, 1979) has a total thickness of over 900 m and has an age range extending from Early Silurian to probable Early Devonian. The sequence is of shallow-water marine origin and is a litho-stratigraphic correlate of the Eldon Group of western Tasmania.

Constituent formations are:

McLeod Creek Formation	>400 m
Tiger Range Group	
Currawong Quartzite	150 m
Richea Siltstone	220 m
Gell Quartzite	130 m

The Arndell Sandstone was included with the Gordon Limestone Subgroup and not the siliclastic Tiger Range Group because the very obvious topographic change is associated with the base of the highly resistant Gell Quartzite, whereas the Arndell Sandstone has a much less positive topographic expression more similar to the limestone sequences. This was in keeping with the original concept of Corbett and Banks (1974) who included their 'Westfield Beds' in the Gordon Subgroup.

Stl - *Gell Quartzite*

The Gell Quartzite is composed of hard grey quartzite which forms the prominent topographic ridge along the eastern edge of the Tiger Range [DN529755].

The unit is unfossiliferous and consists of well-sorted fine- to very fine-grained quartzose sandstone (Baillie, 1980). The tops of beds are very commonly rippled and indicate deposition in very shallow water. Interference patterns in symmetrical wave ripples have been observed.

Using the computer method of Komar (1974), a study of wave ripples in the Gell Quartzite indicates that the sediments were deposited in less than 3 m of water.

Stf - *Richea Siltstone*

This formation consists mainly of buff-coloured bioturbated siltstone, with minor siltstone. Two important latest Llandovery graptolite/shelly fauna localities are known and have been described (Baillie, 1980; Jell and Baillie, 1984). A third graptolite horizon was discovered early in 1984 and has yielded numerous specimens of *Pristiograptus initialis* Kirste (R. B. Rickards, pers. comm.) together with a single specimen of *Dalmanites*. The fauna was found at DN515820 in buff-coloured siltstone similar to other known occurrences of the formation. Depositional environment is offshore marine in quiet shallow water affected by gentle currents.

Sta - *Currawong Quartzite*

The Currawong Formation forms a second prominent topographic ridge in the major synclinal axis between the Gordon and Florentine Rivers [DN508850]. It consists of interbedded massive very-fine grained quartz sandstone and lesser micaceous siltstone. Fossils present indicate a Late Silurian age (Clarke in Baillie, 1979).

Oscillation ripples have been studied using the method of Komar (1974) and indicate that deposition took place in water depths of 0.6–1.2 m.

Sts - *McLeod Creek Formation*

The uppermost formation of the Tiger Range Group comprises over 400 m of siltstone and fine sandstone which is probably a correlate of the Bell Shale of Western Tasmania (Baillie, 1979).

The formation was only seen in Coles Creek [DN494925], where it consists of thinly-bedded, grey, micaceous fine-grained sandstone and siltstone in beds 40–200 mm thick. As is the case with the Bell Shale (Baillie and Williams, 1975) the upper part of the formation is less sandy and consists dominantlly of siltstone and mudstone suggesting some deepening of the basin of deposition prior to orogenic uplift.

Carboniferous - Triassic(?)

(Parmeener Supergroup)

P. W. Baillie

INTRODUCTION

Rocks of the Parmeener Supergroup crop out on Wherretts Lookout [DN533713] and on the flanks of Mt Dawson [DN574890]. On Wherretts Lookout rocks of the Supergroup unconformably overlie limestone of the Gordon Subgroup, but in the Mt Dawson area all contacts are faults against the older rocks. Due to extensive faulting and differential tectonic tilting thicknesses were not able to be calculated but the following sequence is present:

Upper Freshwater Sequence (Pfa)

Upper Marine Sequence (Pga)

Lower Freshwater Sequence (Pf1)

Lower Glacio-marine Sequence

- Fossiliferous siltstone (Pglb)
- Massive siltstone (Pglw)
- Tillite sequence (Pglt)

Pglt - *Tillite*

Lithologies present in this unit include feldspathic sandstone, rhythmites, pebbly conglomerate and tillite. Feldspathic sandstone ranges from fine- to coarse-grained, and individual beds are generally less than 100 mm thick.

Where observed tillites are massive, structureless diamictites without a fabric. Angular to rounded clasts up to boulder grade, and of varied lithology, occur in a clay matrix.

The sequence is a correlate of the Truro Tillite of southern Tasmania (Farmer *et al.*, 1985).

Pglw - *Massive siltstone*

Conformably overlying the tillite sequences are massive, generally featureless siltstones that are correlated on lithological grounds with the Woody Island Siltstone of southern Tasmania (Farmer *et al.*, 1985).

Where it is has been observed, bedding is lenticular, with individual lenses up to 3 m in width. Rare dropstones, pyrite, and glendonites are present in the unit that, with the exception of a single specimen of *Peruvispira* is unfossiliferous.

The rock characteristically weathers to flat, angular, polygonal blocks less than 100 m in diameter.

Pglb - *Fossiliferous siltstone*

The base of this unit is taken as being the first appearance of fossiliferous beds, although lithologies are similar to underlying rocks. With the appearance of fossils there is a corresponding increase in the number of dropstones. Within a stratigraphic interval of about 3 m the rocks become coarser and beds of fossiliferous sandstone occur. The sandstones are composed of rock fragments and are generally 100–200 mm thick. The proportion of siltstone to sandstone is variable although siltstone is usually dominant. Fenestellids are more common than brachiopods in siltstone whereas brachiopods are the most numerous fossils present in sandstone.

On lithological and palaeontological grounds the unit is correlated with the Bundella Mudstone of the Hobart area.

Pfl - *Lower Freshwater Sequence*

On Breganti Road [DN552931] and Dawson Road [DN564907] rocks assigned to the Lower Freshwater Sequence crop out. The sequence on Breganti Road consists of thin lenticular beds of micaceous sandstone and shale. Carbonaceous debris is common. Interbedded with the fine-grained rocks is 3 m of medium-grained, sparkling, cross-bedded quartz sandstone, which occurs in beds 20–300 mm in thickness. On Dawson Road no sparkling sandstones are present and the sequence consists of thinly-bedded very micaceous sandstone and carbonaceous shale.

These rocks are considered to be correlates of the Liffey Group of northern Tasmania.

Pga - *Upper Marine Sequence*

The portion of the Permian section between the two freshwater sequences on Huntley Sheet has not been subdivided, because of the overall poor outcrop and the lack of readily identifiable marker beds such as the Risdon Sandstone of the Hobart area. An overall stratigraphy has been worked out that depends in part on fossil determinations made in the field, during mapping, by M. J. Clarke. The contact with the underlying rocks of the Lower Freshwater sequence has not been observed because of the presence of faults.

The lowest part of the Upper Glacio-Marine Sequence is observed on the unnamed branch of Westfield Road at DN588849 where *Cancrinella* occurs in calcareous grey siltstone and interbedded lithic sandstone. Calcareous siltstone which contains a slightly younger fauna is faulted against the Lower Freshwater Sequence on Breganti Road [DN553931].

Higher in the sequence the rocks take on a 'cyclic' appearance. Medium- to coarse-grained, often fossiliferous, sandstone beds are interbedded with siltstone layers. Sandstone beds may be rarely up to 5 m in thickness, and they have sharp tops and bottoms. These rocks are correlated on litho- and bio-stratigraphic grounds with the Malbina Formation of the Hobart area and the rocks exposed at Arcadian Siding near Maydena.

Higher in the sequence there is a gradual fining of the rocks and massive siltstones or fine sandstones occur. These unfossiliferous rocks, often rich in erratics, occur in beds 300–600 mm thick. The mudstones are often bioturbated. Near the top of this portion of the sequence, though not mappable and generally only observed as float, is at least 4 m of coarse quartz sandstone or granule conglomerate containing angular to rounded clasts of quartz, chert and jasper. The rock contains concentrations of larger clasts which appear to have been winnowed by current action. This portion of the sequence is a lithostratigraphic correlate of the Ferntree Mudstone of the Hobart area.

At the top of the Upper Marine Sequence is a thin sequence of micaceous black mudstone with thin interbedded sandstone beds.

Pfa - *Upper Freshwater Sequence*

Overlying the black mudstone described above are beds of finely laminated, cross-bedded feldspathic sandstone 20–80 mm in thickness. The rocks are usually micaceous and carbonaceous and are correlated with the Cygnet Coal Measures of southern Tasmania (Farmer *et al.*, 1985).

Quaternary

FLORENTINE VALLEY - DENISON RANGE AREA

P. W. Baillie

Quaternary deposits of the region include fluviatile, slope and glacial deposits. There is a continuum between true glacial, reworked glacial, periglacial and fluviatile deposits. Because of the general poor nature of outcrop it is impossible to map the various facies and lines shown on the map are often somewhat generalised.

Qp - *Till and fluvioglacial deposits*

Till (Qpt) and fluvioglacial deposits (Qpf) are shown separately on the map where they can be differentiated, or as undifferentiated glacial deposits (Qp) where they cannot.

The only deposits considered to be till in the Florentine Valley occur near Lawrence Rivulet, where it is crossed by Westfield Road [DN590812]. The drift consists of unsorted dolerite clasts ranging in grain size from 10 mm to 2 m in a clayey matrix. No bedding was observed and no fabric is present. Further downstream the gravels become well-rounded, often display imbricate fabric and bedding can be observed. These gravels represent reworked glacial material of fluvioglacial origin.

Previously unrecognised glacial deposits were recognised and mapped to the east of the Thumbs [DN480745], where a small cirque developed along lines of weakness associated with small faults in the conglomerate bedrock (Odc). The associated till covers about 0.6 km^2 and has a very knobbly surface expression caused by the large number of disoriented boulders of conglomerate boulders, some of which are angular, others a little rounded. A good lateral moraine is present on the southern edge of the till [DN480741].

In the Denison Range and Rasselas Valley there abounds abundant evidence of the former presence of glacial ice. Both depositional and erosional features are present. Lakes Rhona [DN413885] and Murray [DN413903] occupy the site of former cirques and downslope of these lakes are spectacular moraines composed of bouldery till. The till merges gradually with material that has been reworked, and also with slope deposits.

The immaturity of topography and lack of soil development associated with the deposits suggests a Last Glacial Stage age for the glaciation.

Qqa - *Older alluvium*

The valley of the Gordon River above Gordon Bend [DN485765] is virtually choked with alluvial deposits that are currently being incised by the river. As a consequence bedrock outcrop is very scarce in the Rasselas Valley, in direct contrast with the Florentine Valley to the east, in which outcrop is very abundant.

In the left bank of the Gordon River at DN480832, 2 m of sediment are exposed consisting of interbedded sand and gravel which displays rapid changes of lithology. It seems likely that the deposits were formed during period of higher water discharge than the present as attested by the fact that the deposits are everywhere being incised and there seems to be very little deposition in the Rasselas Valley at the present time.

Qqs - *Slope deposits*

Periglacial slope deposits are extensive in the region and have been observed to have thicknesses of greater than 6 m. They reflect local derivation and have been differentiated accordingly on the map according to dominant clast type: dominantly dolerite (Qqsd), quartzite (Qqsq), conglomerate (Qsqc), sandstone and/ or, quartzite (Qqst).

The deposits consist of angular clasts in either a sandy or clayey matrix depending on parent rock type: dolerite slope deposits invariably have a clay matrix, whereas siliciclastics have a sandy matrix.

No deeply weathered slope deposits are known from the mapped area and it is likely all were formed during the Last Glacial Stage. Available radiocarbon dates support this conclusion (Colhoun, 1975).

Qha - *Younger alluvium*

Areas of alluvium associated with currently active streams are present in various parts of the mapped area.

To the north of Mt Dawson at DN575918 marsh deposits occur that are probably related to the infilling of a lake.

LOWER FLORENTINE VALLEY - TIGER RANGE AREA

P. G. Lennox

Near the intersection of Tims Track with Adamsfield Track erratics of dolerite, quartzite and conglomerate outcrop on a hillock [DN522703]. The well-rounded, coarse-grained, holocrystalline dolerite boulders, up to 1.5 m x 1 m, are dispersed amongst more abundant, up to 2 m diameter, angular quartz-conglomerate boulders commonly containing pebble to small cobble fragments.

As mentioned previously the Karmberg Limestone outcrops as a lag of angular chert fragments up to 150 mm across as noted uphill of the erratics described above.

The till on the Gordon River Road which covers the Florentine Valley Mudstone-Tim Shea sandstone boundary consists of a chaotic assemblage of variously sized sandstone blocks in a sandstone matrix. There are occasional pockets of bedded gritty sandstone indicating deposition from the meltwater.

There are a number of glacial deposits cropping out along the Gordon River Road in up to 2 m deep erosional troughs in the Eocambrian sequences. The extensive till near the Tims Track-Gordon River Road junction consists of generally subrounded boulders of quartzite, dolerite and Permian (?) sediments (up to 20%) of 0.5 m diameter size randomly orientated in a matrix of minor fine sand and abundant clay. On a road parallel to the Gordon River Road adjacent to the Tims Track junction [DN523667] the till thickness varies considerably being at its thickest 1.5 m thick, whilst it reaches 2 m thick on the Gordon River Road [DN527682].

There are a number of outcrops of fluvioglacial outwash of dominantly well-sorted cobble in the Little Florentine River (plate 12). These deposits range up to 1.5 m thick and on rare occasions the cobbles may show imbrication.

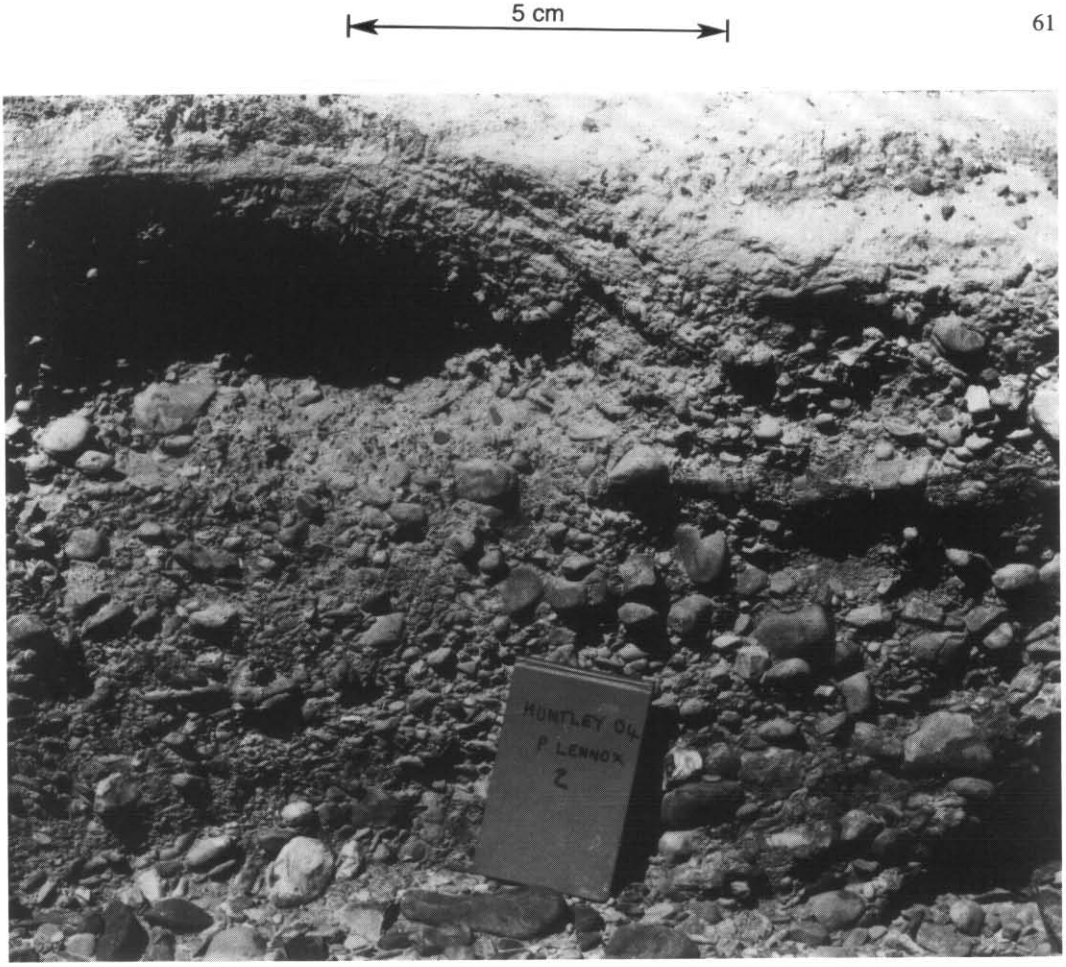


Plate 12. Fluvial outwash of dominantly well-sorted cobbles in the Little Florentine River.

DENISON PLAIN - BOYES RIVER VALLEY AREA

A. V. Brown

Qqs - *Scree and talus of dominantly conglomerate* (Qqsc), *or mixed conglomerate and sandstone* (Qqss)

Scree and talus fans occur down the western slope of Stepped Hills, in the upper Boyes River valley between Trial Ridge and South and Centre Star, with remnants of similar fans on the western slope of Clear Hill and South Star. These fans have been dissected in recent times with original basement now being re-exposed. In places creeks have cut small valleys up to 15 m deep and 200-300 m wide into the fans (e.g. western slope of Stepped Hills).

Qu and Qha - *Younger alluvium, swamp and marsh deposits*

Virtually all the area below the 310 m contour (top of Lake Gordon flood level) consists of flood plain gravels, sand and silt which have been reworked by recent misfit streams and rivers. In places these deposits are up to 10 m thick (bulldozer cuts) but the total thickness, variation in thickness and underlying rock type is unknown. Occasional outcrops of various rock types were found below the 310 m level but only add to the overall information of the area and were not critical to any section after flooding.

DENISON PLAINS (SOUTH) AND DENISON GAP AREA

N. J. Turner

Qha - *Younger alluvium, swamp and marsh deposits;* Qu - *undifferentiated*

The floors of many river valleys, particularly the broader ones, are covered by buttongrass sedge which obscures the underlying deposits. However, various areas within the valleys can be distinguished on the basis of land form. Adjacent to water courses there are often areas that are level and, commonly, marshy. They are thought to be underlain by clay, sand and gravel such as are exposed in the stream channels and are classed as Qha. The alluvial gravels are fairly well-rounded and of local derivation.

Between the river-side plains and the steep valley walls the type of material underlying the sedge is generally unknown (Qu). The fine, black, organic-rich soil related to the sedge may be up to one metre thick although fine angular gravels consisting of quartz and quartzite are sometimes exposed on mounds and terrace edges. These gravels probably represent both residual and colluvial accumulations. However, the influence of alluvial processes in generating these gently sloping, sometimes extensive areas are indicated by the present of lag of well-rounded gravel against the valley walls in places (e.g. near DN296675).

Qqs - *Talus*

Extensive areas of talus occur on the western slopes of Denison Range. It consists of angular blocks up to about one metre across. The blocks were derived from the Great Dome Sandstone and are loosely packed with virtually no interstitial matrix. Similar matrix-free talus occurs in some other places but for the most part talus on lower and gentler slopes is an intimate mixture of blocks and fine matrix.

IGNEOUS ROCKS

Precambrian

METADOLERITE DYKES

J. McClenaghan
M. P. McClenaghan

In the Gordon River at DN195689 a 5 m thick amphibole dyke (Ꝑm) cuts the sequence of mixed grey phyllites (Ꝑpu). It is blue-grey, medium grained, roughly foliated and both the trend of the dyke and the foliation are parallel to the cleavage in the adjacent phyllite.

The foliation is defined by actinolite and elongated areas of quartz + zoisite + muscovite. Large crystals of actinolite and chlorite occur throughout the rock. These crystals sometimes have their cleavage parallelling the foliation but it is often at an angle to it. Rounded anhedral to subhedral crystals of garnet are scattered throughout the rock overgrowing the actinolite and quartz defining the foliation and often associated with large irregular patches of ore. There is some albite in the rock though the major leucocratic constituent is quartz. The original plagioclase has probably altered to zoisite + muscovite.

At DN202746 a two-metre unfoliated dyke of hornblende lamprophyre dyke (Ꝑm) (PM) occurs cutting a quartzite band in the light green-grey phyllites (Ꝑl). It consists dominantly of cloudy altered plagioclase, euhedral to subhedral brown hornblende, chlorite and actinolite. Accessory apatite, ore and quartz is also present. The chlorite and actinolite are clearly secondary. The unfoliated nature of this dyke indicates that it post dates the deformation of the country rocks.

Eocambrian–Cambrian

ULTRAMAFIC ROCKS

ADAMSFIELD - BOYES RIVER AREA

A. V. Brown

€rp - *layered serpentinised peridotite;* €rs - *serpentinite;* €ru - *unspecified ultramafic rocks*

In areas covered by the Huntley sheet, ultramafic rocks crop out as elongate N-S masses in two areas along the northern extension of the Lake Edgar Fault Zone; (1), along the western side of the Saw Back Range, the Adamsfield Ultramafic Complex; and (2), along the western slopes of the Stepped Hills and the Denison Range, the Boyes River Ultramafic Complex.

The ultramafic rocks within these complexes consist of fault juxtaposed blocks of partially serpentinised layered peridotite successions and serpentinite derived from it. The ridges of layered peridotite belong to two compositionally and mineralogically distinct successions. These successions are distinguished as a layered dunite-harzburgite succession (LDH) and a layered pyroxenite-dunite succession (LPD) (Brown, 1986).

The ultramafic bodies at Adamsfield and Boyes River are only two of at least fifteen areas in Tasmania which contain fault juxtaposed blocks belonging to three mineralogically and chemically different ultramafic rock succession (see Brown, 1986, for a summary, also fig. 42, *op. cit.*). These successions are usually associated with Eocambrian-Cambrian volcano-sedimentary successions in any specific area. Historically, the two most important references to the Adamsfield area, which relate to the ultramafic rocks, are Nye (1929) and Carey and Banks (1954).

The main features of Tasmanian ultramafic rocks are the fact that mineralogically; they are orthopyroxene and not clinopyroxene rich; and, that even when plagioclase is present (it occurs in only one of the three recognised successions), it is only in minor amounts when compared with ultramafic bodies which are dominated by clinopyroxene. Chemically; they are high in MgO and Cr_2O_3 and low in Al_2O_3 and TiO_2, with respect to clinopyroxene dominant ultramafic rocks found world wide. The reasons for these characteristics is considered to be that the Tasmanian ultramafic complexes were formed from high temperature magmas (1200–1300°C), at low pressures (2–5 kb), in crustal magma chamber associated with the Eocambrian-Cambrian volcanism, and not in association with ocean floor, back arc basin or subduction type terrains where clinopyroxene-rich ultramafic rocks are found (Brown, 1986). Tasmanian ultramafic rocks are also chemically and mineralogically dissimilar to the large layered body, such as the Stillwater or the Bushveldt Complex.

Both the Adamsfield and Boyes River Complexes were tectonically emplaced into the local basin of deposition after deposition of the Middle Cambrian Trial Ridge Beds and before deposition of the Late Cambrian fossiliferous succession (Ol), which in the Adamsfield area unconformably overlay the ultramafic rock. The Late Cambrian sequence (Adamsfield Beds) (Carey and Banks, 1954) consist of beds derived completely from ultramafic detritus interbedded with white and pink cross-bedded quartz sandstone and pebble conglomerate units. The serpentinitic sediments also have been recorded to contain detrital chromite, osmiridium and red jasperoid fragments, presumably derived from the ultramafic rocks (Nye, 1929). A fossil fauna containing trilobites of Idamean to post-Idamean age (Late Dresbachian to Early Franconian, Öpik, in Banks, 1962) has been described from this sequence. Fossil faunas found during the mapping of this sheet confirm this age (see page 51).

The ultramafic complex at Adamsfield now forms the core of a large meridional anticline, formed during an early phase of Devonian deformation. During a later phase of this deformation the ultramafic rocks were re-emplaced into the overlying Ordovician sedimentary rocks. The complex crops out over an arcuate belt, up to 1.5 km wide and 14 km long. The main body is 8 km long, 4.5 km of which is covered by the Huntley Sheet, the remaining portion extends south into the Pedder 1:50 000 Sheet.

Along the northeastern margin of the Adamsfield Ultramafic Complex the contact between the ultramafic and sedimentary rocks is marked by a zone of brecciated riebeckite- and hematite-bearing quartzite. At DN468709, a small ridge of bedded quartz sandstone, belonging to the Late Cambrian succession (Ol) was tectonically incorporated by sheared serpentinite during Devonian re-emplacement of the complex through the overlying Cambro-Ordovician cover.

The northern 8 km of the Adamsfield complex, covered by the Huntley sheet, is still partly overlain by serpentinitic Late Cambrian sedimentary rocks, and consists of elliptical ridges of partly-serpentinised ultramafic rocks, surrounded by sheared serpentinite, with their long axes aligned parallel or sub-parallel to the north-south anticlinal axis and the steeply-dipping bounding faults of the complex.

The ultramafic lenses are well layered, and this layering, as the schistosity in the serpentinite, is orientated north-south with steep dips. The similarity in tectonic direction and orientation of the ultramafic lenses is another result of Devonian deformation. To the south, on the Pedder Sheet (see Explanatory Notes for the Pedder Sheet, in prep.), the complex passes into a melange of interspersed lenses of serpentinite and country rock, mainly mudstone. A poorly-exposed amphibole body occurs with in this melange, and was the only mafic rock found associated with this ultramafic complex. Similar bodies of amphibolite was found associated with the Boyes River Complex to the north-west.

To the north of Adamsfield, in the Boyes River Valley, sheared and blocky serpentinite with minor primary orthopyroxenite crops out as numerous small, poorly exposed masses in creeks along the western slopes of both Stepped Hills and the Denison Range, which were cut down through the overlying scree fans. Along the floor of the Boyes River almost continuous outcrop exists between DN387811, north, along Star Creek, from its confluence with the Boyes River, to near DN376865.

The Boyes River complex consists of essentially totally serpentinised coarsely layered ultramafic rocks. The serpentinite is highly weathered, sheared, and contains numerous gash veins filled with chrysotile cross-fibre. Bastite pseudomorphs, after orthopyroxene indicate a greater degree of deformation and brecciation of the sequence than is found at Adamsfield. Relict layering is recognised due to differential weathering surfaces, and indicates that the complex consisted of interlayered (10–1200 mm) dunite, orthopyroxenite, and orthopyroxene bearing dunite units. Remnant pyroxenite layers appear to be less frequently than at Adamsfield, and are usually less the 250 mm thick. Only one sample of relatively fresh orthopyroxenite was recovered during mapping, and this sample, as well as remnant features, indicate that the only ultramafic rocks exposed in the Boyes River Complex are part of the LDH succession (Brown, 1986).

In both areas the mineral assemblages resulting from serpentinisation consist of lizardite ± chrysotile ± brucite ± magnetite. The brucite content is determined by the olivine to orthopyroxene ratio of the original rock. Ratios of iron and magnesian to silica range from primary to serpentinised equivalent rocks, indicating expulsion and/or redistribution of Mg, Fe, and Si, and suggesting a volume change during serpentinisation (see Brown, 1972).

Petrology

The following petrological descriptions are based on Brown (1972) and Varne and Brown (1978) which incorporated data obtained during mapping of the Huntley Sheet. Data on bulk rock geochemistry can be found in the above two references and electron microprobe analyses of mineral components in Brown (1986) and Varne and Brown (1978).

Remnants of the layered dunite-harzburgite succession (LDH) consist of massive dunite [DN461670] with zones of interlayered dunite and orthopyroxene bearing dunite [DN463645] and massive orthopyroxenite [DN462660] and [DN461707]. The outcrop pattern suggests that the thick orthopyroxenite zone overlies the interlayered dunite-orthopyroxene succession. This is substantiated by chemical evidence and evidence from areas of LDH succession in the Dundas Trough (Brown, 1986). Within the northern block of massive orthopyroxenite, rare lenses and layers of dunite and chromitite indicate that the massive zones are probably derived from thick layers. The contact between the massive dunite and orthopyroxenite zones is irregular on outcrop scale, with interdigitation due to solid-state flow evident around DN461665.

In the massive dunite zone, thin lenticular banding occurs. In thin section this banding shows up as strips of markedly contrasting grain sizes.

Olivine and spinel grains are commonly elongated parallel or near-parallel to the grain size banding. Olivine grains are mantled and meshed by an intergrowth of lizardite, chrysotile and brucite. Fabric analyses were not made, but the textures within the dunite resembles flattening by solid state flow, similar to those described by Nicolas *et al.* (1971).

Large olivine grains (3–5 mm long) within the massive dunite are rhomboidal to wedge shaped, and commonly display pronounced undulatory extinction. They appear to be remnants of even larger grains which have been dismembered into strips. Kink bands within olivine grains are not common and the few seen had diffuse boundaries. Some of the kink band boundaries are near-normal to the optic axial plane (001) and near-parallel to (100); this orientation is common in olivine grains from complexes which have undergone solid state deformation ('alpine type' ultramafic complexes), and implies slip on {Okl} [100] at high temperatures ($>800°C$; Carter and Ave'Lallement, 1970; Raleigh, 1968), however, most of the distinct kink band boundaries in the olivine grains are parallel or near-parallel to the optic axial plane (001). Olivine grains with these (001) kink band boundaries have external rotation axes near [010]. Sets of faint, closely-spaced lamellar structures near-parallel to (100) may be multiple (100) kink bands, but are believed to be deformation lamellae associated with abundant (001) kink band boundaries. Slip on (100)[001] seems to be the preferred mechanism in olivine at low temperature and high strain rates (Carter and Ave'Lallement, 1970).

In the zones of interlayered dunite and orthopyroxene bearing dunite, the orthopyroxene grains have a porphyroclastic texture and usually contain exhibit undulose extinction, some are dismembered into plates along (010) or (100) planes, which are pulled apart of progressively offset. The layers (bands) of large olivine and orthopyroxene grains are separated by zones where the mineral grains show a seriate gradation down to about 0.01 mm. These small grains also commonly display undulating extinction. There is little sign of recrystallisation after deformation.

Enstatite grains, within the massive orthopyroxenite, have irregularly interlocking boundaries, and range in size from 40–50 mm down to less than one millimetre. The larger grains display undulose extinction and are dislocated into sub-grains. Kink band boundaries join grain boundaries at serrations to form triple points. Prominent sets of deformation lamellae at high angles to kink band boundaries, presumably the trace of slip planes, are seen where large rotations ($>20°$) have occurred. Zones of intense kinking terminate within grains along boundaries which are probably slip planes, leading to the development of subgrains which are frequently curved plates.

Chemically, the olivine grains in the massive dunite are very magnesian, $Fo_{92\text{-}93}$, which is very similar to the overall value for the LDH succession of Fo_{93}. Spinel grains are extremely chromium-rich ($Cr/Cr+Al$), (Cr^*) = 0.89–0.96, (LDH succession average $Cr^*=92$) and the orthopyroxene grains have a clinoenstatite like composition being $En_{92\text{-}94}$ (LDH average $En_{93.5}$), and a CaO level below the detection limit of the electron microprobe.

The massive orthopyroxenite is considered to be a later phase to the dunite and orthopyroxene-bearing dunite. Enstatite compositions of En_{92}, Spinel with $Cr^*=95$, and rare olivine grains of Fo_{88}, have been recorded.

Remnant blocks belonging to the layered pyroxenite-dunite (LPD) succession occur as elliptical masses sheathed by sheared serpentinite in the northern part of the Adamsfield Complex between DN464674 and DN464704.

The main body is composed of very regular layers which persist along strike throughout outcrop length. Layers range in thickness (20–2000 mm) and consist of irregularly alternating dunite, olivine orthopyroxenite and orthopyroxenite. Contacts between adjacent layers are sharp, and the layers retain a relatively uniform thickness along strike. Due to the overall characteristics of this layered succession, layering is considered to have been controlled by thermodynamic and chemical conditions during formation of the succession and not by gravitational settling of crystals.

In some of the olivine orthopyroxenite layers, contiguous stubby orthopyroxene phenocrysts are set in a serpentinised matrix of olivine, clinopyroxene and spinel. The orthopyroxene grains range in diameter from 1–5 mm and infrequently contain tiny spinel and olivine grains. In some layers the orthopyroxene grains are distinctly embayed against olivine and spinel of the matrix. Spinel grains are euhedral.

The effects of solid deformation on the porphyritic olivine orthopyroxenite layers are confined mainly to the olivine-rich matrix and cause little disturbance to the texture. The olivine grains of the matrix show sweeping extinction and some kink bands, and form a mosaic with clinopyroxene. The orthopyroxene phenocrysts are twisted in places and show undulating extinction and minor kink banding. Trains of small unstrained orthopyroxene grains have formed along some kink bands.

Bulk chemical compositions of the olivine orthopyroxenite layers reflect their richness in orthopyroxene (Varne and Brown, 1978). Composition of individual orthopyroxene grains vary to a greater extent in the olivine orthopyroxene layers than in the dunite and orthopyroxene layers. This variation in composition appears to be due to different amounts of $CaMgSi_2O_6$ component solid solution. Exsolution lamellae of clinopyroxene occur as very thin sheets in the (100) plane of some of the orthopyroxene grains and may explain this variation. If the composition of small diopsidic clinopyroxene grains in the olivine-rich matrix is added to the co-existing low-calcium orthopyroxene composition, in likely proportions (5% cpx + 95% opx), the calculated pyroxene composition matches the high-calcium orthopyroxene composition. However, the small orthopyroxene grains of the deformed matrix lack exsolution lamellae, implying that the exsolution, if it occurred, was here quite complete (Varne and Brown, 1978).

In dunite layers, pervasive serpentinisation has obscured textural details. Only very rare relic olivine cores exist with minor spinel, in a matrix of mesh-textured lizardite, magnetite, chrysotile and brucite. The relict olivine cores display undulose extinction and a few kink bands, and pre-serpentinisation grain size of olivine appears to have been 0.1–0.5 mm.

Layered orthopyroxenite units have xenomorphic textures with intergrown, often serrated, grain boundaries. Small spinel grains are enclosed by orthopyroxene. Olivine grains are either lacking in these units or occur as small serpentinised interstitial grains. In coarse-grained (8–10 mm) layers, orthopyroxene grains often contain kink bands, display undulose extinction and sub-grain formation. Along some grain boundaries, trains of small unstrained orthopyroxene grains have formed.

Chemically, rock of the LPD succession have lower MgO and higher CaO, FeO and Al_2O_3 contents than similar units from the LDH succession. Olivine averages Fo_{87} in the LDH succession blocks at Adamsfield, in comparison to an average Fo content of 87.48 from all known areas of LPD succession (Brown, 1986). Orthopyroxene have (Ca:Mg:Fe) average ratios of (1.90 : 86.3 : 11.8); in comparison to (1.94 : 86.41 : 11.65) for the whole succession; minor clinopyroxene grains have an average (Ca:Mg:Fe) ratio of (45.25 : 49.7 : 5.0); in comparison to (46.86 : 48.66 : 4.49). Chrome spinel grains have an average Mg* of 45.15; *cf* 42.97 (mainly due to serpentinisation and not the initial magmatic value) and Cr* of 60.40 *cf* 65.49 (Brown 1986).

Along the outer edges of most of the LPD succession blocks, but also throughout the block occurring around DN463701, solid state deformation ranging from simple folding to total mylonitisation, is exhibited.

Plate 13. Isoclinally folded dunite and orthopyroxenite layers. 5 cm

Folds of the layering are very tight to isoclinal (plate 13), with axial surfaces being parallel or near-parallel to the layering. Intrafolial and rootless folds of orthopyroxenite are enclosed by dunite. One originally isoclinal fold has an asymmetrical-intrafolial fold imposed upon it, with the later axis near-orthogonal to the first, but, in general, only one generation of folds is seen.

Orthopyroxene layers are usually continuous around the folds, but exhibit pronounced thickening in the closures and thinning on the limbs, although it behaves as the more competent material in comparison to the relatively plastic dunite layers. One dunite layers was completely squeezed out of the core of a fold, and two previously separated orthopyroxenite layers have become contiguous. Extreme thinning of fold limbs led to detachment of thickened cores, yielding rootless boudin-like bodies of orthopyroxenite in dunite.

Detailed descriptions of the deformational variations can be found in Brown (1972).

Brown (1972) and Varne and Brown (1978) considered that all the parts of the Adamsfield Ultramafic Complex formed from the same magma and are part of a continuing differentiation succession. It has been shown by Brown (1986) that the above is not the case, and that the complex is formed from juxtaposed pieces of the LDH and LPD successions.

Similarly, due to lithological relationships of the various sedimentary, volcanic and ultramafic rocks in the Dundas Trough (Brown, 1986) it is not considered viable that the ultramafic rocks of western Tasmania formed in the submarine ridges of immature volcanic island arc. Rather,it is considered that the LDH succession formed at temperatures of $1250 \pm 50°C$ and very low pressure (2–5 kb) in the forsterite + protoenstatite + spinel + liquid stability field from a quartz normative liquid, rich in magnesium and chromium and low in titanium, calcium, sodium and potassium, with a small water content; and that the LPD succession crystallised at temperatures between 1200 and 1300°C and pressures of 5 kb or greater, from a picritic liquid in the olivine + spinel + liquid to orthopyroxene + clinopyroxene + olivine + spinel + liquid stability fields. (Brown, 1986; see also Varne and Brown, 1978 and Rubenach 1973).

KINDLING CREEK AREA

N. J. Turner

A complex of mafic and ultramafic rocks is probably faulted against the Trial Ridge Beds and is overlain by strata of Late Cambrian age. On the flank of Trial Ridge west of the crest near DN386885 there is exposure of mafic rocks. Abundant float derived from this material is present in the stream draining west to the Pokana River and in the Pokana River itself in the vicinity of where the stream enters it. In hand specimen the rocks comprise of white and green grains varying in size from medium to coarse. Interbanding of different grain sizes occurs at a scale of a few centimetres in some exposures. There is a strong dimensional orientation of grains and where banding is present it is parallel.

In thin section the rocks show varying degrees of granulation and alteration giving a range from cataclasites to mylonites. Relict coarse grains of original minerals rest in varying amounts of matrix comprised of granulated material and tremolite/actinolite. The original proportions of mineral species cannot be determined accurately because of deformation and alteration but the rocks must have ranged in composition from plagioclase rich (greater than 60%) to hornblende rich (greater than 80%). The following associations of original minerals occur; plagioclase; plagioclase-light green hornblende; plagioclase-brown hornblende-clinopyroxene-orthopyroxene; pale green hornblende-pyroxene. Colourless chlorite with distinctive anomalous blue birefringence can be present as an alteration product of plagioclase or pseudomorphing tremolite/actinolite along sharp edged zones. Green chlorite can be present in veinlets.

Serpentinite occupies the floor of the valley north of Trial Ridge. In thin section it consists of mesh textured serpentinite (?antigorite) plus dusty opaques. The dusty opaques define a polygonal pattern possibly related to a pre-serpentinisation texture. Approximately 1% by volume of euhedral chromite was found in one sample.

A well developed shear surface with polished and striated surfaces occurs in the serpentinites and in places a vague compositional banding or grain orientation lies parallel to it. It is regionally conformable with the surface surface designated as S_3 in the section on Structural Geology of the older Precambrian-Eocambrian sequence.

Jurassic

DOLERITE

P. W. Baillie

A flat-lying sill of dolerite, in excess of 300 m in thickness, overlies rocks of the Parmeener Supergroup in the north west-corner of the map sheet [DN570930]. The base of the sill is fine grained and there is an overall increase in grain size with increase in height, suggesting that the top part of the sill has been removed by erosion. The intrusion occurred near the base of the Upper Freshwater Sequence.

A 3 m subvertical dyke of fine-grained dolerite was found intruding coarse-grained dolerite at DN579908.

Tertiary

BASALT

P. W. Baillie

A vertical 20 m dyke of weathered vesicular basalt intrudes siltstone of the Parmeener Supergroup at DN552933. Other occurrences of Tertiary basalt are known from the north Florentine Valley, a short distance north of the northern edge of the map sheet (Jennings, 1956).

STRUCTURAL GEOLOGY

Precambrian rocks

TWELVETREES RANGE AREA

J. McClenaghan
M. P. McClenaghan

Throughout the area the rocks show three major phases (D_1-D_3) and a later minor phase (D_4) of deformation. The multi-phase fold deformation structures are co-axial with low plunges trending north in the southern area but showing a progressive swing to NE-SW with low to moderate plunges to the north-east in the Pleiades and Junction Range area.

Minor structures are abundant throughout the area in all lithologies and locally structural sequences can be established. Correlation of structures in different lithologies is limited because of the different ways they respond to the deformation and the overall parallelism of the structures, and can only confidently be made within the phyllites or within the quartzites.

STRUCTURES IN THE MAJOR QUARTZITES

In the Twelvetrees Range some of the least deformed quartzite (Ꝑq) of the area can be seen and bedding can be established. This has been modified by fractures along which there has been no movement. The fractures are parallel to bedding whether curved or planar and occur within beds and along bedding surfaces. The bedding has been folded into a series of open to tight and isoclinal folds with wavelengths about 3 m and amplitudes often up to 5-6 m. The hinges of these folds trend 155° to 175°, frequently around 170° with plunges at low angles, generally 0° to 15°, but up to 40°, to the north and south (fig. 3). Their axial planes are vertical to steeply inclined to the east or west. These are the earliest folds (F_1) and no earlier recumbent structures are found. A penetrative cleavage is developed axial planar to the folds (S_1). In the massive banded quartzite this cleavage has a preferred development along the bedding and fracture planes. In many places though, in particular along the eastern part of the Twelvetrees Range, the cleavage becomes dominant and bedding is often obliterated. In many fold closures the cleavage shows fanning.

Where the cleavage intersects bedding it gives rise to a fine lineation which trends 160-176° plunging at 0-27° to the north and south. This lineation is often seen at an angle on the surface of sedimentary ripples. However, there are sometimes other linear structures which are broad and often plicate in profile. These can in places, be seen to be tectonic mullions forming where the cleavage penetrates massive quartzite bands as more widely spaced fractures; they have a similar orientation to that of the fine lineation. Not all mullion-like structures are geometrically related to deformation structures and it is likely that they have resulted from tectonic modification of sedimentary ripples. Where the cleavage intersects the platy laminae of the current bedding it gives the appearance of two cleavages.

In the eastern part of the Twelvetrees Range in the region of Harper Point [DN235705] the S_1 cleavage is folded on a minor scale with hinges trending 165-176°, plunging at 6-45° south, but mainly 25-40 south. The axial planes trend 170° and are vertical or steeply inclined to the east and west. Vergence of the folds is towards the west. More commonly though, the cleavage is folded into minor conjugate kink folds. These often appear transverse to the early folds with hinges trending ENE, plunging at 55-75° WSW and vertical axial planes giving rise to steep kink-bands.

Other late kink folds have hinges plunging at 25-30°S (fig. 3).

The quartzite (Ꝑq) unit separating the mixed grey phyllite (Ꝑp) and light green-grey phyllite (Ꝑl) to the west of the Twelvetrees Range is more finely banded and there are zones of micaceous schistose quartzite. The banding possibly represents bedding but there are no sedimentary structures and this cannot be proved. As on the Twelvetrees Range joints parallel to the bands are present. An early set of minor folds, of a similar size to those on the Twelvetrees Range and generally tight and intrafolial, fold the banding. They have hinges trending 160-172° plunging at 14-45°N and axial planes inclined at 85°E-80°W. These folds are considered as being F_1. A penetrative cleavage (S_1) is developed axial planar to the early folds and becomes dominant in the zones of more micaceous quartzite. This cleavage and banding are for the most part parallel. A fine lineation is developed on the banding surfaces where S_1 intersects and has the same approximate trend and plunge as the F_1 hinges.

Later minor folding of the S_1 cleavage and the banding can be seen in places with axes trending

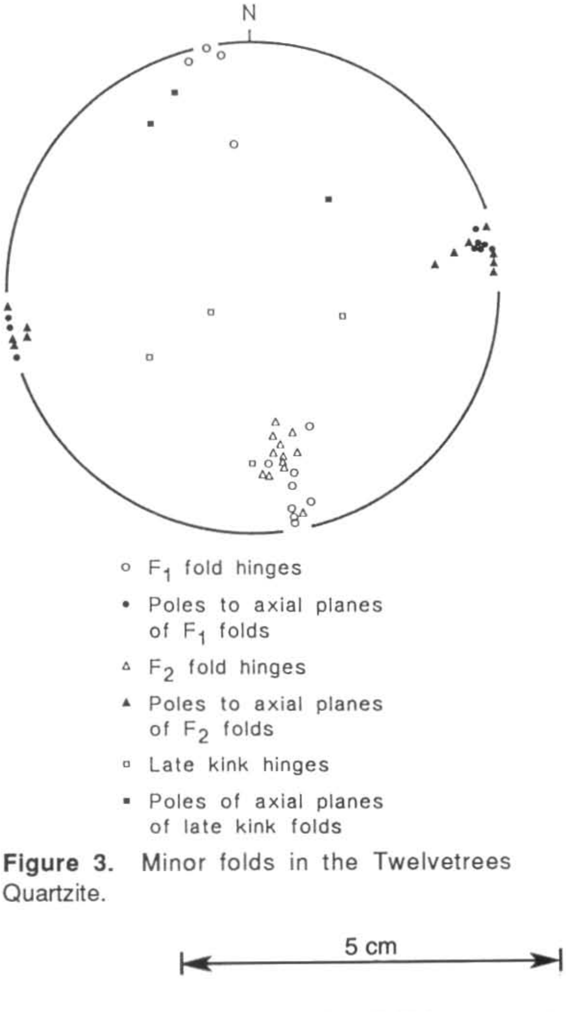


Figure 3. Minor folds in the Twelvetrees Quartzite.

150–175° plunging 20–75°S and axial planes inclined at 70–85°E.

In the Atkins Range quartzites (Ꝑq) only occasional early minor folds occur. These fold the banding and have a similar attitude to those of the Twelvetrees Range (i.e. axes 160–180° plunging 11°N to 25°S). The penetrative cleavage is developed axial planar to them. More commonly seen are minor folds folding the S_1 cleavage with axes trending 170–185° plunging 14–45°N and axial planes 170–185° dipping 90 to 80°E. Some later conjugate kink folds occur with axes also trending 150–175° but steeply plunging 50–85° to N and S. In phyllites within the quartzite at DN271727 minor F_2 folds have axes trending 150–170° and plunging at 8–32°N, and axial planes inclined at 80°E. The dominant S_2 crenulation cleavage is axial planar to these folds.

STRUCTURES IN THE PHYLLITES

In the light green-grey phyllite (Ꝑl) D_1 to D_3 with minor D_4 structures are seen. The dominant structures are S_2 and S_3 crenulation cleavages which trend N to NNW, inclined at 70°E–90° and F_3 minor folds. These structures are particularly well seen at DN187684, DN203705, DN192731 and DN191721. At DN191721 minor F_3 fold axes trend 112–115°, plunging 22–40°E with axial planes inclined at 80°S, but the folded S_2 crenulation cleavage is dominant. Some minor kink folds with hinges trending N-S with low plunges appear to be subsequent D_4 structures. At DN203705 the S_3 crenulation cleavage becomes the dominant cleavage.

In the sequence of mixed grey quartz-mica and mica-quartz phyllite (Ꝑp) D_1 to D_3 structures are seen and the dominant structures are an S_2 crenulation cleavage, minor F_2 folds and minor F_3 kink folds.

In the phyllites generally no folds are seen associated with the S_1 cleavage. The early structures are only preserved where thin quartzite bands are intercalated with the phyllites and at DN235717 some minor F_1 tight folds are seen refolded by open to isoclinal minor F_2 folds. Minor F_2 folds are common in outcrops along the Gordon River in phyllites east of the Twelvetrees Range, particularly at DN235716, DN241709 and DN237714. The F_2 hinges generally trend 145–180° plunging at 25–55° SSE and axial planes parallelling the dominant S_2 crenulation cleavage inclined at 45–85°ENE, though occasionally at high angles to the W (fig. 4). In places the dominant S_2 crenulation cleavage is folded into minor conjugate F_3 kink folds. The trend of the hinges is very variable (see stereogram, fig. 5) with plunges of 20–87° to the NNE to SE. At DN241707 two sets of F_3 folds are seen, one set with hinges transverse to the strike and steeply plunging to the east and another set with hinges in the direction of the strike and gently plunging to the south.

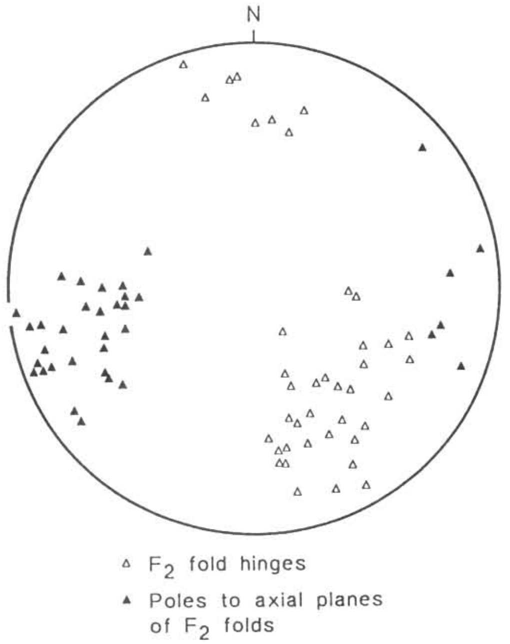


Figure 4. Minor F_2 folds in the mixed grey mica-quartz and quartz-mica phyllite east of the Twelvetrees Range.

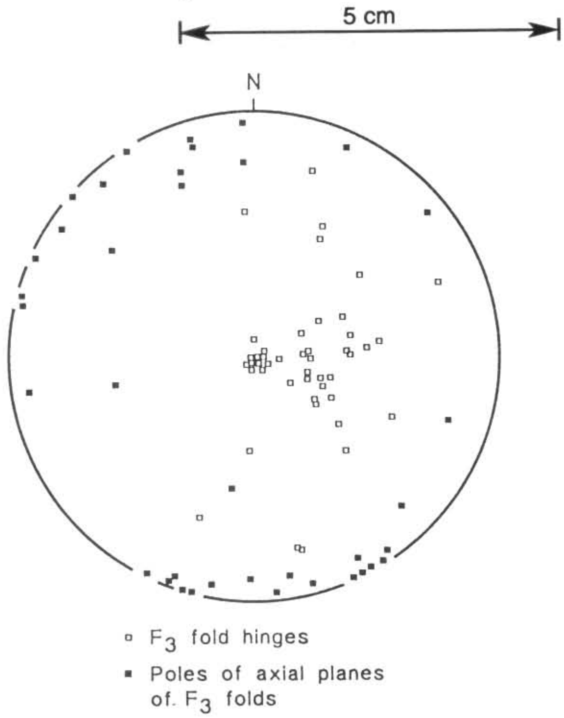


Figure 5. Minor F_3 folds in the mixed grey mica-quartz and quartz-mica phyllite east of the Twelvetrees Range.

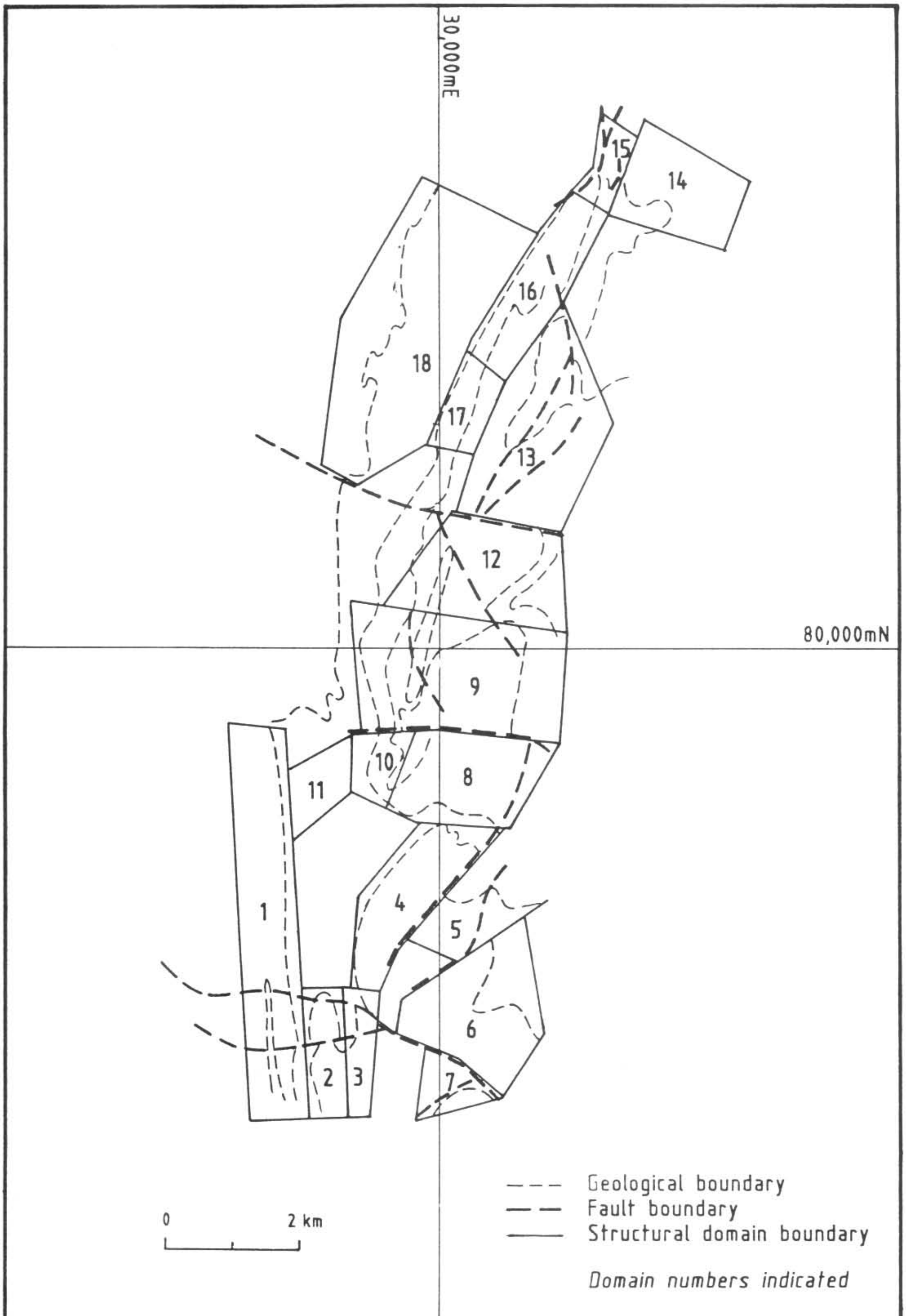


Figure 6. Structural domains in The Pleiades Range.

5 cm

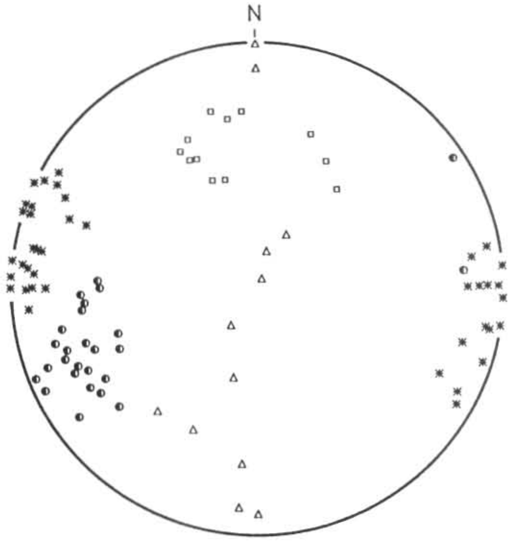


Figure 7. Stereoplot of structural elements from domain 1.

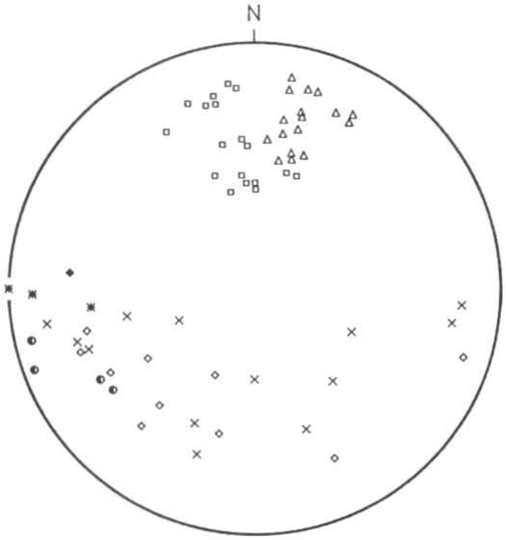


Figure 8. Stereoplot of structural elements from domain 2.

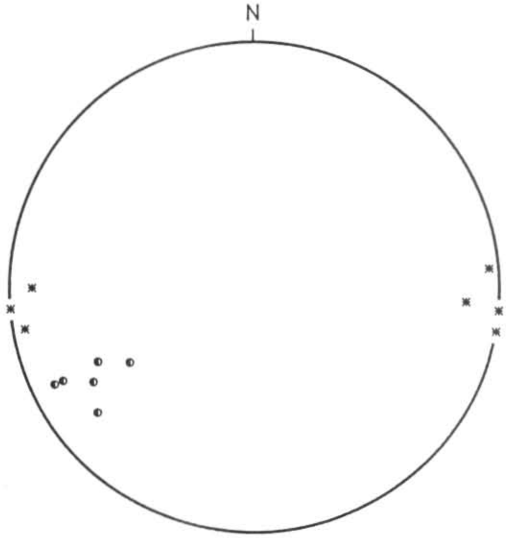


Figure 9. Stereoplot of structural elements from domain 3.

5 cm

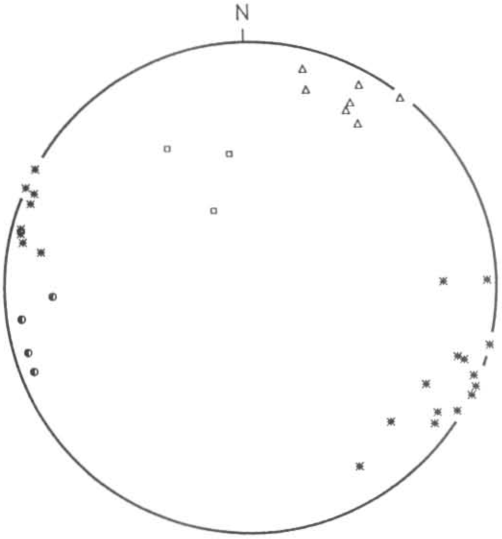


Figure 10. Stereoplot of structural elements from domain 4.

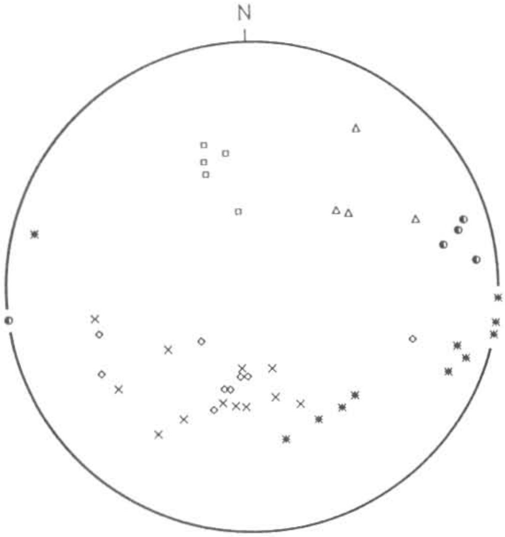


Figure 11. Stereoplot of structural elements from domain 5.

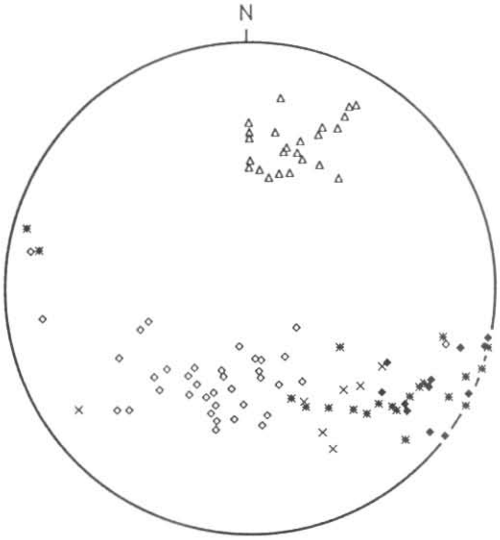


Figure 12. Stereoplot of structural elements from domain 6.

5 cm

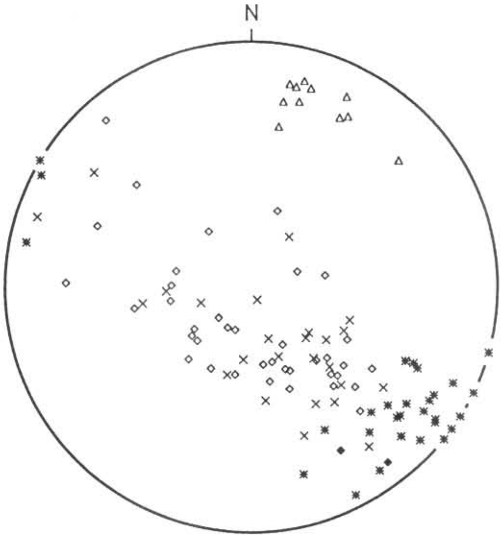


Figure 13. Stereoplot of structural elements from domain 8.

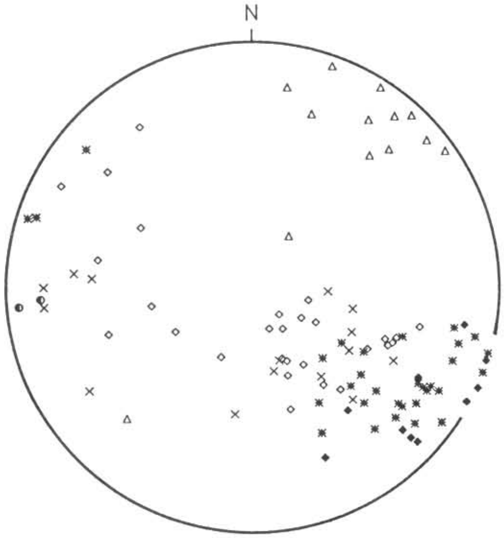


Figure 14. Stereoplot of structural elements from domain 9.

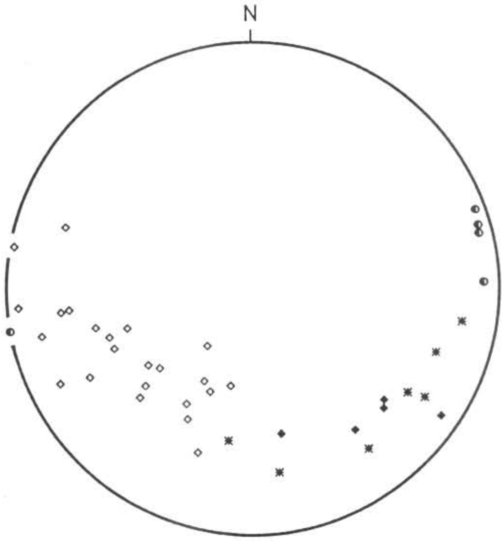
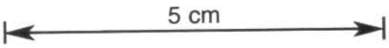


Figure 15. Stereoplot of structural elements from domain 10.



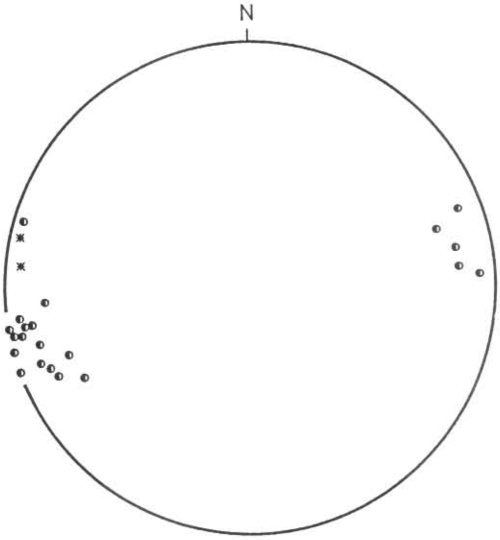


Figure 16. Stereoplot of structural elements from domain 11.

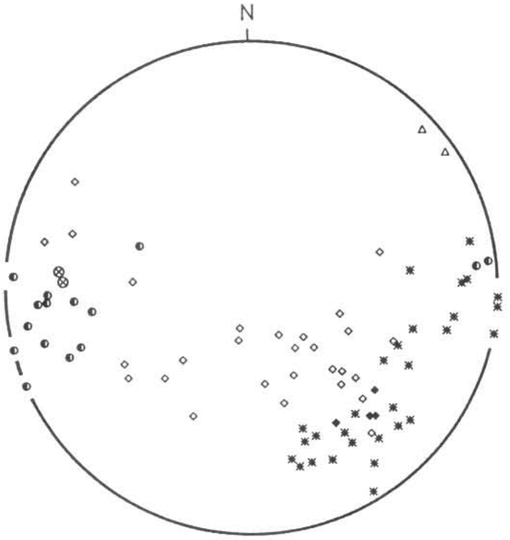


Figure 17. Stereoplot of structural elements from domain 12.

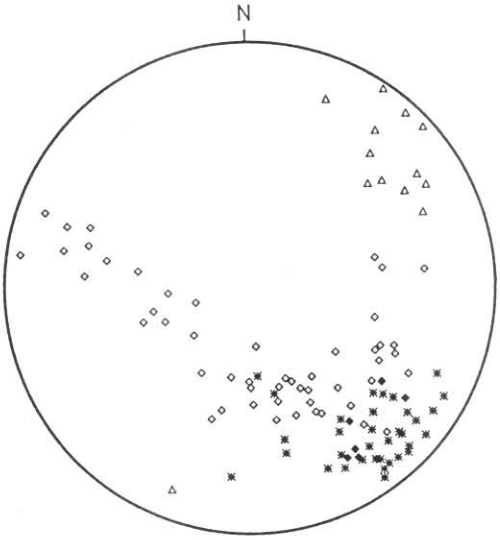


Figure 18. Stereoplot of structural elements from domain 13.

5 cm

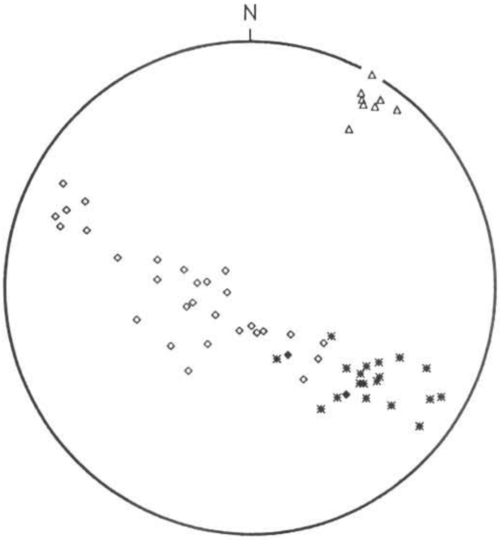


Figure 19. Stereoplot of structural elements from domain 14.

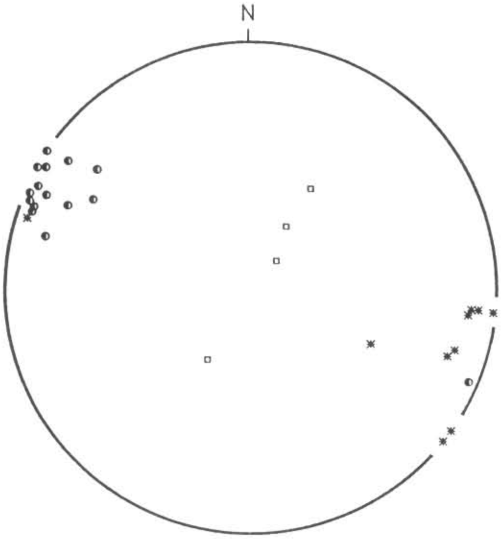


Figure 20. Stereoplot of structural elements from domain 15.

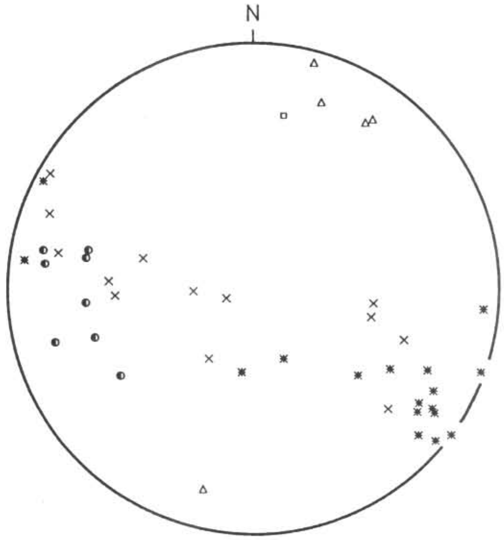
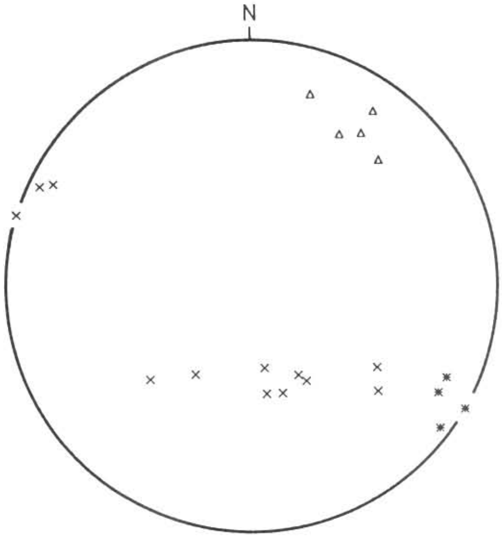


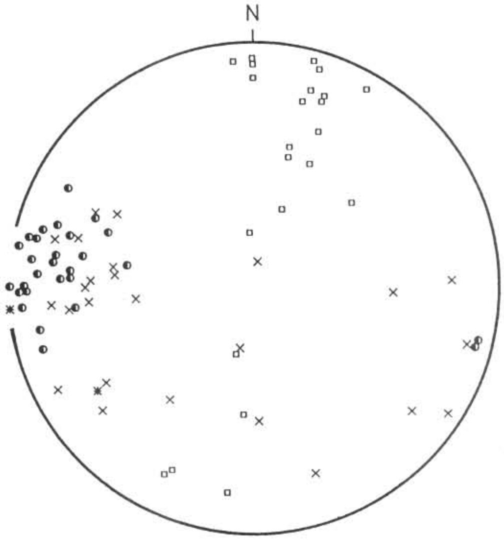
Figure 21. Stereoplot of structural elements from domain 16.

5 cm



△ F_2 fold hinges
✱ Poles to S_2 cleavage
× Poles to bedding, way up unknown

Figure 22. Stereoplot of structural elements from domain 17.



▫ F_3 fold hinges
✱ Poles to S_2 cleavage
• Poles to S_3 cleavage
× Poles to bedding, way up unknown

Figure 23. Stereoplot of structural elements from domain 18.

5 cm

The sequence of mixed grey phyllite (Ᵽp) and flanking quartzite to the west of the Twelvetrees Range form a major southward plunging, asymmetric synform. Minor structures suggest this is a D_2 structure.

FAULTING

On the continuation of the Twelvetrees Range north of the Gordon River aerial photographs reveal a pattern of approximately E-W and NE-SW lineaments. These lineaments displaced a N-S zone of dark vegetation which at DN232705 in the Gordon River was confirmed as marking a phyllite band. One of the major lineaments coincides with the displacement of several rock units farther east thus indicating that it corresponds with a fault. This displacement indicates a sinistral wrench component to the fault since the displaced structures are close to vertical. It is probable that the other lineaments also represent faults.

THE PLEIADES AREA

M. P. McClenaghan

Throughout the Pleiades and Junction Range area (PRW) the very uniform coarse grained massive current bedded quartzite (Ᵽa) units have a single cleavage which is axial planar to minor folds with hinges trending and plunging north-east and with axial planes dipping north-west. The north-west limbs of these folds are frequently overturned. A series of major folds of similar attitude to the minor folds occur along the eastern side of the Pleiades Range. In the phyllite units an earlier cleavage associated with minor folds of the same attitude is crossed by a later crenulation cleavage which in the southern part of the Pleiades Range trends at 180–140° swinging progressively to 10–40° in the north and generally having a steep dip to the east. In the south this cleavage has marked angular discordance with the earlier cleavage. The earlier cleavage in the phyllite is tentatively correlated with the cleavage in the quartzite due to its similar attitude and the similar attitude of the minor folds associated with the cleavage in both rock types. It is concluded that the dominant cleavage in the quartzite is the same one throughout the area due to its uniform attitude and style of development. At DN337869 in the northern Pleiades the dominant cleavage in the quartzite can be seen to be a crenulation cleavage and thus at least S_2 in that area. In the central and southern Pleiades at DN313804 and DN300773 a crenulation cleavage in light green-grey phyllite (Ᵽl) has the same attitude as the cleavage in the adjacent quartzite thus suggesting it is also at least S_2. The latest cleavage in the phyllites can be seen at a few localities (e.g. DN325880, DN305863) to crenulate a crenulation cleavage and thus to be at least S_3. These observations suggest that the dominant cleavage in the quartzites in The

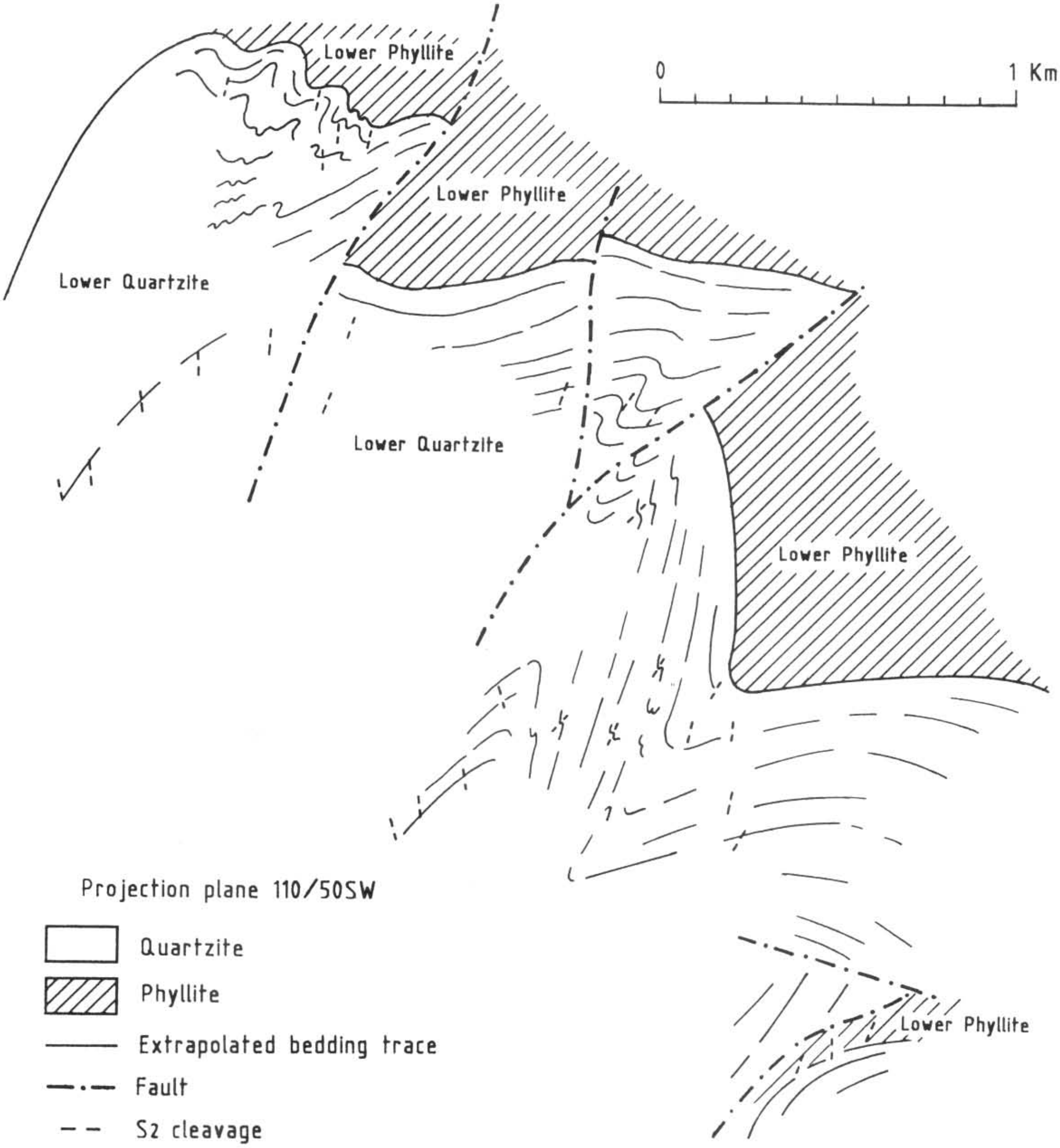


Figure 24. Down plunge profile, domains 4 to 7.

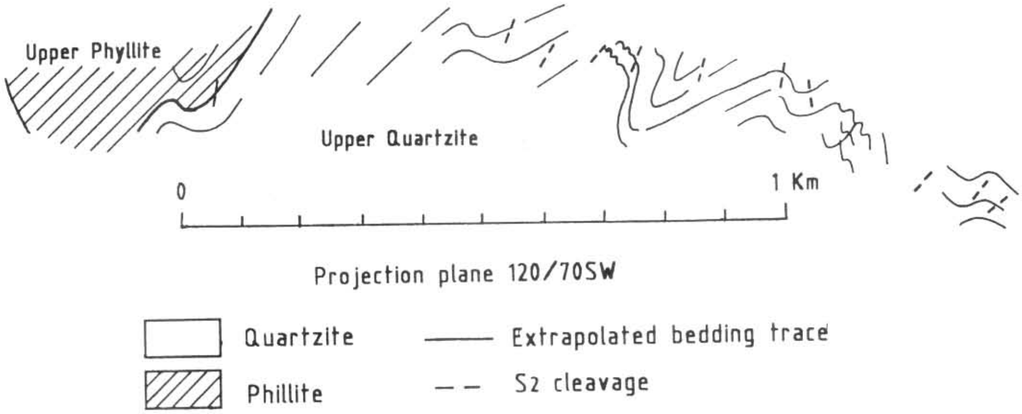


Figure 25. Down plunge profile, domain 8.

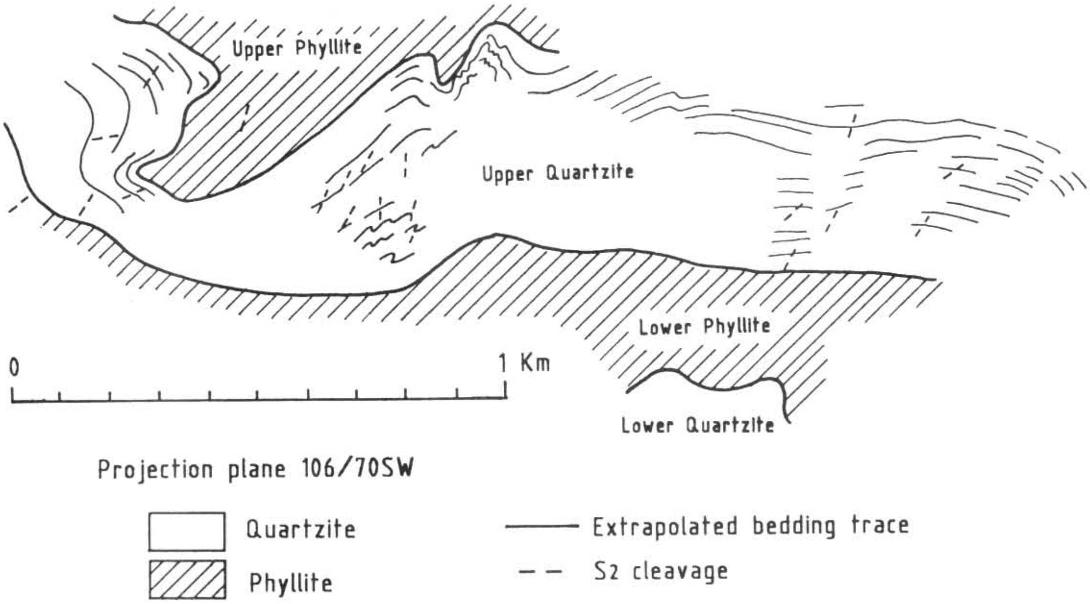


Figure 26. Down plunge profile, domain 9.

5 cm

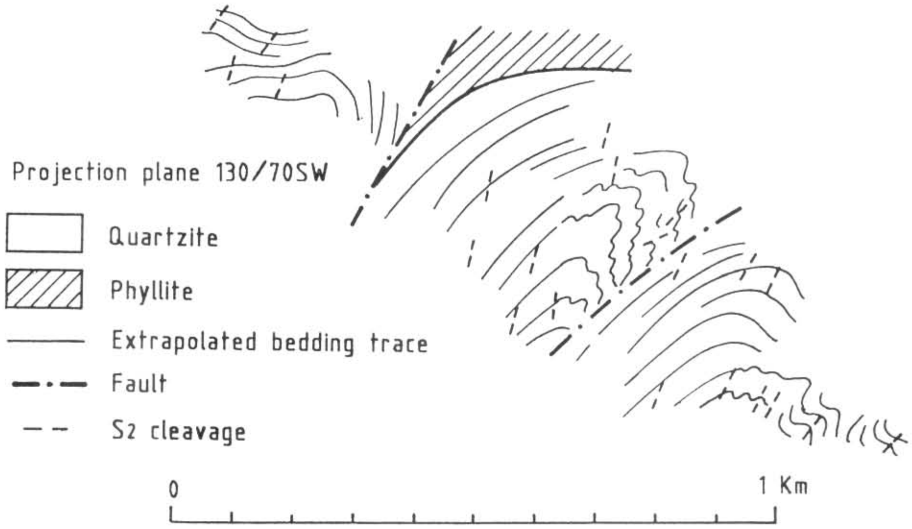


Figure 27. Down plunge profile, domain 13.

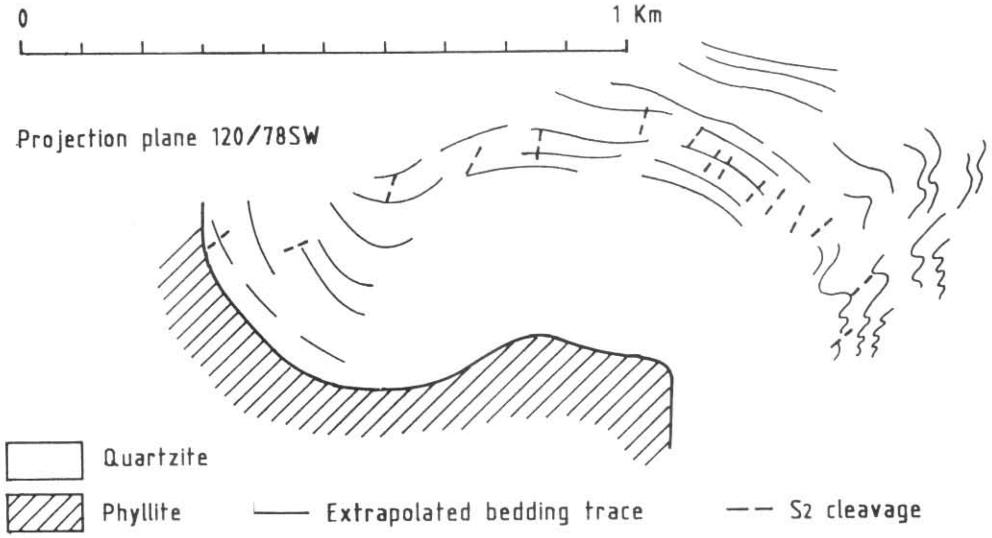
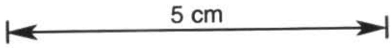


Figure 28. Down plunge profile, domain 14.



Pleiades is S_2 and that the dominant cleavage in the phyllites is S_3. The S_1 cleavage is almost entirely obliterated.

The Pleiades Range has been divided up into a number of structural domains (fig. 6) and structural measurements from these domains is presented in fig. 7–23. A series of structural profiles (fig. 24–28) illustrate the major structures.

On the Pleiades Range sharp breaks in the structure, bringing distinct rock types against each other, have allowed a number of faults to be mapped. The faults occur with three main trends, approximately E-W, NW-SE to N-S, and NE-SW.

The faults of the latter trend are clearly high angle since they bend only slightly where they cross areas of high relief. The down throw sides are to the south-east (fig. 24, 27). The correspondence of their trends with that of the major folds suggests that they were produced by the same stress field and that they are high angle thrusts with a sense of movement to the south-east.

The faults of the other two trends are also high angle as judged by their trace across areas of high relief. A downthrow to the south can be postulated for two of the E-W faults but for the other faults the throws are unclear.

JUNCTION RANGE (WEST)

N. J. Turner

The interbanded quartzite and phyllite (Ꝑgp) on the western ridge of Junction Range displays approximately coplanar structural features related to two or, probably, three phases of deformation. A few cross folds are also present which are probably related to a fourth deformation phase.

Quartzite in the sequence generally has mortar texture (plates 1, 2) in which sand-sized, clastic grains of mainly monocrystalline quartz are contained in a microcrystalline matrix. The clastic grains are strained and have undergone some reduction in size by removal or replacement of material around their margins. They make up all but a few per cent by volume of some rocks but there is a range of compositions such that matrix may comprise up to 60% (volume estimate from outcrop and thin section) of other rocks. Quartz or quartz and phyllosilicates comprise the matrix and display variable texture. In some quartzite the matrix quartz grains are equant whilst in other quartzite they are elongate and well aligned. Length to breadth ratios of elongate grains range up to about 3:1. Strong elongation and good alignment of quartz grains often coincides with the presence of higher proportions of phyllosilicates in the matrix.

On weathered surfaces the clastic grains in quartzite appear discoidal in shape and show strong preferred orientation giving rise to a penetrative fabric. The apparent grain shape is sometimes misleading in that the clastic grains may be fairly equant but the well aligned matrix sweeps around them and beards have formed thus imparting a lenticular fabric. Where the clastic grains are actually lenticular there is evidence of solution in the plane of the cleavage. This is indicated by the truncation of grain margins that are oriented parallel to cleavage, by very thin, relatively long seams of very fine grained, opaque material (?carbonaceous plus hematite) or muscovite that is rich in opaque material. These seams are interpreted as insoluble residue and may provide the strongest parting surface in the quartzite.

The penetrative cleavage defined by the shape of matrix and clastic grains is the earliest cleavage (S_1) identified in the quartzite and is also the dominant cleavage. It occupies the axial surfaces of folds with thickened apices and variable, steep plunges (fig. 29) whose limbs form dihedral angles of 20 to 30° at the hinge but become less divergent away from the hinge. Similarly oriented, flattened folds with larger dihedral angles (about 80°) and crenulation cleavage as the axial surface structure are also present and are plotted in Figure 30. The crenulation cleavage may be close spaced,

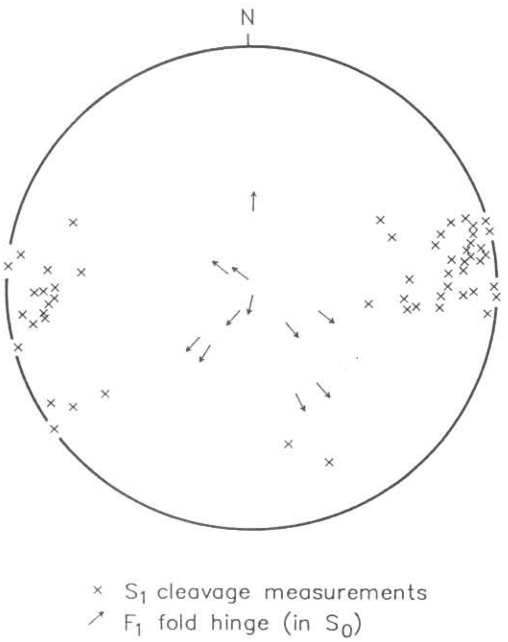


Figure 29. Lambert projection of measurements of the orientations of S_1 cleavage and F_1 folds in Ꝑqp on Junction Range.

5 cm

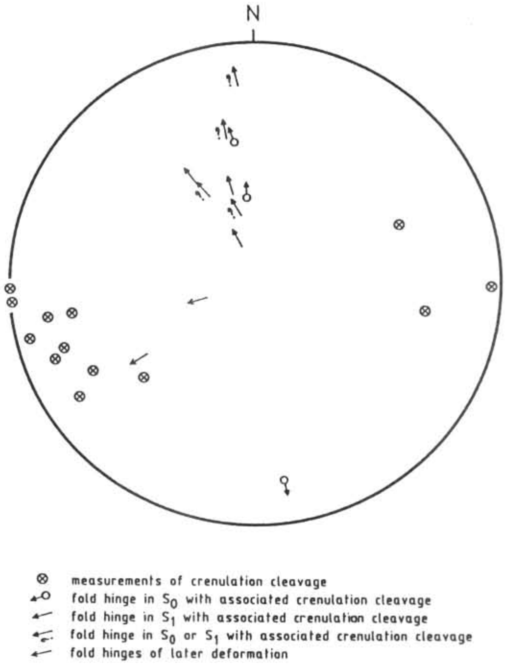


Figure 30. Lambert projection of measurements of orientation of crenulation cleavage in Ꞓqp on Junction Range (west). Folds associated with crenulation cleavage and two minor cross-folds are also shown.

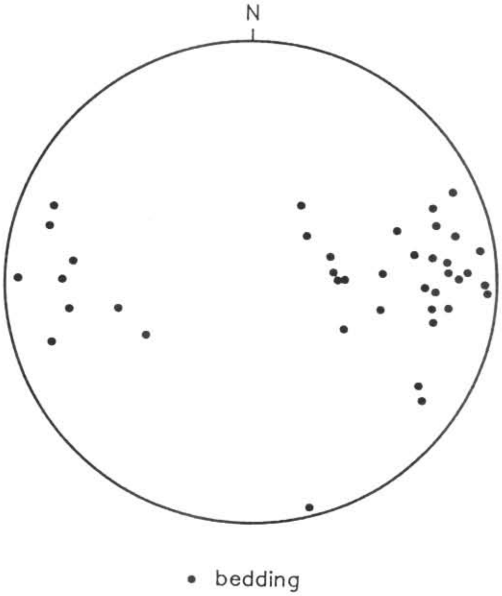


Figure 31. Lambert projection of measurement of bedding orientation in Ꞓqp on Junction Range (west).

5 cm

dominant and widespread in interbanded phyllite but is expressed in quartzite only as close-spaced parting in the near vicinity of the hinge. Some uncertainty arose in the field as to whether or not there may be two coaxial and coplanar fold phases with associated crenulation cleavage because the morphology of crenulation can vary greatly. It may be widely spaced (5–10 mm) and occur in narrow zones associated with angular, chevron or kink-like folds. Alternatively it may be very close spaced and pervasive through large outcrops. A few open late folds of short wavelength and low amplitude plunge at right angles to the main fold trend. No associated cleavage was recognised and the plot of bedding measurements (fig. 31) for the western ridge of Junction Range indicates that this phase of folding had little regional effect.

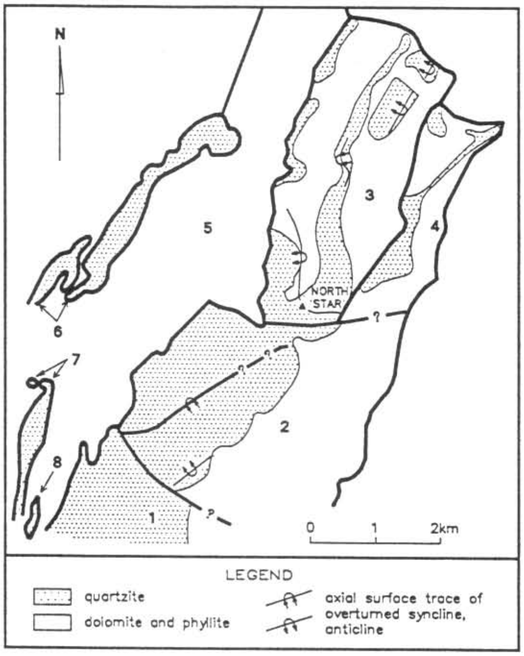


Figure 32. Map of structural sub-areas in the Precambrian rocks of the North Star area. Quartzite units are stippled. Sub-area 3 extends about 0.5 km north of the boundary of Huntley map.

NORTH STAR AREA

N. J. Turner

From the northern part of The Pleiades through North Star to beyond the northern edge of Huntley map there is a continuous belt of Precambrian quartzite. There are smaller, separate belts of quartzite north-east of North Star, on Mt Curly and south of Mt Curly. Structural data for these belts of quartzite and

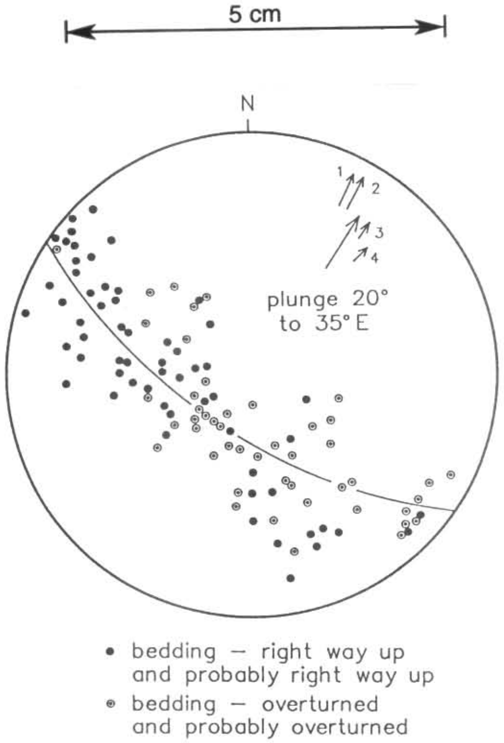


Figure 33. Lambert projection of measurement of bedding orientation in quartzite in Sub-areas 1-4 of the North Star area. The best-fit axis for each sub-area is shown together with the overall best-fit axis.

for the intervening tracts of dolomite and phyllite are presented according to the subarea scheme shown in Figure 32.

Quartzite in Sub-Areas 1–4

Bedding: Measurements of bedding (S_0) orientation in Sub-areas 1–4 are shown in equal area projection in Figure 33. The data approximate to a cylindroidal pattern with an axis plunging 20° below 35° E. Axes for the individual sub-areas are also shown and these cluster close to the overall axis although there is a progressive dextral rotation of the axes from Sub-area 1 to Sub-area 4. Because of fewer data, the axis for Sub-area 1 was not as well defined as those of other sub-areas.

As in other parts of the Precambrian terrane covered by Huntley map there are several generations of cleavage in Sub-areas 1–4 but the cylindroidal form of the S_0 projection indicates that the folding phases associated with their development have been essentially co-axial. Such a cylindroidal form of folding permits the projection of bedding measurements in order to generate a fold profile. In preparing the profile in Figure 34 the positions of quartzite boundaries were also projected. The projected boundaries exhibit intervals which are discordant to inferred bedding traces derived from projected bedding measurements and these discordant intervals are interpreted as faults. The accuracy of the positioning of faults in the profile is dependent on their structural concordance with the folds. Only those faults or fault-segments which contain a line parallel to the axis of folding will be accurately portrayed in the profile. Faults which clearly cross-cut the fold axis such as those which form the boundaries between Sub-areas 1 and 2 and Sub-areas 2 and 3 are not accurately portrayed. Movement on these cross-cutting faults is considerable. There is at least 180 m, and probably over 300 m, of north-side-up movement causing the repetition of the recumbent anticlinal hinge across the south-western boundary of Sub-areas 1 and 2. About 380 m of north-side-up movement between the two isolated bodies of quartzite in the northern part of Sub-area 3 is indicated by matching the hinges of the major recumbent anticlines that are present in each. As a consequence of the inability to accurately project these major faults, the structural profile presented in Figure 35 is approximate rather than accurate.

Cleavage: Three cleavages have been distinguished in the quartzite in Sub-areas 1–4 and in quartzite elsewhere in the North Star and Mt Curly regions. The earliest cleavage (S_1) has the same morphology as the earliest cleavage in quartzite on Junction Range (see previous section). It involves penetrative alignment of metamorphic matrix grains and relict clastic grains in mortar-textured quartzite. Figure 36 is an equal area projection of measurements of S_1 in Sub-areas 1–4 and demonstrates that the cleavage in Sub-areas 2, 3 and 4 is folded about a girdle with axis plunging 28° below 37°E, that is, almost parallel to the axis about which bedding is folded. Each of the sub-areas defines a different part of the girdle and Sub-area 1 is a little off the girdle.

The second cleavage (S_2) in the quartzite is spaced and is the dominant cleavage in Sub-areas 1–4. It is defined by close spaced partings with less than one to several millimetres separation. The partings are discontinuous and they anastomose. They coincide with thin (0.5 mm) muscovite seams in which fine grained opaque minerals may be concentrated. Highly elongate quartz grains are sometimes present in the seams as may be microlithons in which earlier crenulated fabric is preserved. Between the seams or partings the S_1 cleavage may be well-etched in weathered outcrop.

The equal area projection of S_2 measurements in Sub-areas 1–4 (fig. 37) shows Sub-areas 2, 3 and 4 again combining to define a cylindroidal fold with Sub-area 1 a little off the fold girdle. The axis of the fold plunges 25° below 43°E which is close to the values for the folds defined by both S_0 and S_1. Cleavages (S_3) and outcrop-scale folds (?F_3) which are thought to have been produced in the same late deformation period in which S_2 was regionally folded were measured throughout the North Star vicinity and are

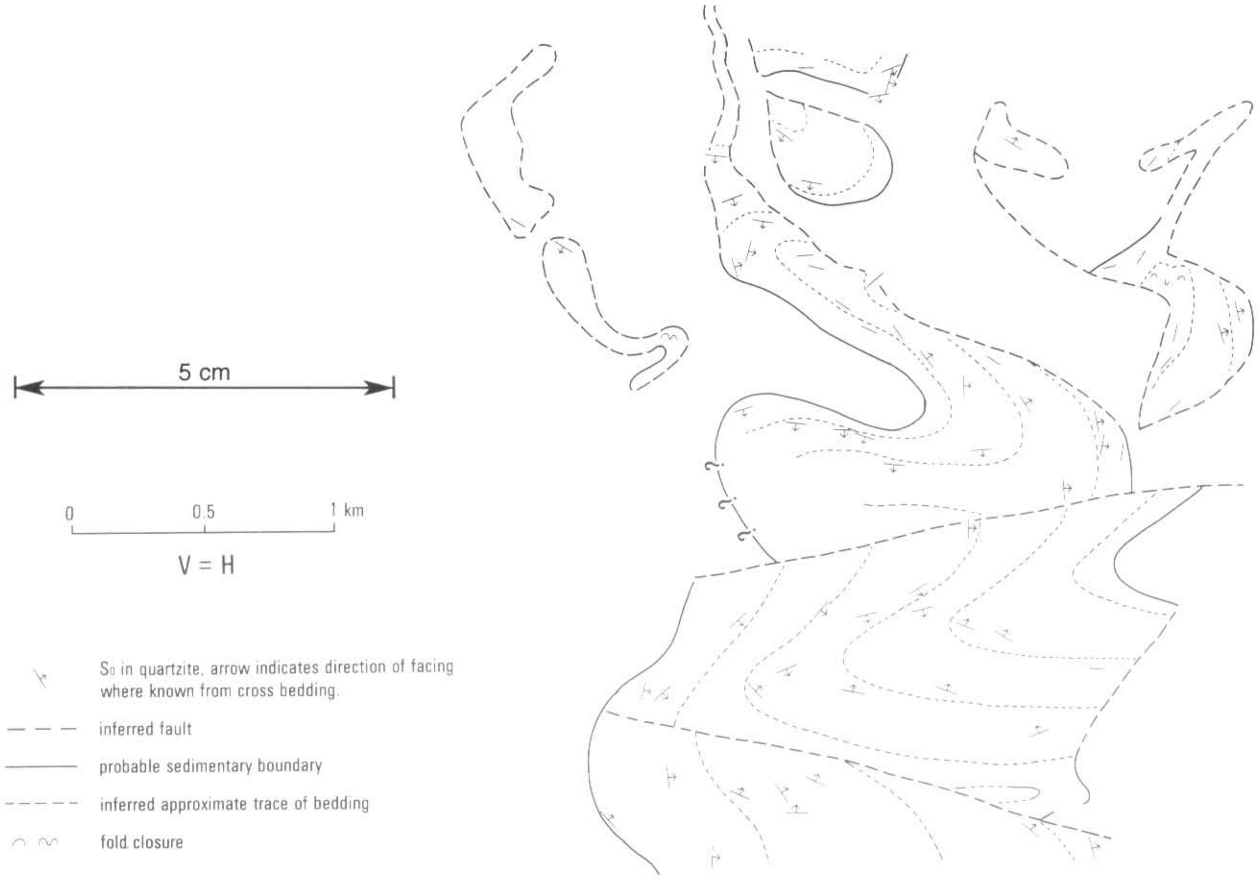


Figure 34. Axial projection of measurements of bedding orientation and traces of quartzite boundaries in Sub-areas 1-4 of the North Star area. The plane of projection strikes 125°E and and dip 70°SW. See text for comments on the accuracy of the projection.

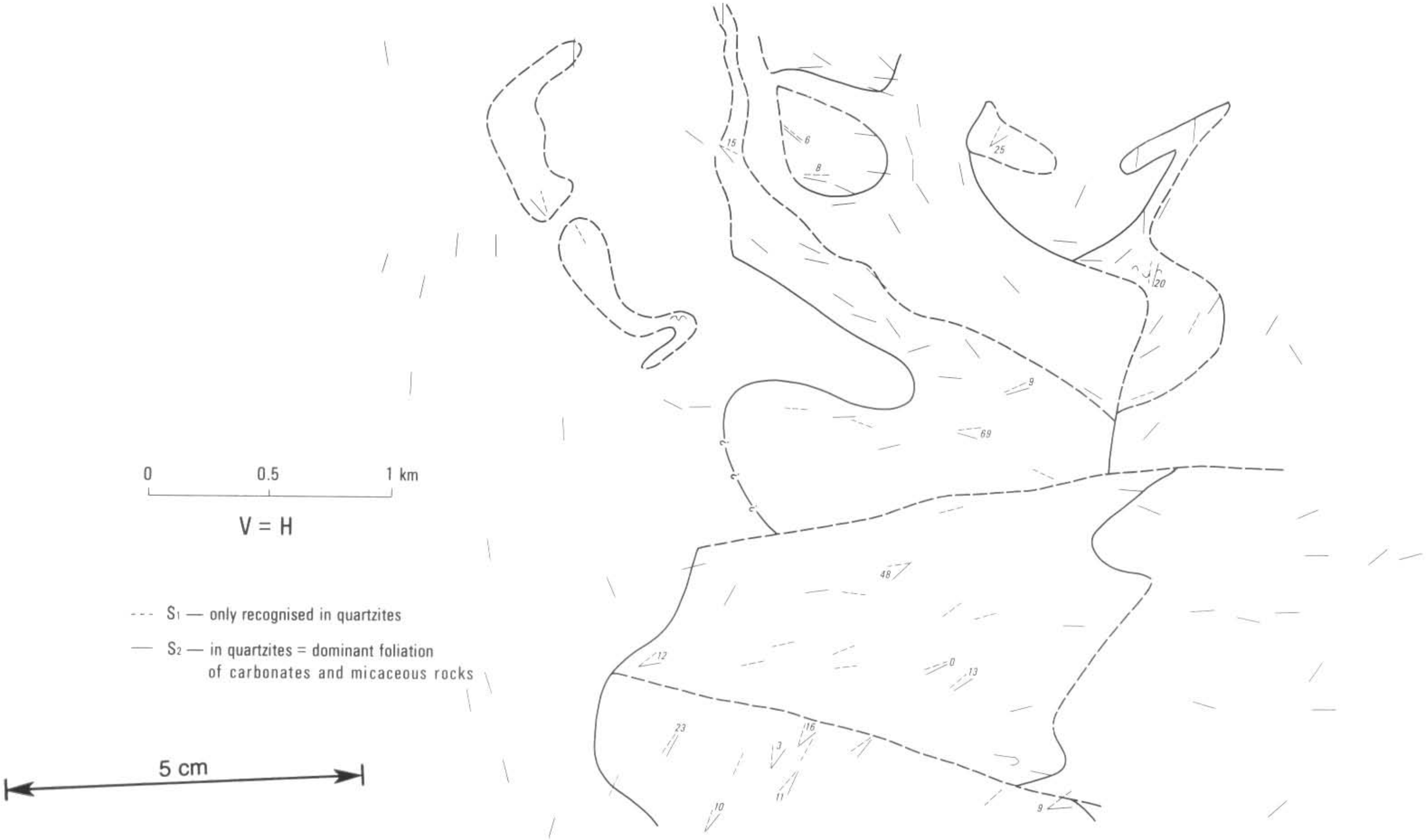


Figure 35. Axial projection of measurements of bedding orientation and traces of quartzite boundaries in Sub-areas 1-4 of the North Star area. The plane of projection strikes 125°E and dip 70°SW. S_1 and S_2 cleavage orientations projected.

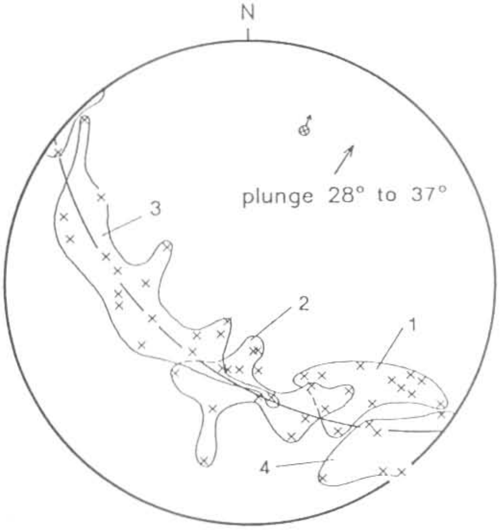


Figure 36. Lambert projection of measurement of S_1 cleavage and on F_1 fold in quartzite in Sub-areas 1-4 of the North Star area. The data are identified according to the sub-area from which they were derived.

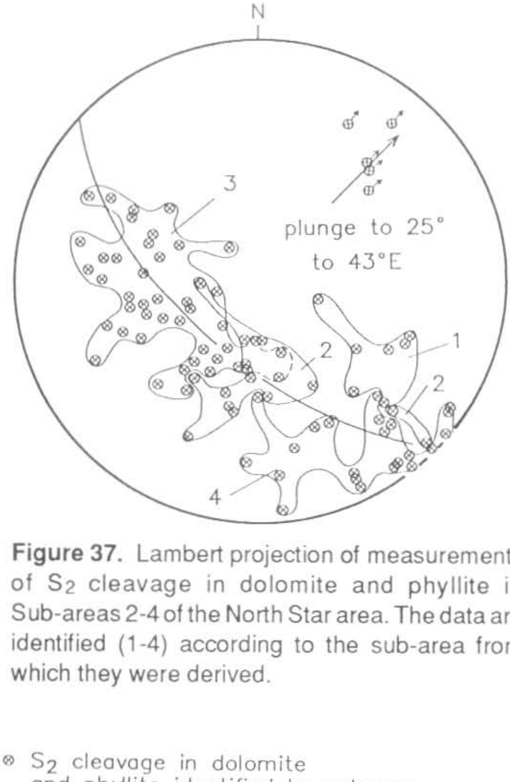


Figure 37. Lambert projection of measurements of S_2 cleavage in dolomite and phyllite in Sub-areas 2-4 of the North Star area. The data are identified (1-4) according to the sub-area from which they were derived.

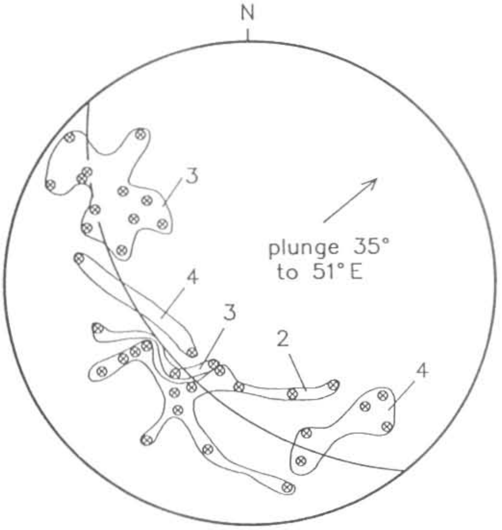


Figure 38. Lambert projection of measurements of S_2 cleavage in dolomite and phyllite in Sub-area 2-4 of the North Star area. The data are identified (2-4) according to the sub-area from which they were derived.

5 cm

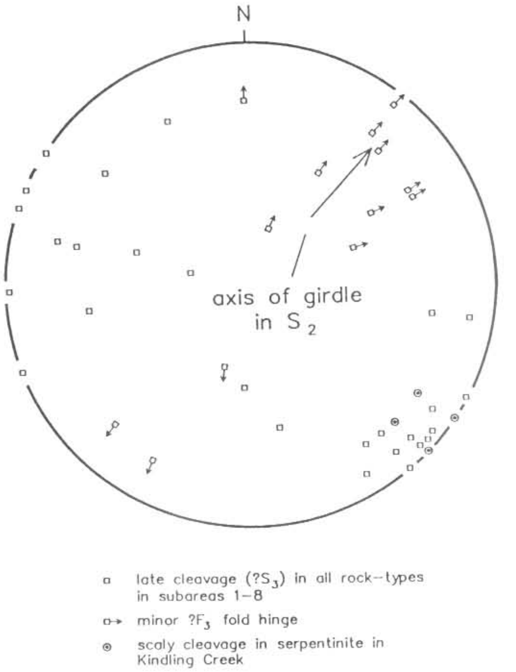


Figure 39. Lambert projection of measurement of the orientation of late cleavage ($?S_3$) and folds ($?F_3$) in all lithologies in Sub-areas 1-8 of the North Star area. Several measurements of scaly cleavage in serpentinite in Kindling Creek are also plotted.

plotted in Figure 39. Their trends and plunges are statistically consistent with the trend and plunge of the regional fold in S also, their axial surfaces are generally steeply dipping and they show no clear evidence of further re-folding. In outcrop the folds have short wavelengths and low amplitudes and the cleavage tends to be wide-spaced (10 mm) with little associated metamorphic differentiation. The folds and cleavage occur in localised zones within individual outcrops.

Dolomite and phyllite in Sub-Areas 2–5

Throughout the North Star region the main cleavage in mica-dominant phyllite is strong and imparts a finely foliate character to outcrops. Metamorphic segregation is not particularly marked either in outcrop or in thin section although some segregation of fine dusty opaque minerals and muscovite may be evident. Little evidence of cleavages earlier than the main cleavage was found. The best indication of an earlier, structurally-related fabric is provided by preferred orientation of crystallographic cleavage in chlorite/muscovite porphyroblasts in phyllite (Ꝑg) east of The Pleiades. The porphyroblasts predate the main foliation and their internal cleavage may be aligned oblique to compositional banding.

Metamorphic differentiation is more pronounced in quartz-dominant phyllite and in places there is good preservation of a cleavage (S_1) earlier than the main cleavage (e.g. DN328895). The early cleavage is defined by penetrative alignment of tiny muscovite flakes that are intermixed with equant quartz. Metamorphic differentiation is a feature of the second (S_2) and main cleavage which is defined by anastomosing mica-rich folia with intervening relatively quartz-rich regions. It is in these latter regions that S_1 may be preserved (plates 14–15).

In outcrop the main fabric in dolomitic rocks is commonly a spaced parting which may be either oblique to thicker compositional banding (e.g. DN389932) or parallel to it. The parting itself is often due to a thin, compositional lamination comprising 1–2 mm folia of aligned muscovite which separate subplanar lenses of relatively pure, massive dolomite 5–20 mm thick. An earlier, crenulated fabric is occasionally (rarely) recognisable in the dolomite laminae and may correspond to S1. Late, wide-spaced, poorly differentiated crenulation cleavage (S_3) is present in zones in dolomite outcrops and is also present in both mica phyllite and quartzose phyllite.

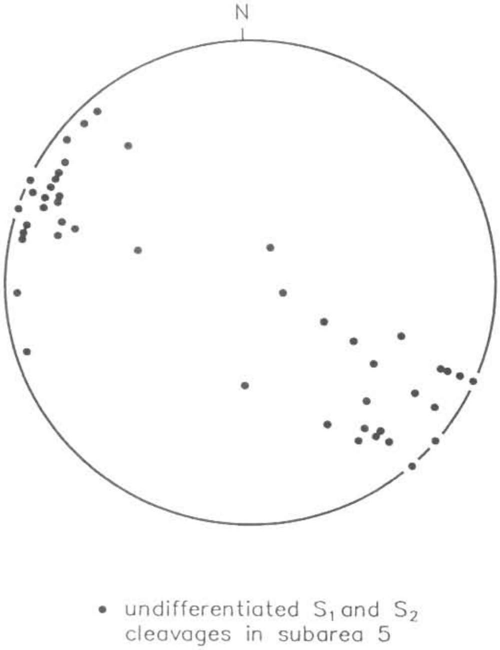


Figure 40. Lambert projection of measurements of the orientation of cleavage (undifferentiated S_1/S_2) in dolomite and phyllite of Sub-area 5 of the North Star area.

5 cm

Plate 14. Photograph of an outcrop of quartz dominant phyllite in which the spaced, main cleavage (subhorizontal) is S_2. S_1 is preserved as a penetrative surface in some of the wider, more quartzose, lithons between individual S_2 surfaces. Note the quartz vein which is isoclinally folded with S_2 as the axial surface fabric. The open, subvertical, fold in S_2 is the type of structure categorised as F_3. Elsewhere in this outcrop a wide-spaced crenulation cleavage exhibiting relatively little metamorphic differentiation occurs in the axial surface of such folds.

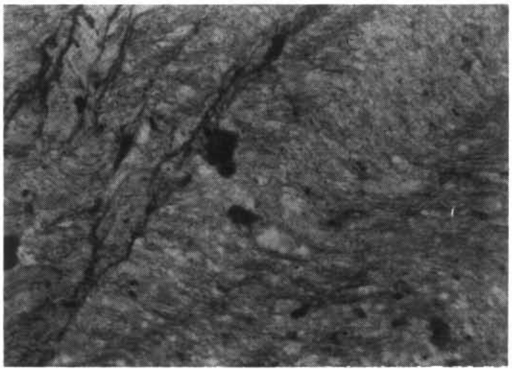


Plate 15. Photomicrograph of a phyllite similar to that illustrated in Plate 14. S_1 is the penetrative fabric whilst S_2 is defined by the anastomosing stringers of opaque mineral. These stringers are within a seam of muscovite. Field of view 4.33 x 2.8 mm.

Orientation data - Sub-areas 2–4: The main cleavage in dolomite and phyllite in each of Sub-areas 2, 3 and 4 is of similar orientation to the S_1 and S_2 cleavages in the adjacent quartzite and data from the three sub-areas combine to define a regional fold axis (fig. 38) that is very similar to those defined by S_1 and S_2 data from quartzite. On the basis of the orientation data it is impossible to correlate either S_1 or S_2 in the quartzite with the main cleavage in the micaceous and dolomitic rocks. However, outcrop relationships indicate that the main cleavage in dolomite and phyllite is the second cleavage and thus a correlation with S_2 in quartzite is very probable.

Orientation data - Sub-area 5: Sub-area 5 extends along the entire western side of Sub-areas 1, 2 and 3 but there is no change in orientation of the regionally sub-parallel and generally steeply dipping S_1 and S_2 cleavages (fig. 40) corresponding to the changes in orientation of S_1 and S_2 in these sub-areas. It is therefore inferred that a major fault marks the eastern boundary of this region of dolomite and phyllite.

Quartzite in Sub-Areas 6–8

A strong NE-SW trend is maintained by structures in each of Sub-areas 6, 7 and 8. In Sub-area 6 the S_1 and S_2 cleavages are again regionally subparallel and steeply dipping (fig. 41). The absence of a girdle from the cleavage data was unexpected because folds in some parts of the quartzite belt appear to be recumbent when viewed from a distance (e.g. DN343926, DN335913). Cleavage relationships in these folds were not satisfactorily resolved in the field. In Sub-area 7 (fig. 42) the main S_2 cleavage is shallowly dipping at DN328895 and in Sub-area 8 the S_2 cleavage defines a partial girdle (fig. 43) on approximately the same axis as S_0.

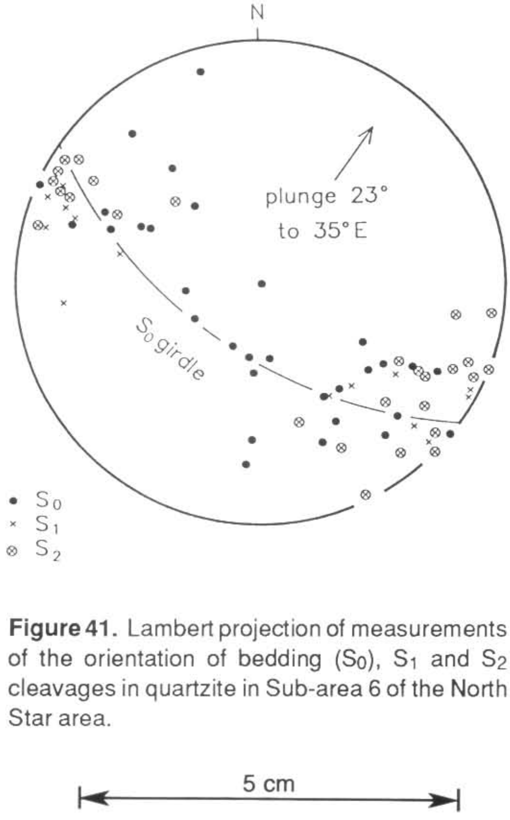


Figure 41. Lambert projection of measurements of the orientation of bedding (S_0), S_1 and S_2 cleavages in quartzite in Sub-area 6 of the North Star area.

Plate 16. Relatively open, minor folds in well-bedded quartz arenite at North Star [DN372908]. The folds are in the nose of a recumbent anticline.

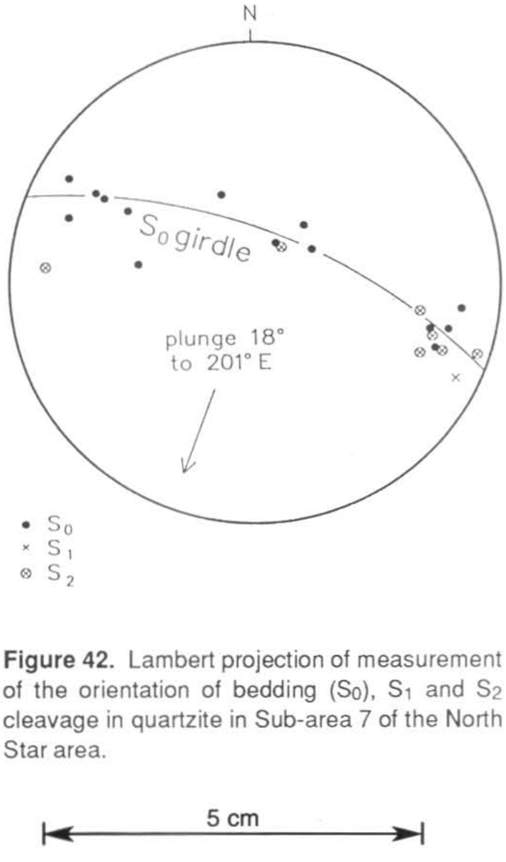


Figure 42. Lambert projection of measurement of the orientation of bedding (S_0), S_1 and S_2 cleavage in quartzite in Sub-area 7 of the North Star area.

Summary and regional relationships

Outcrop and thin section relationships show the presence of folds and cleavages indicative of at least three deformation phases (D_{1-3}) in the North Star region. Equal area projections of bedding and cleavages (fig. 33, 36–39) in quartzite and in dolomite/phyllite sequences in Sub-areas 2–4 demonstrate that the three deformation phases are approximately co-axial. Similarly trending strain features occur in Sub-areas 1 and 5–8 (fig. 33, 36–37, 39–42).

The outstanding feature of the structural profile of Sub-areas 1–5 is the progressive overturning of folds together with S_1 and S_2 cleavages from upright to recumbent in Sub-areas 1–3 and their return to more upright configuration in Sub-area 4 (fig. 34, 35; plate 16). In the projection of S_2 cleavage measurements from these sub-areas there is a girdle corresponding to the progressive overturning which consists of discrete parts, each relating to one of the sub-areas. Such discreteness is also evident in the structural profile where the change in cleavage and fold orientation across the faulted subarea boundaries is sharp rather than transitional. This pattern of discreteness is suggestive of block rotation and it may be that such deformation occurred between the formation of S_2 and S_3. The contribution of D_3 folding to the generation of the girdle in S_2 is unclear because although

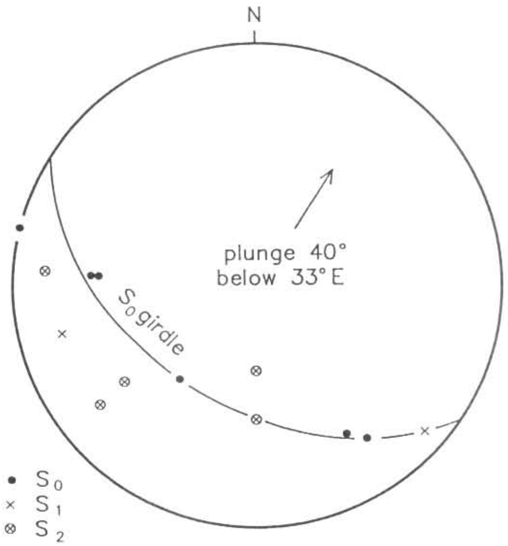


Figure 43. Lambert projection of measurements of the orientation of bedding (S_0), S_1 and S_2 cleavage in quartzite in Sub-area 8 of the North Star area. 5 cm

outcrop scale D_3 structures are evident in all sub-areas, the evidence within the individual sub-areas of D_3-related regional scale folds is limited.

Three phases of cleavage formation have been identified in the Precambrian rocks at North Star whereas five phases were identified by Boulter (1978) in rocks of similar lithology and age on Frankland Range, 50 km to the south-west. Of Boulter's cleavages the third is very restricted geographically and the fifth is restricted lithologically (to phyllite). His first and second cleavages are widespread and exhibit well-developed microfabrics that compare closely with the S_1 and S_2 microfabrics at North Star. The fourth cleavage on Frankland Range is also widespread and is the same type of widely spaced, steeply dipping, metamorphically undifferentiated or poorly differentiated cleavage that has been designated S_3 at North Star.

Major upright folds of about 4 km wavelength are associated with the fourth cleavage on Frankland Range whereas major overturned to recumbent east-facing folds are associated with the first cleavage. Second phase folds are subordinate and mimic the pattern of west to east overthrusting shown by the first phase folds. Third and fifth phase folds are minor.

Correlation of D_1 and D_2 folds and cleavages at North Star with first and second phase structures on Frankland Range is regarded as highly probable. Correlation of most D_3 structures with fourth phase structures at Frankland Range is probable but some folds and cleavages equivalent to the third and fifth phases at Frankland Range may have been included in the D_3 category at North Star. Folds of all phases in both areas are essentially coaxial and at Frankland Range all phases are considered to be pre-Ordovician in age. At North Star a scaly cleavage that is widespread in the ultramafic rocks in Kindling Creek is regionally subparallel to S_3 in the Precambrian rocks (fig. 39) but the relative timing of development with respect to S_3 has not been demonstrated.

Eocambrian-Cambrian rocks

DENISON PLAIN - DENISON GAP REGION

DENISON GAP AREA

N. J. Turner

The main cleavage (S_2) in Sub-area 4 of the Precambrian rocks at North Star is subparallel to the main cleavage in the younger conglomeratic (€ep) and chert-bearing (€ecp) sequences to the east and north-east. There is also subparallelism of main cleavages across the exposed unconformity at DN390937 between quartzite (Ꝑq) in Sub-area 4 and conglomerate. However, because of the similar orientation of all cleavages in the older rocks, the relative ages of cleavages in the younger rocks is uncertain. Since the main cleavage in €ep crenulates an early microfabric, correlation between it and S_2 or a younger cleavage in the Precambrian sequence is likely. The early microfabric is defined by penetrative alignment of tiny muscovite (?phengite) flakes intermixed with very fine-grained, equant to weakly elongate quartz grains. It is associated with the development of 'beards' adjacent to clastic sand grains. The main foliation is defined by long, ragged, discontinuous seams of muscovite in which dusty opaque material may be concentrated. These seams reflect solution on the limbs of crenulations in the early microfabric and consist of insoluble residue.

Correlation of the main foliation in €ep with S_2 in the Precambrian sequence is supported by comparison with cleavages in €ep and €er/€eq in the area south-west of Centre Star. The main cleavages in both €ep and €er/€eq in this area are second cleavages and exhibit similar easterly trending, northerly dipping orientation. Cleavage measurements in €ep (fig. 46) form a partial girdle which plunges approximately 62° to 42°E. Although steeper in plunge than the axes of the S_1 and S_2 girdles (fig. 36–38) in the Precambrian rocks, the trend of the €ep axis is virtually identical. This similarity combined with the the main foliation in €ep being a crenulation cleavage suggests correlation with S_2 in the Precambrian rocks.

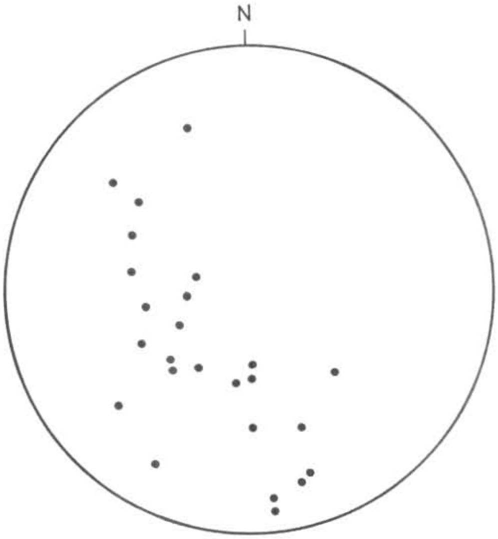


Figure 44. Stereoplot, bedding in Ꞓeq/Ꞓer. 24 measurements.

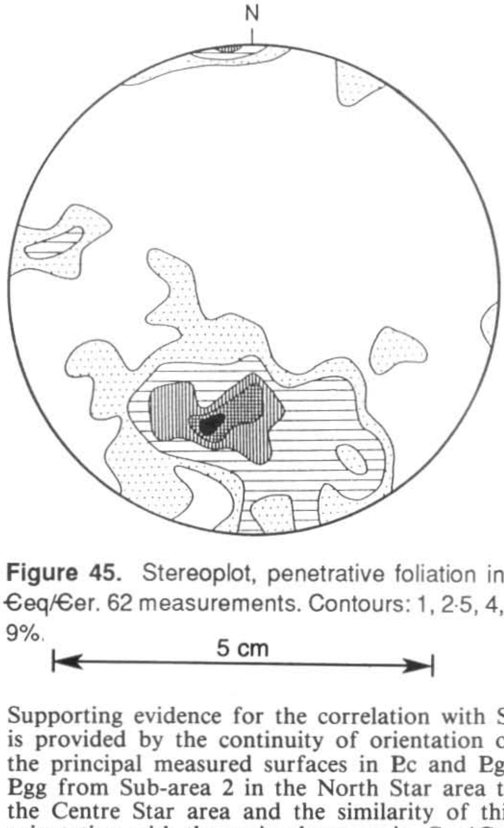


Figure 45. Stereoplot, penetrative foliation in Ꞓeq/Ꞓer. 62 measurements. Contours: 1, 2·5, 4, 9%.

5 cm

Supporting evidence for the correlation with S_2 is provided by the continuity of orientation of the principal measured surfaces in Ᵽc and Ᵽg/Ᵽgg from Sub-area 2 in the North Star area to the Centre Star area and the similarity of this orientation with the main cleavages in Ꞓer/Ꞓeq and Ꞓep. In the North Star area the S_2 cleavage is the principal measured surface in Ᵽc and Ᵽg and is subparallel to compositional banding,

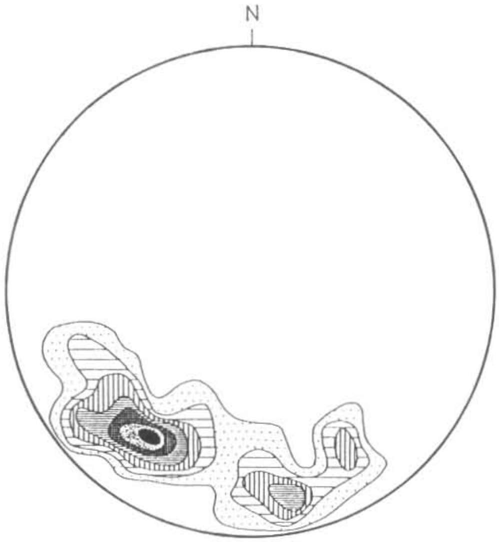


Figure 46. Stereoplot, schistose pebbly sandstone and conglomerate (Ꞓep). 44 measurements. Contours: 1, 3·5, 6, 8, 12·5, 17%.

whereas further south compositional banding is the principal measured surface and the orientation of cleavage is subparallel or slightly oblique. If it is the same cleavage throughout then S_2 is subparallel to the main cleavage in Ꞓer/Ꞓeq and Ꞓep.

The correlation of S_2 in the older rocks with crenulation cleavage in Ꞓep, Ꞓecp, Ꞓer and Ꞓeq implies the direct equivalence of deformation phases in both groups of rocks and therefore it implies either a Precambrian age for Ꞓep, Ꞓecp, Ꞓer and Ꞓeq or a younger (Eocambrian-Cambrian) age for the S_1 and S_2 cleavages. It further implies that there is a transitional change in degree of deformation and metamorphism in the North Star-Centre Star area. However, A. V. Brown reports that Ꞓep in the Centre Star area contains clasts of cleaved, metamorphic rocks, identical to rocks in the Precambrian sequence.

Although an unconformity exists between Ᵽq and Ꞓep in the Denison Gap area, it seems that there was no cleavage-forming event prior to deposition of Ꞓep. This conclusion is supported by the apparent absence of pre-existing cleavage(s) in clasts in Ꞓep in that area. In addition, the quartz arenite (orthoquartzite) clasts have retained very nearly their original texture, that is, they comprise clastic grains with unrecrystallised authigenic overgrowths. This implies that they had not experienced a high degree of deformation prior to incorporation into Ꞓep, also, that subsequent strain was largely taken up by the matrix of Ꞓep.

Despite the absence of a major cleavage forming event prior to the deposition of Ꞓep in the Denison Gap area it is clear that the Precambrian quartzites had become well-lithified. This is demonstrated by the degree of rounding displayed by boulders and cobbles of quartzite in Ꞓep. The possibility that these rounded clasts were derived from a sequence more distant than the local Precambrian sequence is thought unlikely in view of the local derivation implied by the passage from angular to rounded material above the unconformity at DN390937. Additionally, lateral variations in clast type imply local derivation. In particular, carbonate clasts were not observed around the unconformity at DN390937 but are present ENE of North Star.

CENTRE STAR - DENISON PLAIN AREA

A. V. Brown

Due to the faulted nature of the Eocambrian successions in the upper Denison Plains area, the tectonic history of the area could not be ascertained, but by using the number of cleavages within the different successions, two groups of associated successions were defined, the groups are separated by an implied unconformity.

The five western most successions: Ꞓeq; Ꞓer; Ꞓep; Ꞓec; and Ꞓel, all contain evidence of at least three cleavage forming episodes and can be separated from Ꞓlm; Ꞓlr; Ꞓlw; and Ꞓla by an implied unconformity on the basis of material from the foliated group of successions occurs in Ꞓlm, and the fact that the eastern group of successions, (Ꞓlm, Ꞓlr, Ꞓlw, Ꞓla), only contain obvious evidence of one cleavage forming event.

Ꞓeq/Ꞓer - *Schistose micaceous quartzwacke with minor phyllite / Schistose indurated phyllite*

In the small area of Ꞓeq/Ꞓer, only 25 bedding readings were obtained (fig. 44). They are too few and too spread to give any indication of folding. The dominant penetrative foliation, a crenulation in thin section, appears to have been a simple axial surface cleavage (fig. 45), which dipped 45 to 50° to the north-east.

Throughout the Ꞓeq/Ꞓer successions the tectonic surfaces vary in morphology depending on the grain size of the rock unit. In the coarser grained units the main tectonic surface is a planar to anastomosing cleavage which ranges from sub-parallel to nearly perpendicular to the composition banding, where ever this can be recognised, indicating a prior phase of folding. A later cleavage crenulates this main parting surface at a high angle, and at times is expressed as kink bands.

In finer grained units, the main parting surface varies its morphology between a crenulation and transposition depending upon the angle to compositional banding, again indicating a prior phase of folding with cleavage formation. The later crenulation cleavage, observed in the coarser grained units is also present.

Overall, in the Ꞓeq sequence, the first tectonic cleavage is an anastomosing surface. This surface was subsequently affected by both a later crenulation cleavage and, in places, by kink bands, both running at a high angle to the earlier surface. Indurated siltstone samples are finer grained equivalents of the muscovitic quartzwacke and have a good anastomosing cleavage, which was also subjected to the later crenulation and kink band forming deformations. The dominant penetrative cleavage is a transposition surface, when observed in the axial surface of small scale folds (50 mm across). These folds, fold a compositional banding, the surface of which is a crenulation cleavage, suggesting yet an earlier cleavage, which, if correct, indicates an overall minimum of four cleavage development phases.

In the Ꞓer sequence, original bedding was also not observed, but a compositional banding which is probably due to an early transposition cleavage is easily recognised in outcrop. Thin quartz veins occur throughout the sequence parallel to this banding. The main parting surface within the sequence is usually an anastomosing cleavage, but in places it is planar. This surface varies from sub-parallel to nearly perpendicular to the compositional banding, indicating another phase of folding prior to the formation of this cleavage. A later penetrative surface, again a crenulation cleavage, along with undulations formed by a spaced cleavage or minor kink bands, all form at a high angle to the anastomosing cleavage.

The dominant foliation varies its morphology between crenulation and transposition, depending upon the angle to compositional banding. The higher the angle between the compositional banding and the main foliation the greater the transposition. This dominant cleavage cuts across small scale folding, transposing compositional banding and crenulating the earlier cleavage. The latter surface is later crenulated by a spaced cleavage, which forms a good planar foliation in the last transposed compositional bands, picked out by recrystallised muscovite, and along which this banding is offset by kink bands.

Ꞓep - *Schistose pebbly sandstone and conglomerate*

The dominant parting surface in the Ꞓep succession is a transposition surface, which transforms an original sedimentary succession into a tectonic mixtite. The long axis of the clasts in conglomerate units are re-aligned forming tectonic conglomerate or mixtite units with a grey, sand- to silt-grade matrix. A later crenulation, at times expressed as kink bands,

5 cm

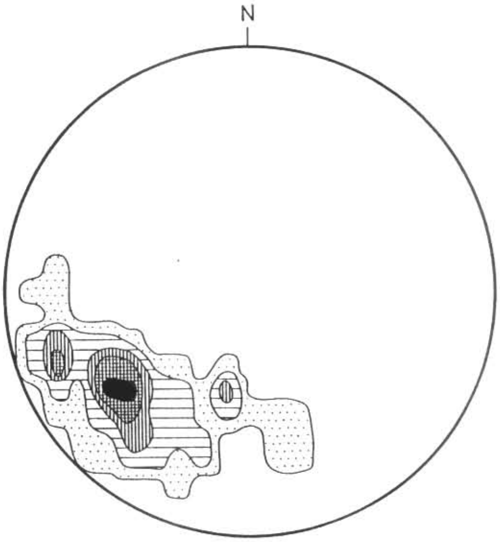


Figure 47. Stereoplot, platy foliation in Ꞓec, north of Gordon River. 34 measurements. Contours: 1·5, 4·5, 7, 13, 16%.

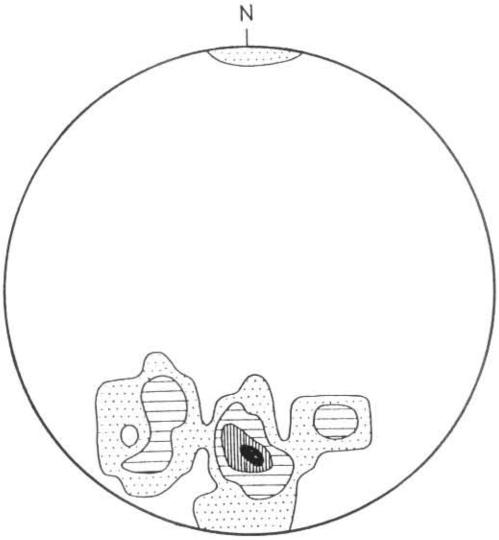


Figure 48. Stereoplot, platy foliation in Ꞓec, south of Gordon River. 35 measurements. Contours: 1·5, 4·5, 10, 16%.

is sometimes observed at approximately 45° to the dominant transposition surface.

In a remnant block of Ꞓep, the earliest tectonic surface is a planar cleavage subparallel to bedding. The second surface, which is the transposition surface in the majority of the sequence, is a crenulation cleavage in this part of the succession. The third surface is the later crenulation surface, which is observed in the deformed part of the succession.

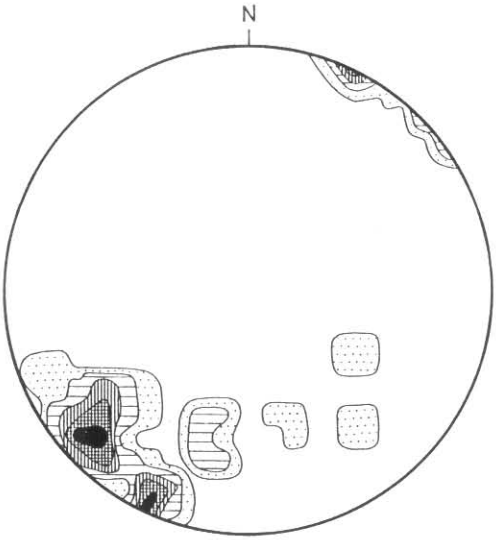


Figure 49. Stereoplot, penetrative foliation in Ꞓec, north of Gordon River. 26 measurements. Contours: 2, 6, 10, 14, 18%.

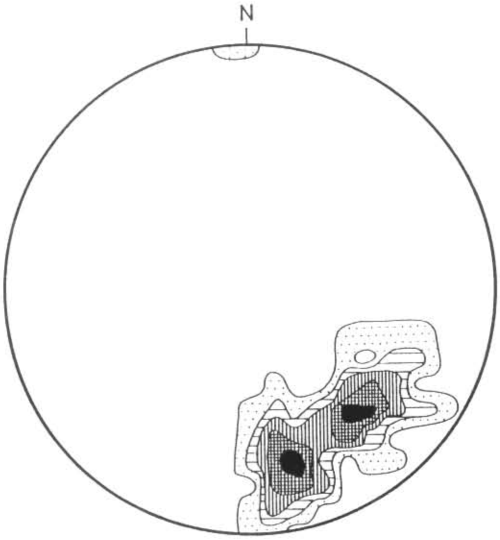


Figure 50. Stereoplot, penetrative foliation in Ꞓec, south of Gordon River. 35 measurements. Contours: 1·5, 4, 7, 13, 20%.

When the readings of the dominant foliation directions from within the Ꞓep succession are plotted on a equal area net (fig. 46), a similar pattern is obtained to that obtained from the massive chert succession (Ꞓec, fig. 47, 49) to the south. The orientation of the readings in this succession are also similar to those in the Ꞓec succession, and have the same clockwise rotation with respect to the area of Ꞓec to the south of the Gordon River (fig. 46, 48) as those to the north of the river.

Ꞓec/Ꞓel - *Chert dominant / Lithic sandstone dominant*

In the Ꞓec succession, two very prominent tectonic surfaces are recorded in nearly every outcrop, the earlier being a platy cleavage, the latter a penetrative surface. When readings of both the platy and penetrative cleavages are plotted on a equal area net, similar results are obtained for areas of Ꞓec to the north and south of the Gordon River (fig. 47-50), but the two areas have been rotated with respect to each other.

The platy cleavage has one main maximum with a smaller maximum on either side in each of the plots from the northern and southern areas. The major maxima from the area of Ꞓec to the north of the Gordon River, has a 54° clockwise rotation with respect to that from south of the Gordon River (fig. 47-48), indicating a fault along the line of the Gordon River.

The penetrative cleavage in both the northern and southern areas of Ꞓec have two maxima. In the northern area they are 25° apart whereas in the southern areas they are 30° apart. The northern maxima have a 54° clockwise rotation with respect to the southern maxima, indicating that faulting occurred after both surfaces were produced.

The space produced by the clockwise rotation of the successions north of the Gordon River is now filled by the Boyes River Ultramafic Complex and possibly occurred during the phase of tectonism which affected the Middle Middle Cambrian Trial Ridge Beds.

Ꞓlm, Ꞓlr, Ꞓlw, Ꞓla - *Sandstone, siltstone and mudstone*

The implied unconformity between the western foliated successions and the relatively untectonised group of successions further to the east, is based on the presence of the Ꞓlm succession which contains clasts of the western cleaved successions of haphazard orientation that are set in a relatively undeformed, uncleaved matrix but which does not itself contain an obvious tectonic surface. The rest of the Eocambrian successions to the east: Ꞓlr, Ꞓlw and Ꞓla all contain one measurable tectonic surface.

NEEDLES REGION

P. G. Lennox

The south-eastern area of the region is dominated structurally by The Needles antiform, whose character is best described by a conical fold inclined at 70° with a 70-80° half-apical angle and an axis dipping at 70° to 330°. This compares with a best fit cylindrical fold of hinge-line dipping 60° to 331° and an axial surface dipping 89° to 253° (fig. 51).

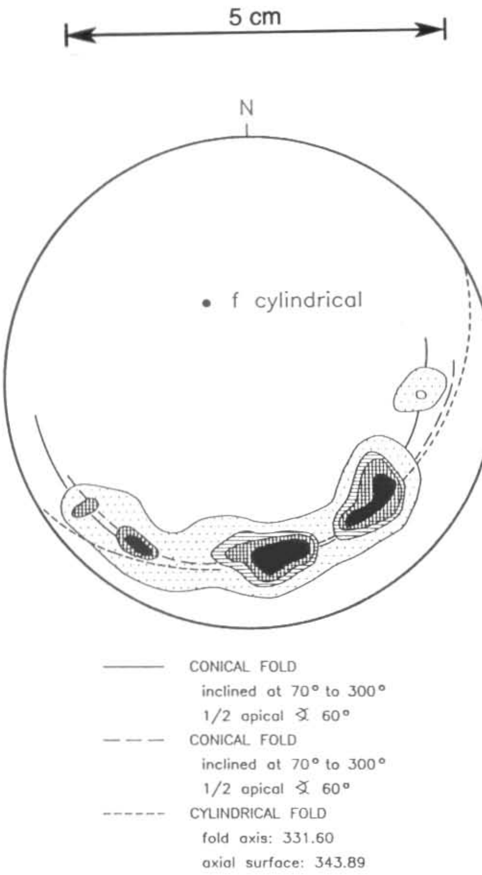


Figure 51. Poles to bedding, Needles anticline. 20 poles to bedding. Contours: 4, 8, 12% per 1% area.

The dominant cleavage of the 'Eocambrian sequence' examined along the Gordon River road, is observed to swing around the antiform in harmony with the change in bedding orientation. The plots on an equal area net of poles to cleavage and plots of poles to bedding for these rocks are closely aligned (fig. 52-54). This indicates that the rocks were cleaved before folding which produced The Needles antiform.

The orthoquartzite of The Needles anticline consists of well rounded and sorted monocrystalline quartz grains (0.2-0.5 mm diameter) commonly exhibiting undulose extinction with generally minor sutured intergrain boundaries and commonly 120° quartz triple junctions. They contain minor chert grains (*c.* 1%) and white mica (*c.* 1%) between the grains.

The well-sorted, equant to slightly elongated (1:1.5), 0.25-0.5 mm diameter quartz grains of specimen 77/243 from The Needles summit [DN549685] exhibit usually planar, rarely sutured grain boundaries with some 120° contacts, some fractured grain and quartz

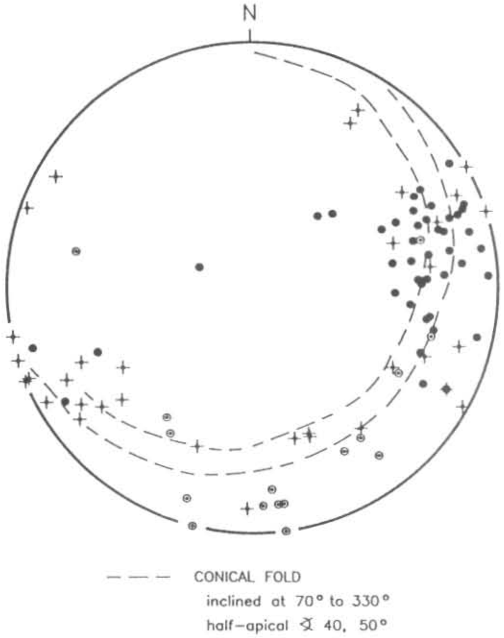


Figure 52. Poles to cleavage, Florentine Valley Mustone and Eocambrian? sequence, Gordon River Road. 38 measurements, Florentine Valley Mudstone; 36 measurements, ?Eocambrian sequence; 17 measurements, Needles Anticline.

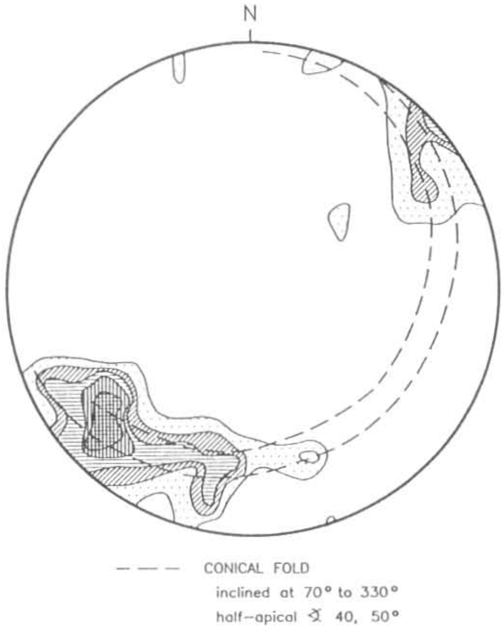


Figure 54. Poles to bedding, Eocambrian? sequence, Gordon River Road - Backroads Creek 1-3. 100 measurements. Contours 2, 4, 6, 8, 10% per 1% area.

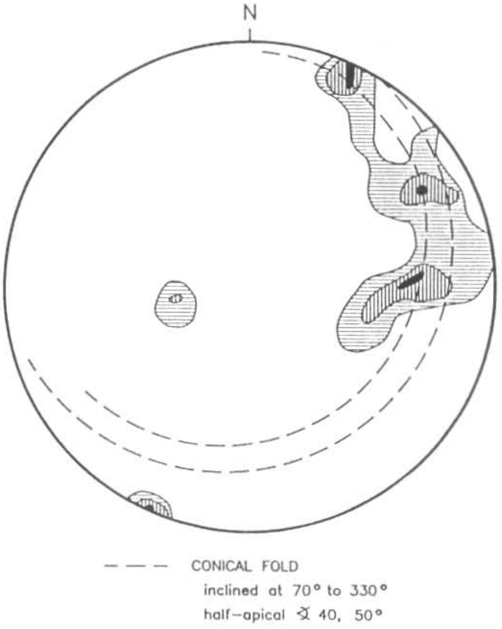
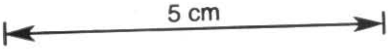


Figure 53. Poles to bedding, Eocambrian? sequence on the Maydena limb of the Needles Anticline. Contours: 5, 10, 14% per 1% area.

Figure 55. Quartz *c*-axes, 77/403. Re-oriented slide: 240.00. 153 measurements. Contours: 0.3, 1, 1.6, 2·3, 3, 3·6, 4·3%, per 1% area.

5 cm



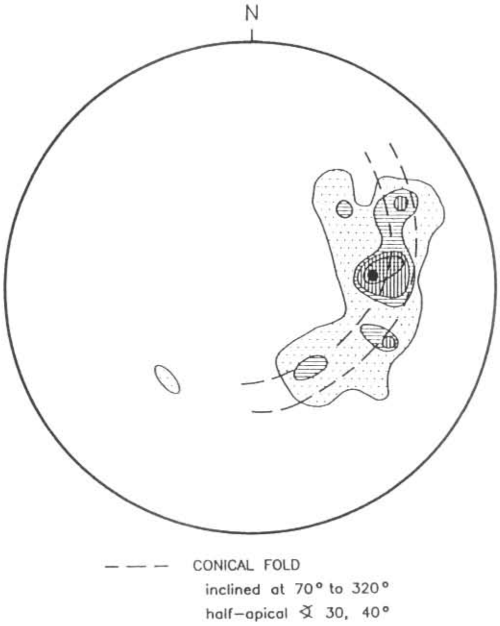


Figure 56. Poles to bedding, Florentine Valley Mudstone, Tim Shea Sandstone and Karmberg Limestone. 70 measurements. Contours: 3, 7, 10, 14, 16% per 1% area.

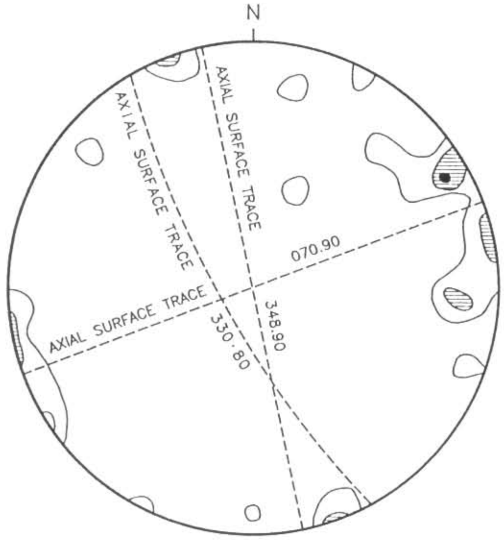


Figure 57. Poles to axial surface of minor folds in the Eocambrian? sequence. 20 measurements. Contours 5, 10, 15% per 1% area.

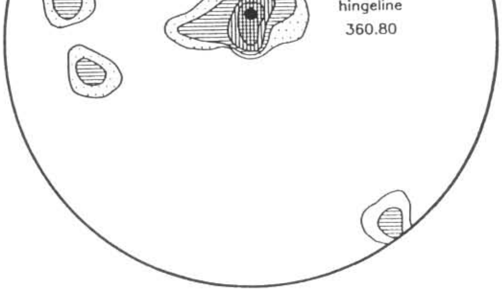


Figure 58. Minor fold hingelines in Eocambrian? sequence. 20 measurements. Contours 3, 5, 10, 15, 20% per 1% area.

shadows. Hand specimen 77/401 contains 2–3 mm thick cross-bedded quartzite with a distinct cleavage. In thin section the up to 0.5 mm diameter quartz grains are commonly monocrystalline with sutured margins and usually well rounded shapes. The cleavage is defined by the elongation of the quartz. The minor chert and rare small flakes of white mica on intergrain boundaries are not visibly aligned in the quartz-grain elongation direction. Hand specimen 77/402 exhibits a cleavage/bedding angle of 40° whilst in thin section it is difficult to discern the bedding orientation. The 0.25–0.5 mm diameter quart grains are elongated up to 4:1.

A petrofabric diagram of quartz *c*-axes for a sample of orthoquartzite from The Needles antiform has triclinic symmetry. The diagram was rotated such that the slide lay at right angles to the hinge line of The Needles antiform. Then the most continuous quartz *c*-axis girdle was around the margin of the diagram indicating a relationship between the folding event and the quartz *c*-axes orientation (fig. 55).

The structural information, such as the folded dominant cleavage of the orthoquartzite of The Needles area, indicates that the Eocambrian sequence was folded and cleaved before deposition of the Denison Subgroup. Nevertheless a comparison of the poles to bedding of the Lower Palaeozoic members (fig. 56) adjacent to the Eocambrian occurrences shows that both the older and younger sequences conform to conical folds with sub-parallel hinge lines and similar half-apical angles. This indicates that The Needles antiform is a Middle Palaeozoic structure. No known preferred orientation in quartz fabric, however, occurs in the Lower Palaeozoic rocks as a result of Middle Palaeozoic deformation. Thus, since the petrofabric diagram of quartz *c*-axes is symmetrical about the present fold hinge line of The Needles antiform, folding of the Eocambrian sequence must have been along a similar trend to that of the present antiform.

Minor folds occur within the Eocambrian sequences. A plot of the axial surfaces shows one group parallel to The Needles antiform hinge-line and another trending almost at right angles (fig. 57–58). Minor folds of similar trends and forms result from Middle Palaeozoic deformation of the younger rocks.

The Eocambrian rocks exhibit a NW-SE trending cleavage crenulating an earlier cleavage in an outcrop in the Gordon River Road some 100 m east of the Humboldt Divide [DN557693], and in an exposure some 400 m uphill of the Little Florentine River/Gordon River Road intersection [DN532687] a transposition cleavage was observed.

Early–Middle Palaeozoic

DENISON PLAIN – DENISON GAP REGION

ULTRAMAFIC ROCKS

A. V. Brown

Regionally, the Adamsfield ultramafic rocks occupy the core of a shallowly north-plunging, N-trending anticline. The eastern limb of this anticline forms the Saw Back Range, while the western limb has been down-thrown. The ultramafic rocks are separated from the enclosing sediments by two large NNW-trending faults, an extension of the Lake Edgar Fault to the west and the Weld River Fault to the east.

All foliations measured in the sheared serpentinitic sheath were vertical, with the strike of the foliation varying according to the direction of the bounding faults, internal cross faults, or the shape of the enclosed rafts of peridotite. In almost any area of the massive and layered peridotite rafts regular joint systems occur approximately orthogonal to the direction of layering within the specific raft.

Along the side of, or at times within, the peridotite rafts zones of tectonism occur. These zones contain folding, boudinaging and mylonitisation of the igneous layering. The folds are small scale (up to 100 mm across) and vary between isoclinal, intraformational and rootless intrafolial (Brown, 1972), according to the terminology of Turner and Weiss (1963). The axial surface of the isoclinal folds are mainly parallel to igneous layering. Pyroxenite boudins in dunite are up to 450 mm long and are usually spindle-shaped. Deformation occurred within as well as between igneous layers, with pyroxene and olivine grains exhibiting plastic to solid flow features as described above.

The plastic to solid-state deformation is considered to have formed during cooling and dismembering of the body during original

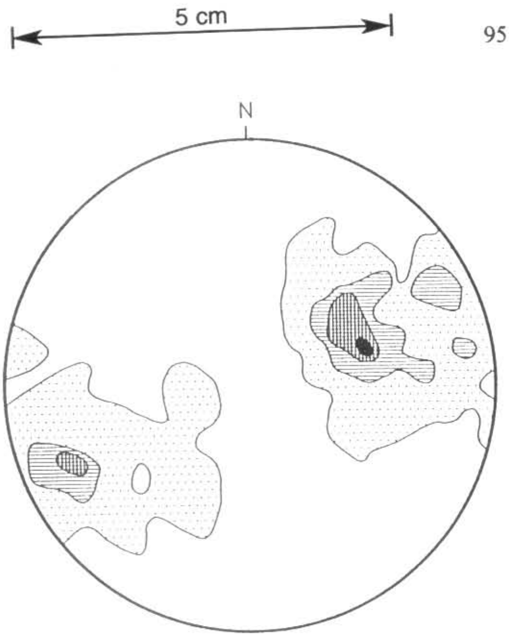


Figure 59. Poles to bedding, Gordon Limestone Subgroup, Florentine Valley. 120 measurements. Contours: 0·5, 5, 8, 10% per 1% area

emplacement, whereas all the directions given by foliations in the associated sheared serpentinite are the result of deformation during Early–Middle Palaeozoic times, which also formed the present regional structures and re-emplaced the ultramafic rocks through their Cambro-Ordovician cover.

Middle Palaeozoic

DENISON RANGE – FLORENTINE VALLEY AREA

P. W. Baillie

The major structure in the area is an open syncline which plunges gently NNW and which has a half wavelength of approximately 8 km. Smaller-sale folds (fig. 59) which are well-developed in the Gordon Group also plunge gently to the NNW and have a wavelength of approximately 2 km.

Cleavage (fig. 60) is developed sub-parallel to the axial surface of major fold trends. The cleavage is slaty in fine-grained rocks and often anastomosing in coarse sandstones. Occasionally late spaced cleavages were observed but not enough were recorded to have any regional significance. As noted previously, the nodular appearance of the Karmberg Limestone has been enhanced by tectonic flattening and associated cleavage development.

Faulting associated with the Middle Palaeozoic folding is recognised in rocks of the Tiger Range Group by displacements in the topographically prominent, more resistant, dominantly quartzite units, the Gell and Currawong Formations. Faults are normal, with throws less than approximately 200 m.

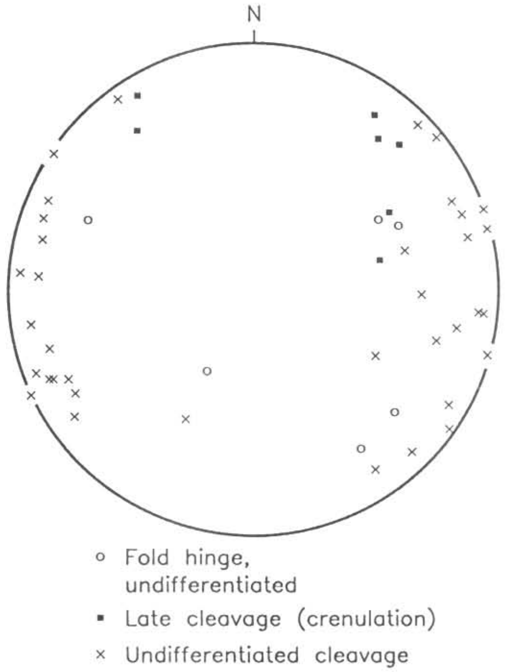


Figure 60. Structural readings, Denison Subgroup.

THE NEEDLES AREA

P. G. Lennox

Deformation during the Middle Palaeozoic caused flattening of the pre-existing Needles antiform and an early cleavage within the Eocambrian sequence, and resulted in a syncline of a half-wavelength of approximately 3.5 km immediately to the west. At the southern end of this syncline the poles to bedding of the Benjamin Limestone form a girdle, the pole of which indicates a hinge line trending approximately N-S.

Minor folds of a half-wave length of about one metre occur particularly within the Florentine Valley Mudstone. These folds are isolated, parallel, and close to open in form. They have gently plunging hinge lines, with moderately inclined axial surface and subrounded closures. The minor folds display orientations which closely correspond with those occurring within Eocambrian sequences to the south-east (fig. 57–58).

Members of the Denison and Gordon Subgroups commonly display two cleavages, the earliest of which is of northerly strike and associated with the northerly trending major syncline. The Florentine Valley Mudstone correlate on the Gordon River Road has a N-S trending cleavage crenulated by cleavage of a NW-SE trend. The Benjamin Limestone also exhibits a N-S trending cleavage, which in crops out above the confluence of Myrtle Creek and the Florentine River is of an anastomosing character subparallel to the bedding trend.

At the Adamsfield Track bridge over the Florentine River anastomosing cleavage is transected by an ENE-WSW trending, steeply N-dipping cleavage. Two clearly defined foliations are visible in the outcrop and thin section specimen 77/30 located adjacent to the western-end of the Adamsfield track bridge over the Florentine River [DN513706]. The sparry calcite-vugh filled dolomicrite has a well-developed pressure-solution cleavage (Seymour, 1975; 1977); that is the cleavage is characterised by being discontinuous, spaced and containing abundant dissolution.

Tertiary faulting

P. W. Baillie

Major faulting has disrupted rocks of the Parmeener Supergroup on the eastern side of the Florentine Valley. Jennings (1955) recognised the presence of Tertiary faulting in the area and noted that the Permian rocks on the flanks of the Misery Plateau were 'block-faulted, closely jointed and tilted'.

Careful lithological mapping with good biostratigraphic control during the Huntley mapping project has allowed for more detailed elucidation of the Tertiary faulting than has previously been possible. The work has demonstrated the presence of a series of NNW-trending dominantly normal faults, and at least one cross-cutting ENE-trending fault. Previously only one fault, the 'Misery Fault' (Jennings, 1955), had been recognised in the area.

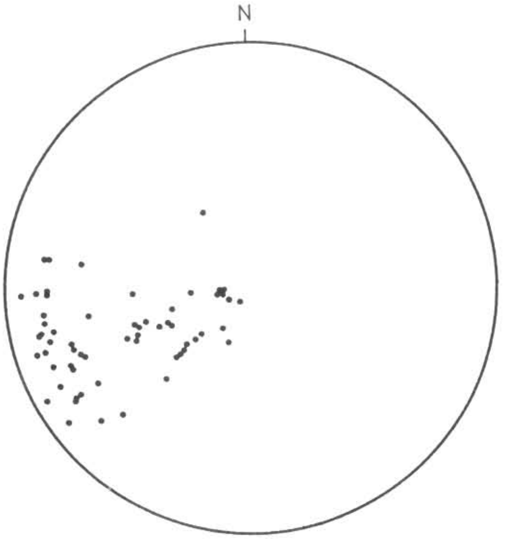
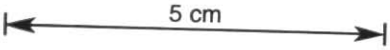


Figure 61. Poles to bedding, Parmeener Supergroup, Misery Range area.



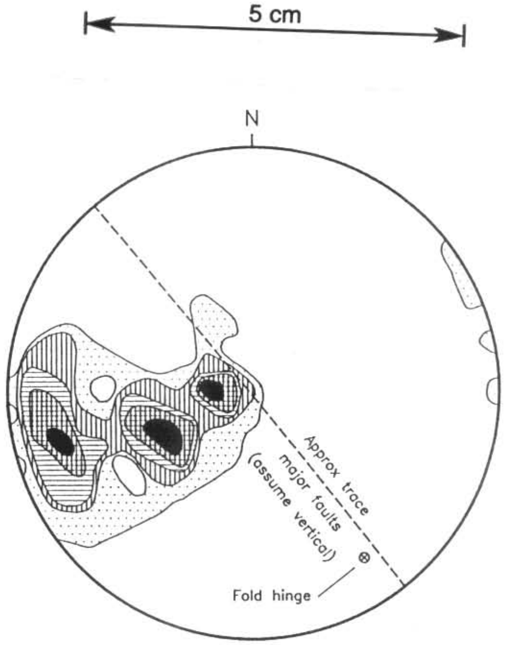


Figure 62. Poles to bedding, Parmeener Supergroup, Misery Range area. 65 measurements. Contours: 0·8, 2, 5, 10, 13%.

The faulting is associated with pronounced drag-folding of the Parmeener Supergroup rocks. Dips apparently increase down the sequence, and with proximity to the major NNW faults. Overturned bedding was recognised near the top of the Woody Island Siltstone correlate at DN581862, suggesting that some reverse movement may have occurred.

Parasitic folding associated with the faulting is present in thinly-bedded sandstone/mudstone sequences of the Liffey Group correlate at DN563908. The small-scale folds have hinges which dip at 20° to 145° and an axial surface of 135W72°.

Figures 61–62 are plots of poles to bedding of the Parmeener Supergroup rocks of the area and clearly shows the effects of faulting on the rocks.

Because no complete sections are present of any of the formations of the area, it is not possible to calculate displacements of the faults.

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APPENDIX A

ECONOMIC GEOLOGY

Metallic minerals

R. S. Bottrill

PLATINUM GROUP ELEMENTS

INTRODUCTION

Platinum group elements (PGE) are one of the few mineral commodities to have been economically extracted from the rocks within the Huntley Quadrangle. The commodity has been known as 'osmiridium' since its discovery in the 1920s, and the use of this term is unavoidable in this report. It must be noted, however, that a number of platinum-group minerals (PGM) have been identified and osmiridium *sensu stricto* seems to be nearly always subordinate to iridosmine and rutheniridosmine in Tasmanian deposits (Cabri and Harris, 1975; Ford, 1981).

The deposits are centred on Adamsfield, and were the source of about half Tasmania's recorded PGE output. Smaller deposits occur at Boyes River and other areas for which few records exist.

HISTORY

Osmiridium was first recorded from this area by Reid (1921), although the area had been prospected as early as the 1870s or 1880s. Osmiridium was probably first discovered in Tasmania by Sprent (in the Wilson River in the north-west, about 1876) and authoritatively identified from Savage River in about 1881, but Montgomery (1894) was the first to officially refer to it (Reid, 1921). It was widespread in some of the western Tasmanian goldfields but was of no interest to prospectors, who were initially penalised by the mints for its presence in gold concentrates before an upsurge in demand in 1909. Reid (1921) visited the Adamsfield area in 1920 in response to reports of osmiridium-bearing serpentinite occurrences but considered the deposits to be 'small, comparatively poor and difficult of access' in comparison to the deposits of Bald Hill, Wilson River and Mt Stewart, in north-western Tasmania.

Despite this report, a party of prospectors discovered abundant osmiridium in the area in 1924, and the first reward lease in the area (9457-M) was granted in 1925, at DN458698, to Messrs A. J. Stacey, C. B. Stacey and R. T. Kingston. This discovery caused a huge 'rush', with over one thousand Miners Rights issued during the latter half of 1925, and the nearby settlement subsequently called Adamsfield may have supported a population of up to two thousand people in late 1925 (Gowlland *et. al.*, 1976). This deposit rapidly superseded in importance all other osmiridium deposits in Tasmania. The peak of production for the field also peaked in the final quarter of 1925 (2238 oz or nearly 70 kg - see table A1).

A subsequent drop in demand for osmiridium caused a fall in numbers of men working the field from over 800 in 1926 to about 100 in 1927 (Gowlland *et. al.*, 1976). The demand for osmiridium, and the number of miners, subsequently improved slightly but the richest and most accessible deposits were rapidly exhausted and production slowly declined after 1928 (table A1). Most alluvial deposits were thought to be worked out by 1934 (Scott, 1935) and attempts at hard rock mining do not appear to have been highly productive.

Few records of hard-rock mining at Adamsfield are available, the best being the 1937 prospectors of Osmiridium (Tasmania) N.L. This details the results of feasibility studies on the existing open cut, shaft and adits into an osmiridium lode. Ore grades and continuity appeared to be very encouraging but no further records are available on the success of this venture. Reports of the Director of Mines for 1935–1937 mention a proposed crushing plant to increase production but it is not known whether this was installed.

By December 1942 over 14 300 oz (445 kg) of osmiridium had been produced at Adamsfield, worth over £282 000 at the time, but production had dropped to 118 oz (3.7 kg) per annum. The last osmiridium produced in Tasmania (probably from Adamsfield) was in 1958, when the price plumetted from £82 to £20 per ounce, in relation to the demise of fountain pens, the largest market for Tasmanian osmiridium.

GEOLOGY AND ORE GENESIS

The osmiridium deposits of Tasmania are spatially associated with, and have long been considered to derive from, the Cambrian mafic-ultramafic complexes (Twelvetrees, 1914; Reid, 1921; Ford, 1981). Brown (1986) and Brown *et. al.* (in press) subdivide these complexes into three successions : a layered pyroxenite-dunite; a layered dunite-harzburgite and a layered pyroxenite-peridotite with associated gabbro. Varne and Brown (1978) considered the complexes to be Alaskan-type rather than ophiolitic in origin. Such complexes are presumed to form at high temperature and low pressure as cumulate bodies in crustal magma chambers (see p.63).

Only the first two of these successions have been identified in the Adamsfield ultramafic complex (see p.62) and the second succession is the only one directly associated with osmiridium deposits (Brown *et. al.*, in press). The PGE were probably concentrated in the residuum of a first stage melt, and precipitated with the cumulates of a second stage melt. The enrichment in Os, Ir and Ru relative to Pt, Pd,

Table A1.
OSMIRIDIUM PRODUCTION FROM ADAMSFIELD SINCE ITS DISCOVERY UP TO 31 DECEMBER 1942
(from Williams, 1942)

Period	Quantity			Value		
Quarter ending:	Oz	dwt	gr	£	s	d
30 June 1925	9	1	12	281	8	11
30 September 1925	625	19	9	20 144	10	11
31 December 1925	2 238	5	9	68 757	1	4
31 March 1926	992	13	7	23 339	0	1
30 June 1926	633	12	20	12 202	18	4
30 September 1926	862	18	16	8 475	8	11
31 December 1926	555	6	6	5 539	1	3
31 March 1927	203	9	11.5	1 909	5	7
30 June 1927	142	3	9	1 706	0	6
30 September 1927	93	16	6	1 132	1	6
31 December 1927	113	10	8	1 362	0	0
31 March 1928	442	8	9	10 509	18	2
30 June 1928	261	19	7	6 529	9	1
30 September 1928	551	16	2	15 350	18	0
31 December 1928	293	5	0	7 840	11	4
31 March 1929	168	9	8	4 147	6	4
30 June 1929	262	7	16	5 683	4	7
30 September 1929	292	2	23	7 905	14	9
31 December 1929	313	2	17	6 208	3	0
31 March 1930	186	9	17	3 278	17	0
30 June 1930	67	6	11	1 300	12	1
30 September 1930	126	16	9.5	1 898	4	10
31 December 1930	347	12	17	4 302	11	5
31 March 1931	240	19	14	4 008	2	4
30 June 1931	251	9	6	3 104	14	9
30 September 1931	251	10	15	3 428	14	6
31 December 1931	354	12	3	4 741	11	10
31 March 1932	250	5	21	3 372	19	9
30 June 1932	136	12	19	1 504	9	9
30 September 1932	80	19	3	869	2	8
31 December 1932	123	7	18	1 038	2	1
31 March 1933	161	0	0	1 368	0	0
30 June 1933	162	0	0	1 458	0	0
30 September 1933	153	0	0	1 364	0	0
31 December 1933	60	0	0	540	0	0
31 March 1934	148	5	0	1 408	0	0
30 June 1934	107	15	0	969	0	0
30 September 1934	71	14	0	645	0	0
31 December 1934	160	0	0	1 600	0	0
31 March 1935	40	0	0	350	0	0
30 June 1935	12	0	0	108	0	0
30 September 1935	127	9	10	1 147	4	7
31 December 1935	55	0	0	495	0	0
31 March 1936	30	0	0	270	0	0
30 June 1936	30	0	0	285	0	0
30 September 1936	133	12	0	2 004	0	0
31 December 1936	65	0	0	1 105	0	0
31 March 1937	54	0	0	918	0	0
30 June 1937	150	10	0	2 709	0	0
30 September 1937	48	10	0	897	0	0
31 December 1937	76	1	15	723	0	0
31 March 1938	28	10	0	413	0	0
30 June 1938	13	0	0	174	0	0
30 September 1938	33	7	0	540	0	0
31 December 1938	97	7	0	1 558	0	0
31 March 1939	65	0	0	1 105	0	0
30 June 1939	100	5	0	1 704	0	0
30 September 1939	48	0	0	816	0	0
31 December 1939	52	11	11	1 051	0	0
31 March 1940	124	3	0	2 793	0	0
30 June 1940	118	14	0	3 412	0	0
30 September 1940	62	0	0	1 550	0	0
31 December 1940	53	14	14	1 075	0	0
31 March 1941	38	17	12	777	0	0
30 June 1941	48	0	0	960	0	0
30 September 1941	60	16	9	1 265	0	0
31 December 1941	44	11	10	919	0	0
31 March 1942	20	0	0	412	0	0
30 June 1942	25	0	0	516	0	0
30 September 1942	29	0	0	598	0	0
31 December 1942	43	12	7	899	0	0
Total	14 309	4	22	£282 347	9	2

Au and Rh is likely to be the result of fractional crystallisation (Barnes *et. al.*, 1985; Brown, 1986), producing the Pt and Pd enrichment in the third succession (Brown *et. al.*, in press).

Concentrations of PGE in the ultramafics rocks are usually low, seldom above 1 ppm (Brown *et. al.*, in press) and PGE minerals are rarely seen *in situ*. Nye (1929), however, describes relatively abundant osmiridium (at least six visible grains) in a sample of light yellowish-brown serpentinite with black serpentinite containing abundant chromite, from T. Stacey's claim on Main Creek (see below). This claim covered a zone of osmiridium-enriched serpentinite described further by Nye (1930), and described as an 'osmiridium lode' by Osmiridium (Tasmania) N.L. (1937). The 'lode' is typically immediately adjacent the eastern border (rarely on the west) of a talcose zone containing some quartz and nickeliferous siderite. The zone approaches N-S in strike but is crescent-shaped, paralleling the bulge in the ultramafic complex in this area. The 'lode' is about 700 m in length, 2-3 m wide, within an olivine bronzite ultramafic, and a few tens of metres west of the eastern boundary of the ultramafic complex (Osmiridium (Tasmania) N,L., 1937). The talcose zone itself appears to be barren of osmiridium. The osmiridium-bearing material consists of one or two veins, up to about 0.3 m wide, of serpentinite which is usually soft, black and foliated, but may be quite hard (Nye, 1930). The veins rarely traverse the talcose zone. Pyroxenite and chromite nodules (up to 100 mm) in size) are associated in places. Hughes (1965) considered the 'lode' to be a consolidated detrital deposit, in disagreement with Nye's (1930) description. The osmiridium may have been remobilised during late stage shearing and serpentinisation.

This occurrence is related to that at the Bald Hill osmiridium field (near the Heazlewood River), described by Reid (1921). At this deposit, in the Heazlewood River Ultramafic Complex, osmiridium was found as 'schlieren' irregularly distributed along structural planes inside the chilled margin of the ultramafic bodies. These planes conform in dip and strike with the margins of the bodies, and often occur in parallel sets. The ultramafic rocks there are almost completely serpentinised, are talcose in part and may be foliated.

Brown *et. al.*, (in press) describe PGE-enriched chromitites as the source of PGE alloys in the Serpentine Hill region (near Rosebery), but such rock types have not yet been identified at Adamsfield.

The serpentinites were mined in places for the enclosed osmiridium, particularly on the above-mentioned 'lode', but were usually of low grade (Nye, 1930). Most osmiridium production was derived from secondary deposits, where osmiridium was concentrated during weathering

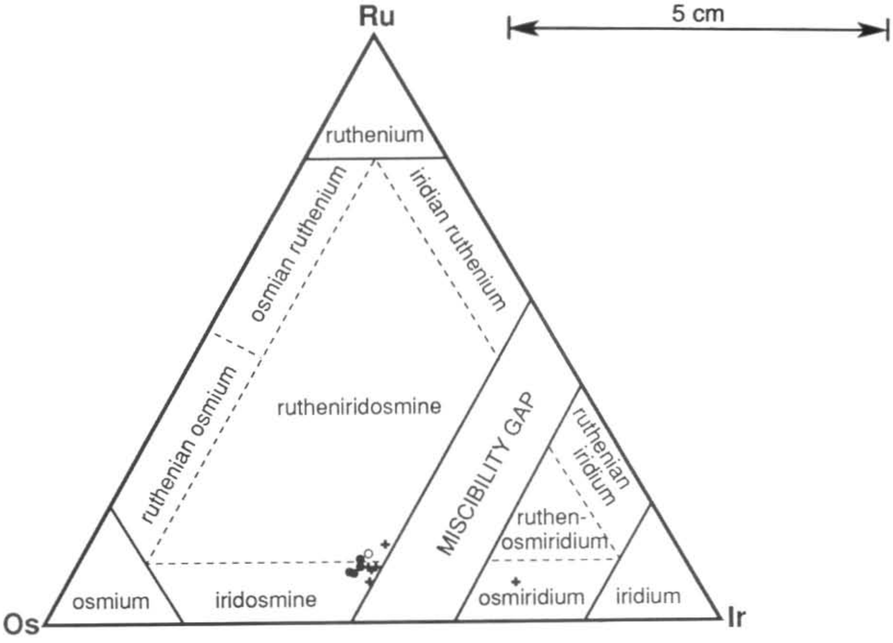

Figure A1. Compositions of Os-Ir-Ru alloys from Adamsfield. Data from Nye, 1929 (o); Cabri and Harris, 1975 (+) and Ford, 1981 (●)

and erosion of the ultra-basics (Nye, 1929). Some of the alluvial osmiridium was quite recent in age, while some was concentrated in drainage systems ancestral to the present system (Nye, 1929). A considerable amount of osmiridium is present in Palaeozoic placers of the Denison Subgroup, and Carey (1957?) considered that the ultramafic complex was an island in Ordovician times. A considerable proportion of the more recent alluvial osmiridium has apparently been reworked from these Palaeozoic placers, particularly in those areas west of Football Hill. The richest alluvial osmiridium tended to overlie serpentinite or sandstone bedrock, but some lay above a 'false bottom' of clay or sandy clay (Nye, 1929). Residual deposits usually overlay serpentinite and apparently varied from weathered serpentinite to soil (Nye, 1929).

In summary, the osmiridium was enriched by fractionation and partial re-melting of Alaskan-type ultramafic rocks, and further enriched during shearing and serpentinisation near the border of these bodies. It was enriched still further by residual accumulation and concentration by eluvial and alluvial action, from as early as Ordovician times to the present day.

MINERALOGY

The mineralogy of the PGE at Adamsfield has been investigated by Cabri and Harris (1979) and Ford (1981). The principal phase identified by both studies was iridosmine (about $Ru_{0.1}$ $Os_{0.5}$ $Ir_{0.4}$), with subdominant rutheniridosmine (similar to iridosmine but with >10 mass% Ru); only minor osmiridium (about $Ru_{0.1}$ $Os_{0.3}$, $Ir_{0.6}$) and platinum dominant alloys (with variable Fe, Ir, Os, Rh and Ru) were detected. Typical electron microprobe analyses of these minerals are shown in Table A2 and Figure A1. The average of 31 analyses of concentrates (Table A3, from Nye, 1930) is also shown on fig. A1, and is close to the average composition of the PGE alloys. There is some variation in the analyses which could indicate variation in PGE distribution within the deposit, if not due to variations in analytical technique. The iridosmine/ rutheniridosmine boundary is arbitrary (Harris and Cabri, 1973) but all other alloys from Adamsfield are structurally distinct (Cabri and Harris, 1975).

Nye (1979) described the usual occurrence of PGM at Adamsfield as 'shotty grains or flat scales, sometimes hexagonal in outline'. Nye (1929) recorded a nugget of 48.3 g in weight, from Main Creek, but most material was quite fine grained. Some gold and chromite were recorded by Nye (1929) as being locked in composite grains with PGM. Magnesium-rich silicate inclusions, including olivine, enstatite and a Ca-Mg-Al pyroxene, were recorded by Ford (1981). Cabri and Harris (1975) noted the presence of rare irarsite (IrAs5) with osmiridium and iridosmine from Heazlewood, but this has not yet been recorded from Adamsfield.

Table A2.

COMPOSITIONS OF PGE MINERALS FROM ADAMSFIELD

	mass %									atomic %						
No.	Os	Ir	Ru	Rh	Pt	Pd	Fe	Ni	Totals	Os	Ir	Ru	Rh	Pt	Fe	Mineral
1	45.51	41.65	6.40	0.29	1.12	tr	na	na	94.97	46.08	41.73	12.19	...	...	...	Bulk sample
2	48.40	44.70	5.60	0.61	0.67	0.05	1.40	0.27	101.70	46.91	42.88	10.21	...	...	...	Rutheniridosmine
3	49.10	46.50	5.30	0.60	0.75	nd	0.07	0.01	102.33	46.72	43.79	9.49	...	...	...	Iridosmine
4	47.90	46.50	5.40	0.66	0.96	nd	0.29	0.04	101.75	46.02	44.21	9.76	...	...	...	Iridosmine
5	26.50	65.30	3.70	0.53	5.00	nd	0.45	0.10	101.58	27.02	65.88	7.10	...	...	...	Osmiridium
6	44.70	46.40	7.60	0.49	1.00	0.05	0.56	0.09	100.89	42.61	43.77	13.63	...	...	...	Rutheniridosmine
7	49.80	46.30	4.20	0.49	0.67	nd	0.28	0.05	101.79	48.11	44.26	7.63	...	...	...	Iridosmine
8	50.46	42.97	6.42	0.00	0.00	na	0.49	na	100.34	48.03	40.47	11.50	...	...	...	Rutheniridosmine
9	51.41	43.13	5.44	0.43	0.00	na	0.54	na	100.95	49.28	40.91	9.81	...	...	...	Iridosmine
10	52.24	42.52	5.18	0.42	0.00	na	0.56	na	100.92	50.20	40.43	9.36	...	...	...	Iridosmine
11	50.81	42.54	4.95	0.67	0.00	na	0.43	na	99.40	49.71	41.18	9.11	...	...	...	Iridosmine
12	50.09	43.03	5.60	0.00	0.00	na	0.58	na	99.30	48.53	41.26	10.21	...	...	...	Rutheniridosmine
13	2.96	7.41	6.10	8.36	72.24	na	3.81	na	100.88	2.45	6.08	9.51	12.81	58.39	10.75	Rhodium iron platinum
14	0.00	1.29	0.00	4.94	86.35	na	7.07	na	99.65	0.00	1.08	0.00	7.70	70.95	20.28	Iron platinum

Analyses: 1 – from Nye, 1929 (the average of 31 concentrates); 2-7 – from; Cabri and Harris, 1975; 8-14 – from Ford, 1981.

tr = trace, nd = not detected, na = no analysis given

Table A3.

ANALYSES OF OSMIRIDIUM FROM ADAMSFIELD (from Nye, 1929)

				mass %				
No.	Ir	Os	Ru	Pt	Rh	Pd	Au	Remarks
1	40.80	46.10	8.00	2.00	0.80	tr	...	From Eames and Scoles' Claim
2	39.20	50.20	6.50	2.00	1.00	tr	...	Hansen's Claim
3	38.40	47.00	9.80	1.60	1.60	tr	...	H. Tudor's Claim
4	36.30	47.25	10.60	2.20	1.60	tr	...	General sample
5	40.12	44.89	6.50	1.02	0.18	...	...	From 60 oz parcels
6	40.48	44.14	6.54	1.00	0.20	...	...	
7	40.02	43.96	6.67	1.16	0.20	...	...	
8	44.35	45.74	6.46	...	tr	...	tr	
9	41.43	43.50	5.35	1.10	0.16	...	0.007	Samples from 50 oz parcels
10	42.33	43.86	5.97	1.06	0.17	...	0.03	
11	42.70	46.28	5.54	1.04	0.18	...	0.003	
12	41.37	46.84	5.29	1.01	0.16	...	0.005	
13	42.80	47.10	5.52	0.48	0.14	...	0.002	
14	42.22	46.30	6.03	0.92	0.14	...	0.005	
15	43.21	45.88	5.81	1.04	0.14	...	0.003	
16	42.39	44.96	6.75	1.25	0.17	...	nil	Samples from 75 oz parcels
17	41.25	43.92	6.59	1.27	0.21	...	nil	
18	42.85	44.10	6.47	1.21	0.19	...	0.007	
19	42.82	44.30	6.12	1.36	0.22	...	nil	
20	43.58	44.36	5.81	0.50	0.14	...	nil	
21	42.11	45.70	6.16	0.56	0.10	...	nil	
22	42.03	45.92	5.73	0.52	0.16	...	nil	50 oz parcel
23	42.62	43.31	6.43	1.14	0.14	...	nil	75 oz parcel
24	41.45	46.80	6.13	1.12	0.16	...	nil	75 oz parcel
25	42.53	44.36	6.02	1.24	0.18	...	nil	50 oz parcel
26	41.66	43.35	6.48	1.34	0.12	...	nil	75 oz parcel
27	42.02	46.22	5.30	1.21	0.11	...	nil	75 oz parcel
28	41.85	46.64	5.49	0.92	0.12	...	nil	50 oz parcel
29	41.76	45.74	6.79	1.14	0.19	...	nil	75 oz parcel
30	42.20	45.83	6.35	1.26	0.18	...	nil	75 oz parcel
31	42.28	46.50	6.31	1.20	0.18	...	nil	50 oz parcel
Average	41.65	45.51	6.40	1.12	0.29	...	0.002	

Analysts:

Samples 1-4. Department of Mines Laboratory, Launceston

Samples 5-7. Daniel C. Griffith & Co., London

Sample 8. Mathey's, London

Samples 9-31. Daniel C. Griffith & Co., London

WORKINGS

The principal area worked for osmiridium in this quadrangle was in the Adams River Valley, and in particular the area from Football Hill to the head of Main Creek. Nye (1929, 1930) described in some detail the claims in existence at the time, and this work is summarised below.

Main Creek

The deposits on Main Creek were mostly underlain by serpentinite and other ultrabasic rocks, with osmiridium most plentiful in the alluvial 'wash' immediately overlying this. The wash ranged from 0.1–1.5 m in thickness and was often angular. It was also commonly recovered from joint planes in serpentinite, although this was not thought to be *in situ*. Some parts of the wash were cemented by iron oxides. Claims to the west of the ultrabasic complex were typically underlain by sandstone, slate or pyritic limestone.

The soil and clay were sometimes treated to recover osmiridium also, in both alluvial and residual deposits.

Much of the osmiridium was considered to derive from vein-like occurrences in an area along the eastern border of the ultramafic body, as described above. Halls open-cut (McAtkins workings) was the principal working on this 'lode' and included small shafts and adits, which have been worked by many miners and syndicates, including Osmiridium (Tasmania) N.L. The lode was reported to average 10-50 g/t osmiridium and trace gold (Osmiridium (Tasmania) N.L.). A shaft immediately to the south of Halls open-cut, on Ivory's claim, worked the same lode, as did Best's workings, Sim's workings, Robert's claim, McAuliffe's workings and Hill, Sweeney and Gladstone's workings, all to the north.

Football Hill

The Football Hill deposits included workings in Moore Creek, Baptist Creek, Smith Creek, Bachelor Creek and Cards Creek. The deposits usually overlay a weathered sandstone, or less commonly shales or clay. The sandstone was sometimes green, probably due to ultramafic-derived material from which the material was probably derived (see above). The osmiridium was usually present in a layer of wash, up to 1.2 m thick, similar to that in Main Creek. It may be enriched on two levels, indicating old stream terraces. Joints in the sandstone contained some osmiridium.

West of the Adams River

West of the Adams River, about 1.5 km west to south-west of Adamsfield, were a number of claims from which osmiridium and minor gold were recovered. These were centred about Barrett Creek, Welsh Gully, Curtain Gully, Scanlon Creek and Lumsden Creek, and were small, being practically worked out by 1925 (Nye, 1929). The ground was relatively thin and underlain by sandstone, shale or clay, with osmiridium sometimes found concentrated in several levels. The area was notable for its relatively high gold content, and there were reports of a trace of cassiterite (Nye, 1929). The osmiridium was presumably reworked from the Palaeozoic sandstones.

Other areas

Millen Creek, about 0.5 km east of Adams River, was worked for osmiridium in serpentinite-bearing gravels overlaying clay. The *Hopper Creek area,* about 1.5 km north-east of Adamsfield, was the site of several claims which worked relatively thin soil and alluvium overlying serpentinite or brown clay (weathered serpentinite). The *Adams River Falls* were prospected for osmiridium between the confluence of the Adam River and Eve Creek and the main Falls. Potholes, up to 10 m in depth, occur in slates and quartzites and were drained to recover osmiridium, although the results are unknown (Nye, 1929). Gold was also found at this prospect, apparently in the quartzite bedrock.

Reid (1925) noted the presence of osmiridium in the Florentine Valley, at widely separated points and of unknown origin (although some may have originated from the Adamsfield ultramafic complex or the associated Palaeozoic placers). He also noted reports of osmiridium around Boyes river; no production is recorded from either area.

The Adamsfield ultramafic complex and associated osmiridium-bearing areas extend south into the Pedder Quadrangle.

The Palaeozoic placers

The Palaeozoic placers were described by Carey (1957?) as large Ordovician marine placer beds containing osmiridium and minor gold, surrounding the Adamsfield ultramafic complex. These beds, presumably of the Denison Subgroup, are almost vertical, up to 330 m in strike length and six metres in thickness, over an area of about 16 square kilometres. Carey (1957?) considered these beds to represent a resource of about 30 to 70 Mt of about 10 g/t osmiridium less than 330 m in depth.

The placer occurs in ultramafic-rich conglomerate unconformably overlying the ultramafic complex, with osmiridium occurring in chromite-rich streaks and rill channels, particularly in the footwall, in grades up to 240 g/t. Carey (1957?) considered that the ultramafic complex was an island in Ordovician times, trending east-west with an axis near Main Creek.

Osmiridium intergrown with chromite and gold was noted, but generally gold was higher where osmiridium was lower.

The production from this formation is unknown, but Carey noted an old drive intersected by 'Pollards new shaft' within the placer.

GOLD

Adams River Falls gold prospect

This prospect, located at DN423698, was granted as a gold reward lease (1721/G) in 1928 or 1929 to a group of osmiridium prospectors. The gold occurrence was discovered during the cutting of a channel for water diversion to enable osmiridium recovery from the Adams River. Nye (1929) described the prospect in detail.

The siliceous conglomerates and sandstones of the Denison Subgroup are locally impregnated with pyrite, and this was considered by Nye (1929) to be related to a large fault immediately to the north-east. The leaseholders found samples of this material assaying up to several pennyweights of gold per ton, although Nye (1929) found no detectable gold or silver in samples he collected and suggested the gold and pyrite may have been secondary.

It is not known what further work was undertaken on the lease.

Other gold deposits

Twelvetrees (1908) found gold near the eastern border of a quartzite schist, just to the east of the Gell River, but no lodes were located.

The Humboldt Mine (q.v.) was originally a gold reward lease and Supprее (1985) confirmed the presence of gold in the lodes.

A significant amount of gold was recovered from the Adamsfield osmiridium field, some of which was directly associated with osmiridium and presumably derived from the ultrabasic complex (Nye, 1929). Some, however, is unrelated to the osmiridium concentration and was presumably derived elsewhere. Nye (1929) noted that the osmiridium-bearing areas west of the Adams River (presumably derived from the Palaeozoic placer deposits) showed a high gold/osmiridium ratio, and Carey (1957?) noted that gold and osmiridium were found to exhibit different patterns of enrichment in the Palaeozoic placers. Nye (1929) noted the gold to be water-worn and up to 1.5 mm in diameter.

BASE METAL DEPOSITS

The only deposits of this type recorded from the quadrangle are the small vein systems of the Mt Mueller [DN574681] and Humboldt [DN579685] mines.

Humboldt mine

The Humboldt mine (Section 8004/M) was originally claimed as a gold reward lease in 1891 and the workings, described by Twelvetrees (1908), Henderson (1939) and Hughes (1952), include adits and shafts. The 'upper lode' consists of a series of quartz-siderite veins up to 200 mm wide with a NE-SW strike, dipping SE, over a width of about 1.3m, in Eocambrian slates. There is a parallel 'Galena Lode' to the south and a parallel argentiferous ferromanganese gossan to the north-east. Sulphides include chalcopyrite, galena and sphalerite while gangue minerals include quartz, siderite, barite and calcite. BHP (1984) recorded anomalous Ba, Cu, Zn, As, Sb and Pb, while Suppree (1985) recorded gold up to 0.3 g/t in grab samples.

Mt Mueller mine

The Mt Mueller mine was first described by Henderson (1939) as new work on the Slides old reward lease (10931/M) but was subsequently described by Hughes (1952) as the Mt Mueller mine. A shaft and small adit were driven on a lode similar to those of the Humboldt mine. Five quartz-siderite veins, up to 80 mm wide, occur in a zone about 0.8 m wide in silicified black slates. The veins dip steeply and strike at N80°E. Sulphides are present as disseminations, patches and microfractures in the veins; pyrite, chalcopyrite, bornite and malachite have been recorded. BHP (1984) and Suppree (1985) detected anomalous copper in grab samples but found no indications of other base metals, gold, silver or tin.

OTHER MINERALISATION

Anomalous tin and tungsten occur with tourmaline in Cashions Creek [DN555850], but the source is unknown (Ruxton, 1982). The presence of cassiterite and topaz in the Adamsfield alluvial deposits, the gravity low in the Florentine Valley (a shallow granite?) and the presence of cassiterite in the Styx and Weld rivers (to the east and south-east of the Huntley Quadrangle) were all considered significant by Ruxton (1982) in this regard. Corbett (pers. comm.) noted that the presence of granite boulders in the basal Permian in this area, perhaps of Antarctic origin, may be related.

Chromite is common in the ultrabasic rocks and associated alluvium, sandstones and quartzites around Adamsfield and the Boyes River (Reid, 1921; Nye, 1929). It was commonly recovered as a by-product of osmiridium mining, but no production is recorded for the area.

Nickel mineralisation was reported by Nye (1929) at Adamsfield, as nickel-bearing siderite in a talcose zone in serpentinite (associated with an osmiridium 'lode'), and as millerite with pyrite in a nearby secondary deposit in alluvium.

Banded ironstones (Ɇi) were noted in the Atkins Range and described earlier in this report. Green (1985) considered these to be similar to the iron formations commonly associated with exhalative sulphide mineralisation, and thus may be prospective for such Pb-Zn deposits.

Arsenopyrite-pyrite-scorodite mineralisation was noted by Twelvetrees (1908) in quartz veins and schist at the base of the Spires.

Numerous limonite deposits in the buttongrass swamps of the Florentine Valley, east of the Humboldt divide, were trenched by early prospectors.

Twelvetrees (1908) noted no lode material and considered them all to be 'bog iron ore' deposits.

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APPENDIX B

PRISTIOGRAPTIDS FROM THE TIGER RANGE

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INTRODUCTION

The Richea Siltstone contains two latest Llandovery graptolite/shelly fauna localities (Baillie, 1979; Jell and Baillie, 1984). A third graptolite-bearing horizon has yielded the pristiograptids described herein together with a single specimen of *Dalmanites*.

The fauna was collected by P. W. Baillie and M. J. Clarke in a road cutting at DN515820 and occurred in buff-coloured siltstone similar to other occurrences of the formation.

SYSTEMATIC DESCRIPTION

Class GRAPTOLITHINA Bronn, 1846

Suborder VIRGELLINA Fortey and Cooper, 1986

Superfamily DIPLOGRAPTACEA Lapworth, 1873, emend Mitchell, 1987

Family MONOGRAPTIDAE Lapworth, 1873

Genus *Pristiograptus* Frech, 1897

Pristiograptus sp. (fig. B1a-i)

Material: About 50 specimens, early growth stages to adult, mostly flattened and with slight tectonic deformation (lineation in tectonic *b* direction indicated by bar on text figures); from the Tiger Range [DN515820].

Description: The sicula is conspicuous and preserved on many of the specimens, ranging in length from 2.0-2.5 mm (mean 2.3 mm). Its apex reaches to at least mid-way between the apertures of th2 and th3, and sometimes to the level of the aperture of th3. The prosicular portion is sometimes obscured where it approaches the nema and exact measurement of the sicular length is not easy. The sicular aperture is even, seemingly lacks any form of dorsal tongue and the virgella is short and spine-like, less than one millimetre long in all the specimens where it is seen. The nema is a robust and conspicuous black rod, almost always clearly visible, and it projects beyond the distal extremity of the thecate part of the stipe for 2 mm or more.

The rhabdosome as a whole is less than 15 mm long and has a maximum dorso-ventral width of 1.10-1.20 mm, but this may be slightly increased by tectonic deformation. At the level of the aperture of th1 and th2 the dorso-ventral width is from 0.50-0.80 mm (mean 0.65 mm), depending upon the direction of deformation. Allowing for tectonic deformation and diagenetic flattening, the rhabdosome of the original specimens was probably less than one millimetre throughout its length; and approximately half that at the proximal end.

Thecal spacing is similarly affected by slight deformation, but ranges from 12-16 per 10 mm in the proximal region to 10-15 in the distal region. Undeformed ranges would be about 13-14 proximally and 11-13 distally. Thecal overlap is approximately 0.5 and the angle of thecal inclination ranges from 30-40°, probably uniformly at around 35° in undeformed specimens (thecal overlap and rhabdosomal length are barely affected by deformation). The interthecal septum is well preserved in a number of specimens (e.g. fig. B1c-f). The apertural lip of the theca is strongly thickened and is usually oriented almost at right angles to the length of the thecal tube. In some cases there is a slight concavity or convexity, and in general a very slight evertion of the apertural region. Growth increments have not been detected except on the metasicula (fig. B1g).

Despite tectonic deformation it is clear that *Pristiograptus* sp. is a short, narrow, and rather straight species. Most specimens are as straight as depicted in Figure B1d, e; some show the *'P. dubius'* curvature (fig. B1h, i) and one has conspicuous dorsal curvature (fig. B1f), a curvature which should be slightly suppressed in this particular example as a result of tectonic deformation parallel to the length of the rhabdosome.

Remarks: Monotype assemblages of pristiograptids are very difficult to identify, and this almost monotypic assemblage is no exception. Most species of the *P. dubius* group can be ruled out because they are much more robust than in Tiger Range specimens; but there are two stratigraphically distinct groups of slender pristiograptids to consider, one of late Llandovery - early Wenlock age, the other of late Wenlock age.

In the early Wenlock only *P. praedubius* Bouček has been described. *Pristiograptus* sp. can be distinguished from this form by having a much longer sicula and in having thecae inclined to the thecal axis at a much higher angle - only the general rhabdosomal dimensions are similar. The curvature of *P. praedubius*

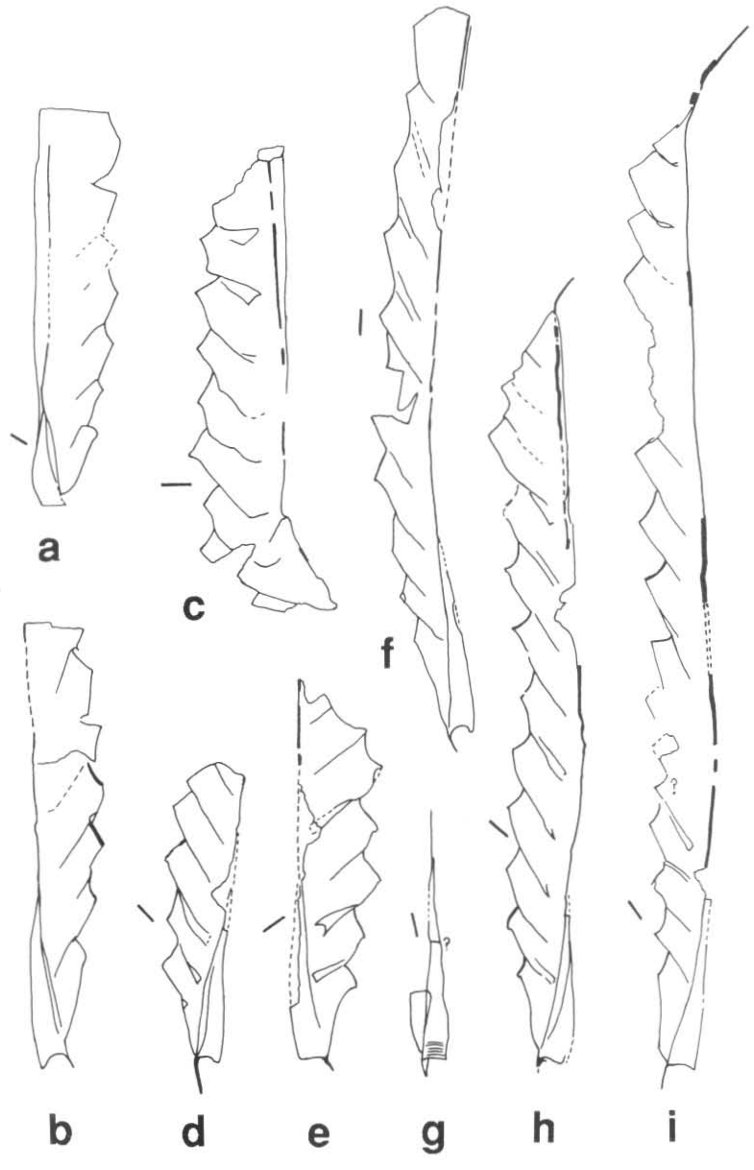
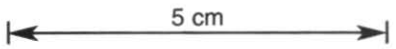


Figure B1. a: *Pristiograptus* cf. *dubius* (Suess); **b–i:** *Pristiograptus* sp. All figures x 10; black bar indicates lineation tectonic *b* direction. Specimens are deposited in the Geological Survey of Tasmania fossil collection.



is more like that of *P. dubius*, that is with distinctive ventral curvature in the proximal region.

Two late Llandovery species of similar rhabdosomal dimensions are *P. initialis* Kirste and *P. pergratus* Přibyl. Both these species are typified by *P. dubius* style proximal curvature, whilst the latter has a very high thecal inclination (45-50°) and a low thecal spacing (10 per 10 mm). *P. initialis* is similar in thecal overlap, has a slightly lower thecal inclination (30°) and a slightly lower thecal spacing of 11-12 in 10 mm (5.5-6 in 5 mm). Both *P. pergratus* and *P. initialis* seem to have a much shorter sicula reaching only between th1 and th2. Despite the overall rhabdosomal dimensions of *P. initialis*, the present author is inclined to doubt any close relationship to the Tiger Range specimens.

In certain regards the Tiger Range specimens are closer to some late Wenlock pristiograptids such as *P. pseudodubius* (Bouček) and *P. jaegeri* Holland, Rickards and Warren, which have rather straight proximal ends and conspicuous siculae. *P. jaegeri* in particular has a 2 mm sicula which reaches the level of the aperture of th2: it differs from *Pristiograptus* sp. in having a lower thecal spacing (12-8 *cf.* 16-10). There is a difference in distal dorso-ventral width, but at comparable distances from the sicula *P. jaegeri* is not noticeably more robust (1.1-1.2 mm *cf.* 1.0 mm). *P. pseudodubius* also has a lower thecal spacing and the sicula is rather short (1.5 mm) though reaching to the second thecal aperture as in *P. jaegeri*. The rhabdosomal width in *P. pseudodubius* is the same as *Pristiograptus* sp., and the most conspicuous difference in respect of overall rhabdosomal aspect is that the thecae are inclined to the axis at a rather low angle (<30°). *Pristiograptus* sp. can be readily distinguished from *P. sherrardae* (Sherwin) from the Forbes Group of New South Wales, simply on account of its lesser curvature and much longer sicula in a different position.

Thus the Tiger Range species cannot readily be equated with previously described pristiograptids whether late Llandovery or late Wenlock. However, the author is of the view that they are closer to the late Wenlock forms such as *P. jaegeri* and *P. pseudodubius* than to the late Llandovery forms. Perhaps supporting such an age attribution is the occurrence with *Pristiograptus* sp. of a few specimens (e.g. fig. B1a) which might be referable to *P. dubius* (Suess) in that they have a short sicula, with its apex between th1 and th2 and they have the correct curvature, thecal spacing and rhabdosomal dimensions. They are not, however, well preserved or common. *P. dubius* occurs from the middle of the Wenlock upwards. In addition, there is a single minute fragment of retiolitid list which is more reminiscent of Wenlock (or higher) retiolitids than of Llandovery forms.

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