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THE GEOLOGY AND MINERALISATION
OF THE MT. LYELL AREA, TASMANIA
EL 47/70

1971: 25

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ABSTRACT

The Stratigraphy, structure and mineralisation of the Palaeozoic rocks of the West Coast Range of Tasmania are discussed and particular horizons of mineralisation noted.

An attempt is made to subdivide gross lithologies and to outline environments of ore deposition with the view of assisting technical staff in field exploration.

It is suggested that the areas of outcrop of the Mt. Read Volcanics and Undifferentiated Dundas Group in the area of EL 47/70 are the most likely areas for mineralisation.

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A. INTRODUCTION

This report is based on research of literature from the Sydney University Department of Geology and Geophysics library, the New South Wales Mines Department library and the Mitchell Library, Sydney.

The objectives of the investigation were :-

- (1) To collect and study published literature on the geology and mineralisation of the area of EL 47/70 and to compile this information into a single report.
- (2) To compile geological maps from this information.
- (3) To outline the areas of EL 47/70 where mineralisation is most likely to occur.
- (4) To provide a basis for detailed field work.

Geological mapping has been carried out by the B.H.P. Company Limited (1969) and Bradley (1954) (maps 1 and 2). The map compiled by Bradley is the most detailed but, however, does not cover a very large area of EL 47/70.

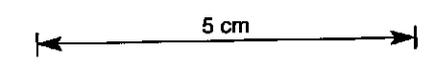
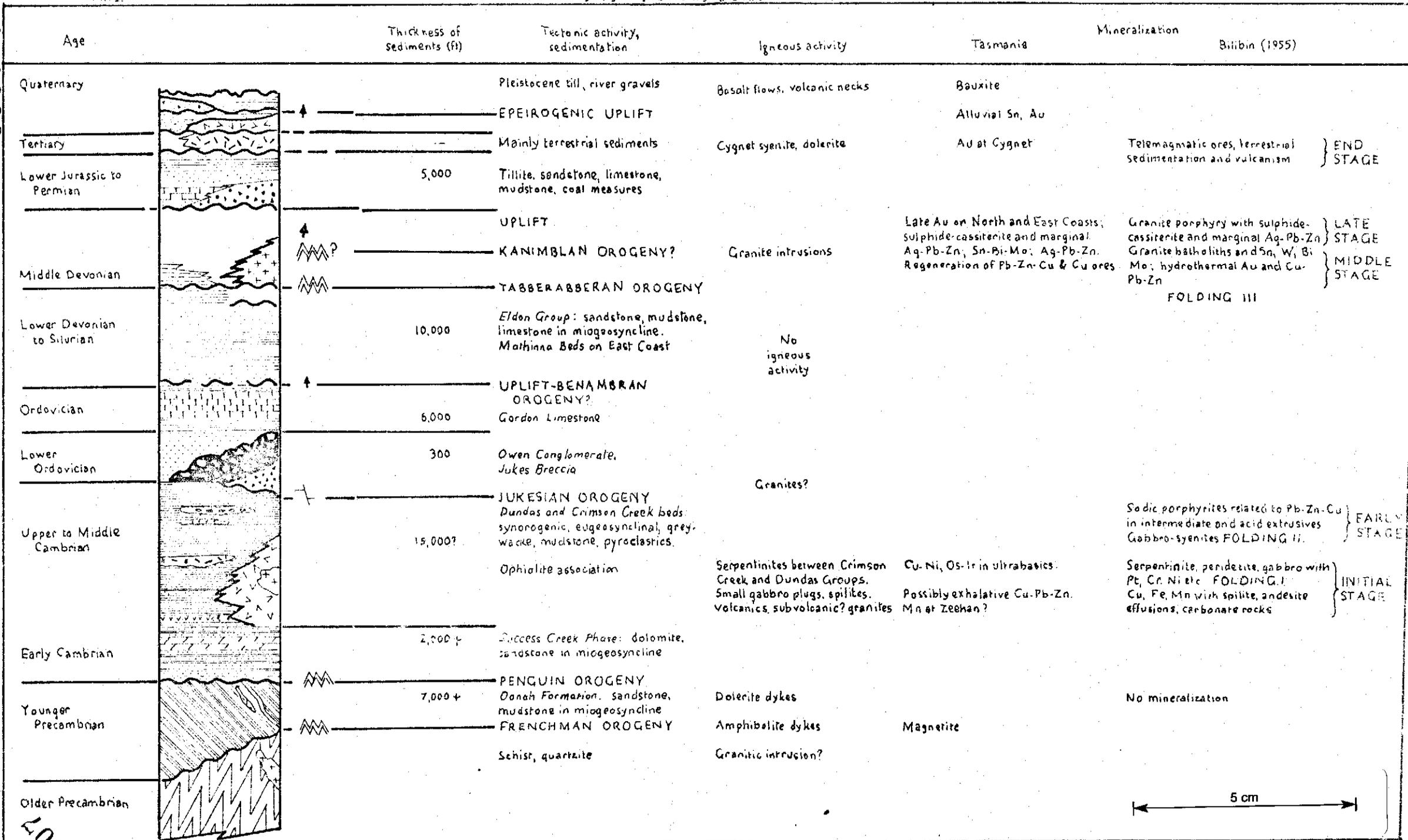
Large discrepancies exist between the two maps, especially in the areas of outcrop of the Cambrian Mt. Read Volcanics of the Dundas Group in the King River-Mt. Sorell area.

It is suggested that the areas of outcrop of the Mt. Read Volcanics and Undifferentiated Dundas Group in the area of EL 47/70 are the most likely areas for mineralisation.

FIG-1.

Summary of geological history and mineralization of Tasmania

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(SULLIVAN 1965).

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B. THE GEOLOGICAL HISTORY OF THE
WEST COAST OF TASMANIA

Prior to the Permian, Tasmania was the site of marine geosynclinal sedimentation; from the Precambrian to the Ordovician, deposition was mainly in tectonically disturbed inter-ridge basins but during the Silurian and Devonian conditions were more stable than during the Cambrian and submergence widespread. The stable phase was halted by the Tabberabberan orogeny (Middle Devonian) and sedimentation did not resume to the Lower Permian. From then to the present tectonic activity consisted mainly of gravity faulting and concomitant hypabyssal intrusion and volcanism; sedimentation, both marine or terrestrial, was relatively thin (Fig.1).

The oldest rocks in Tasmania are those probably outcropping in the Central Highlands and parts of the north and west coasts. They are deformed medium to low grade quartzose schists with muscovite, garnet and albite; schistose quartzites, phyllites and amphibolites and are referred to as the Older Precambrian. The Older Precambrian is overlain by the so called Younger Precambrian. These consist of quartzites and slates with minor dolomites, conglomerates and volcanics, they are relatively undeformed but are of similar primary lithology to the Older Precambrian. There is reason to believe that in part the Older Precambrian rocks are severely deformed varieties of the Younger Precambrian (Solomon 1965). Spry (1962) has tentatively concluded that the two rock units are separated by the Frenchman Orogeny.

The distribution of the Younger Precambrian successions indicates that in the time of their deposition the Older Precambrian formed a Geanticline (the Tyennan Geanticline) in the Central Highlands area and that the surrounding basin formed a Miogeosyncline (Fig. 2). The margins of the Tyennan Geanticline have had a significant control over fold trends in succeeding orogenies.

Deposition was then interrupted by the Penguin Orogeny, with at least two stages of folding, intrusion of dolomite dykes and granite. Dating of the dolerites indicates a late Proterozoic age (Spry 1962).

The geological history immediately following the Penguin Orogeny is uncertain. It is thought, however, that following the Penguin Orogeny several thousand feet of sandstones, siltstones and dolomite were deposited over the Younger Precambrian Miogeosyncline, overlapping for several miles onto the Tyennan Geanticline (Solomon 1965) (Fig 4b). The sediments of this transgressive

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phase include the Carbine Group at Dundas, the Smithton and Jane Dolomites, the Success Creek Group, the sandstones and dolomites at Mt. Bischoff, and the calcareous sequence below spilites on King Island. In the Zeehan district, Blissett (1962) includes many rocks of this phase (called the Success Creek Phase) in the Oonah formation, considered to be Younger Precambrian (Spry 1962.) The age of the Success Creek phase is estimated to be early Cambrian or Late Proterozoic (Solomon 1965).

At Zeehan and other localities the upper parts of the Success Creek phase contain volcanic rocks which herald a pronounced change in the tectonic stability and form of sedimentation within the geosyncline. For the remainder of the Cambrian the Tyennan Geanticline, now considerably reduced in size probably remained emergent or under very shallow sedimentary cover. Similar but smaller islands may have formed on an arc along the Rocky Cape Geanticline, ringing the Tyennan mass to the north and west (Fig.3). The relatively narrow arcuate basin between these two structures is known as the Dundas Trough.

At this time Tasmania formed part of the Tasman Geosynclinal zone of Eastern Australia, the early stages of which are marked by widespread basic and spilitic volcanism in Tasmania and Victoria. These spilites occur within the Success Creek Phase near Zeehan.

The initial intrusion of spilites accompanied a deepening of the sedimentary basin and a change to synorogenic sedimentation characteristic of eugeosynclines, the igneous activity being characteristic of the ophiolite association.

Filling of the subsiding basin was accomplished by:-

- (a) Transport of fine detritus from the shores.
- (b) Occasional inrushes of coarse material from the shores, possibly of lavas and tuff.
- (c) Accumulation of lavas and tuff.
- (d) The products of erosion of volcanic piles and tectonically rising ridges.

The main rock types deposited in the Cambrian, other than volcanics, are paraconglomerates, greywackes and mudstones with minor cherts and limestones.

These rocks succeeding the Success Creek phase are estimated to be 15,000 to 20,000 feet thick on the West Coast and comprise the Crimson Creek argillite (unfossiliferous) and the

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Dundas Group which is of Lower Middle Cambrian to Middle Upper Cambrian (Solomon 1962, Banks 1956).

Carey (1947 (a)) suggested that during Dundas deposition there was a narrow arcuate belt of volcanoes offshore around the margins of the Tyennan Geanticline. The volcanic products which are mainly acid and intermediate types, are termed the Mt. Read Volcanics of the Mt. Read Volcanic Arc. The age relationships between these and the spilites is unknown. The volcanoes were possibly due to deep seated fractures fringing the Tyennan structure (Campana et. al 1963).

Near Mt. Read, the volcanics consist of about 10,000 feet of basal, potash rich, brecciated rhyolites, agglomerates and tuff overlain by mainly sodic volcanic breccias, tuffs, keratophyres and quartz keratophyres (Solomon 1961). The volcanic pile reached its greatest development between the Pieman River and Mt. Darwin, and certain horizons within the pile act as hosts for the largest of Tasmania's sulphide deposits.

At Tullah and Mt. Darwin the Mt. Read Volcanics are intruded by sodic and potassic granite and adamellite of similar composition to the enclosing quartz keratophyres and rhyolites. These granites are crudely concordant and were probably intruded into the core of the volcanic pile towards the end of the volcanic activity (Solomon 1961).

Near Mt. Read, at Mt. Sedgwick, Mt. Darwin and other localities a particular type of potassic lava was intruded by veins up to 200 feet wide of magnetite - hematite - barite, these components being primary constituents of the magma (Solomon 1965, Hills 1914).

Sedimentation ceased abruptly in the Upper Cambrian with the onset of the Jukesian Orogeny, producing folding in the Cambrian and older sediments on trends parallel to the margin of the Tyennan Geanticline. This is evidenced by unconformities south of Queenstown, near Tullah, Moina, Ulverstone and other places. Major faulting of similar trend to that which uplifted the Tyennan and Rocky Cape Geanticlines occurred producing an inter-Geanticline depression. This depression was split by an axial ridge of Cambrian rocks (Dundas Ridge, Bradley 1954, the Porphyroid anticlinorium, Carey 1953) into two elongate basins of which the largest was the Owen basin' on the western and northern flanks of the Geanticline. The Owen basin is regarded as a rift valley, the Owen Rift Valley (Campana et al 1963). The Dundas ridge forms a sharp western wall to the Owen basin from Queenstown to Tullah, the wall marking the line of the prominent West Owen Rift (Campana et al 1959) or the Mt. Lyell Fault Zone. The form of the depression is shown in Fig. 2. Solomon (1965) considers the basin

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and ridge movements of the Jukesian Orogeny to be due to a continuation of the tension stresses causing the initial sag of the Cambrian basin.

The Owen Basin was initially infilled by the Jukes Conglomerate, of Ordovician age, derived from erosion of the Mt. Read Volcanics. This was succeeded by up to 2,500 feet of quartzose conglomerate, The Owen Conglomerate, derived largely from erosion of Precambrian rocks.

Campana et al (1958) regard, that in the main, the Owen Conglomerate is a continental formation brought about by the gravelly and sandy infilling of the Owen Rift Valley. Solomon (1965) subdivides the Owen Conglomerate into three units.

- (1) The Lower Owen - consists of grey and yellowish coarse conglomerates of possible fluvial origin.
- (2) The Middle Owen - consists of reddish, medium grained conglomerates and coarse sandstones.
- (3) The Upper Owen - red finer grained sandstones with marine fossils and fine grained conglomerates.

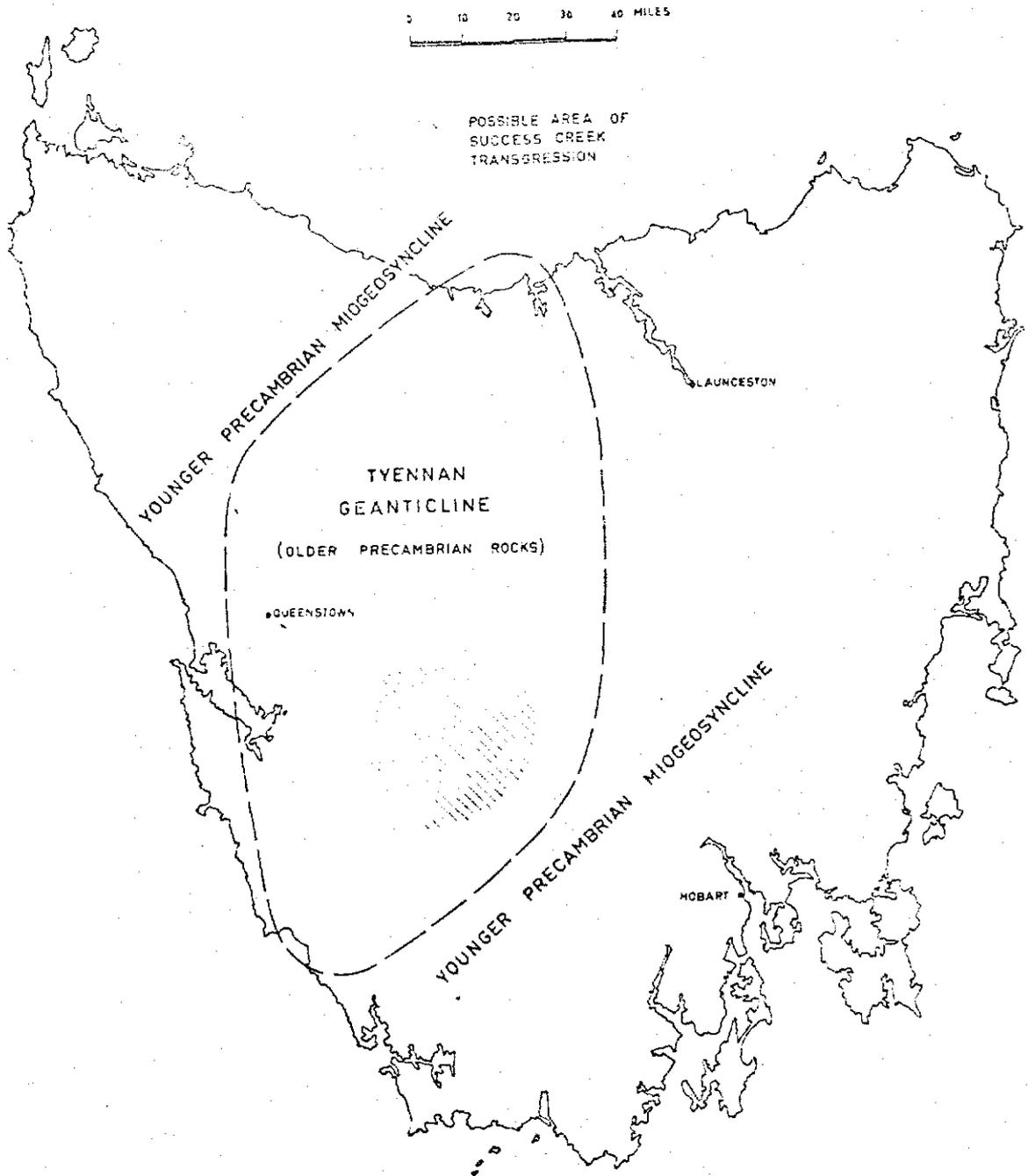
The gradual upward diminution of grain size was accompanied by lateral transgression until, by the close of Owen time, thin marine sandstones covered much of the Dundas Ridge and parts of the Geanticlines (fig.4b). The Caroline Creek Sandstone is correlated with the Upper Owen and carries Arenigian marine fossils (Banks 1962b). At Queenstown, erosion of barite-magnetite veins possibly also containing sulphides, produced localized thick lenses of limonite - hematite rock on the flank of the Owen basin (Solomon 1965).

The marine transgression continued during the deposition of the Gordon limestone (shales and limestones) which was deposited over a wide area of Tasmania. These beds are up to 5,000 feet thick and of Middle Arenigian to Upper Ordovician age. They represent a return to miogeosynclinal conditions.

The basal bed of the Silurian succession, the Crotty Sandstone, is a quartz sandstone or grit that contains detrital chromite and probably is a result of a minor uplift of the source areas. These minor movements are correlated with the Benambran Orogeny of eastern Victoria.

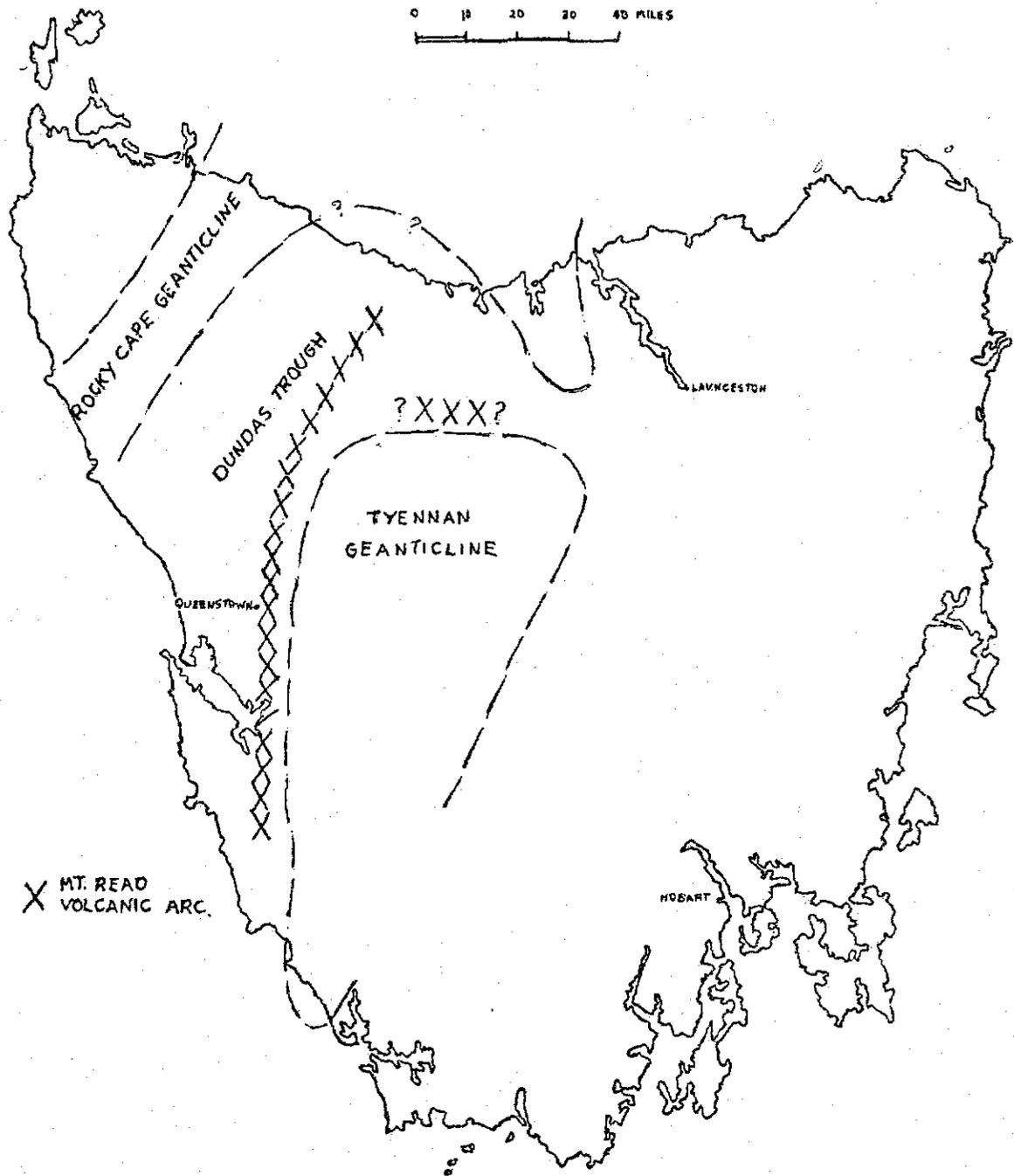
The Crotty Sandstone heralded a prolonged phase of tectonic quiescence during which some 10,000 feet of sandstones, mudstones and limestones of the Eldon Group were deposited, this group extends into the Lower Devonian. Earth movements began to affect the Miogeosyncline in the Lower Devonian (Banks, 1962c) and sedimentation ceased in the

FIG. 2. PALAEOGEOGRAPHY OF THE YOUNGER PRECAMBRIAN



Solomon (1965)

FIG. 3. PALAEOGEOGRAPHY OF THE CAMBRIAN



Solomon (1965)

5 cm

Middle Devonian. This period of deformation is known as the Tabberabberan Orogeny, in which deformation was followed by a major phase of granite intrusion and mineralization.

Solomon (1962) suggested that the Tabberabberan deformation took place in two stages:-

- (1) Stage of differential vertical uplift to form long wavelength, arcuate synclinoria and anticlinoria, movements being controlled by the Tyennan and Rocky Cape geanticlines. The first stage of folding was accompanied by vertical movements on pre-existing faults near the geanticlinal margins such as the Great Lyell Fault Zone.
- (2) Stage where the influence of the Geanticlines was negligible and orogeny was dominated by structures of N.W. trend. Super-imposition, and interference with, earlier folds produced severe local complications. The E-W faults, such as the Linda Fault Zone which has been traced for 20 miles and is several miles wide is attributed to this stage. The Mt. Lyell copper deposits lie within this fault zone.

Granites were intruded late in the Tabberabberan orogeny or during the Kanimblan Orogeny. They appear to be intruded along large scale anticlinal structures (Carey 1953) (Fig. 4). All are characterised by late stage mineralisation near to the margins of the intrusion.

Sedimentation did not resume until early in Permian times and it is likely that earth movements and possibly igneous activity continued into the Kanimblan Orogeny (Upper Devonian). From the early Permian to the present day, tectonic activity has been largely epeirogenic. Faulting on approximately N.W. trends occurred through the Tertiary to form large and small graben structures. Localised terrestrial deposition took place in some of the graben. Most of the tin and gold alluvial deposits were formed during the late Tertiary and Quaternary.

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FIG.4 Arcuate folds of the early phases of the Tabberabberan Orogeny.

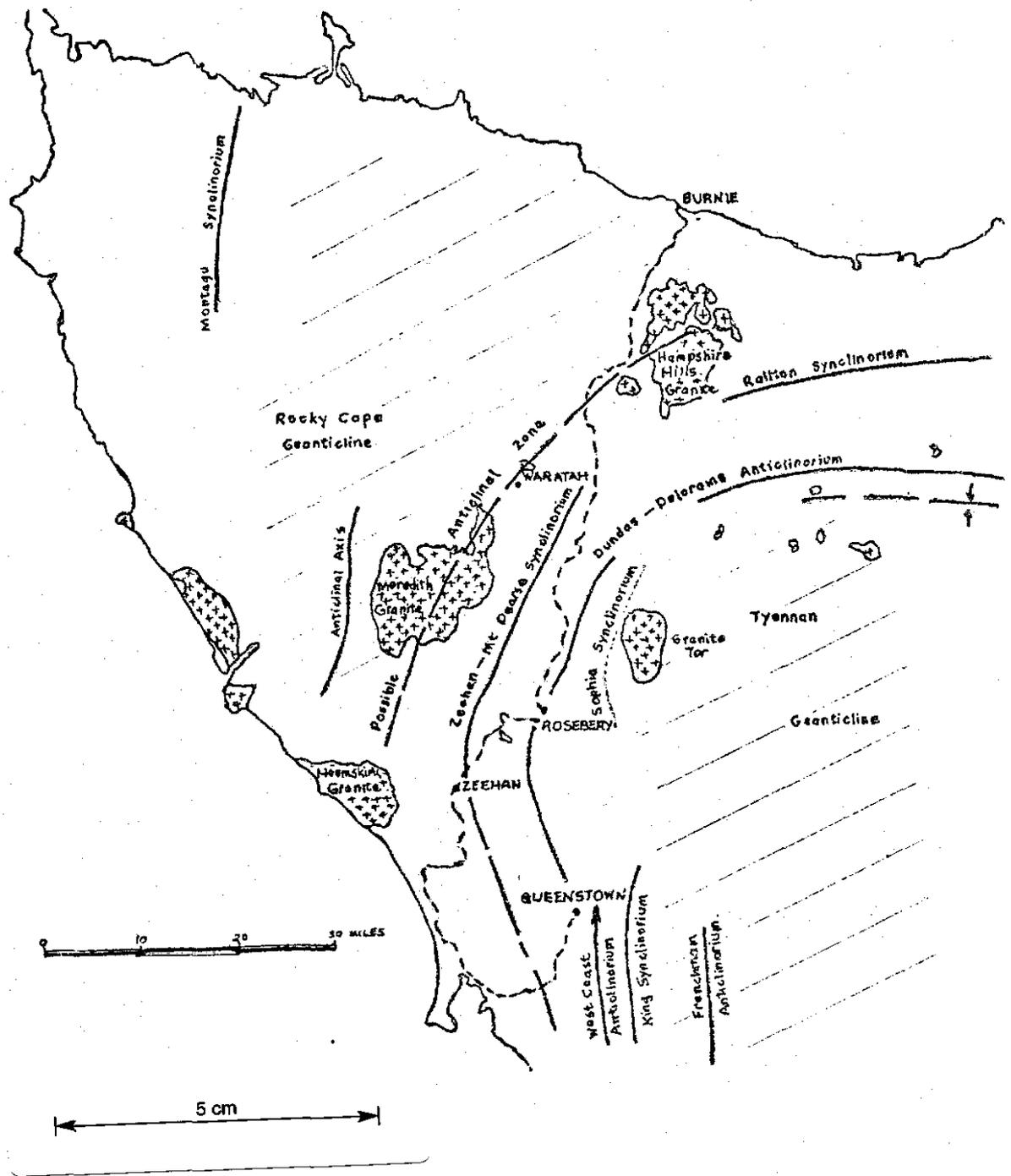
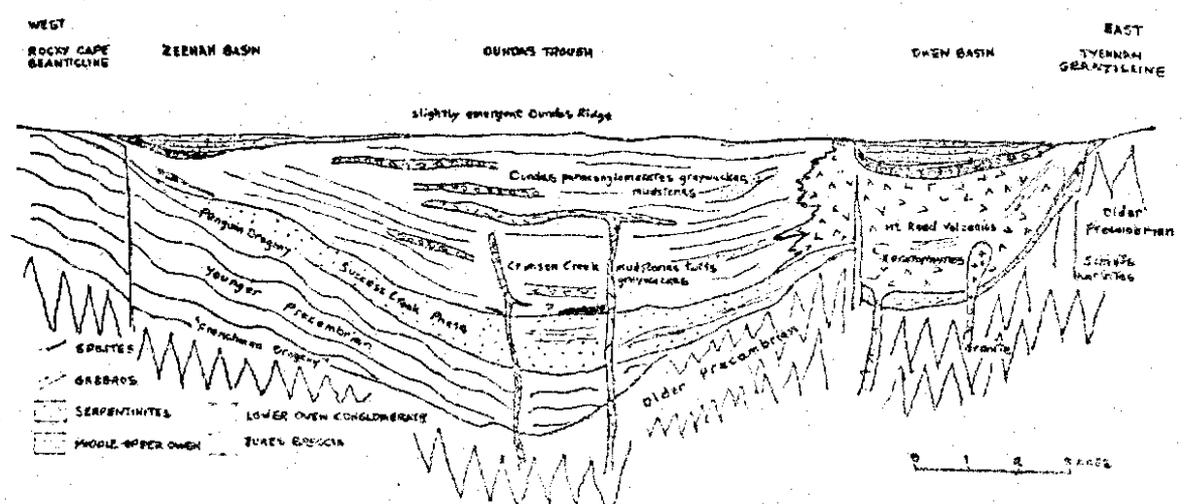


FIG.4b. Palaeoprofile to illustrate the geological history of the Zeehan-Mt. Tyndall area up to the close of Owen Conglomerate deposition (Solomon 1965).



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C. THE PRECAMBRIAN SYSTEM

The Precambrian rocks can be divided into two main groups, the regionally metamorphosed schists, massive quartzites, quartz schists phyllites and slates with amphibolites which are common in the central west of Tasmania and outcrop in the western portion of EL 47/70. The second group consists of scarcely altered sandstones, quartzites, shales phyllites, dolomites and minor rudites which are most extensively developed in the north-west of Tasmania but do not outcrop in the area of EL 47/70.

The major stratigraphic problem is whether the metamorphic rocks are older than the unaltered sediments or are their more altered equivalents. Spry (1962) suggests that they were separated by a period of minor basic igneous activity and extensive regional metamorphism, known as the Frenchman Orogeny. The Penguin Movement (Late Precambrian) probably separated all of these rocks from the Cambrian.

Spry (1962) suggests that on the evidence available the Tasmanian Precambrian rocks can be divided into an older group which shows a low to moderate grade of regional metamorphism and a younger group of rocks which are either unaltered or regionally metamorphosed to a slight degree. He suggests that they should be referred to as the "Older" and "Younger" Precambrian being separated by a metamorphic event.

The best evidence for an unconformity between "Older" and "Younger" types is that advanced by Spry and Zimmerman (1959). South-east of Artists Hill, what is regarded as the Jane Dolomite (equivalent to the thick dolomite which occurs at the top of the "younger" Precambrian sequence at Smithton and Tim Shea) is unmetamorphosed but rests on regionally metamorphosed and strongly deformed "Older" Precambrian Scotchfire Group, Breccia phases in the dolomite contain pebbles identical with the adjacent schists and quartzites.

1. THE METAMORPHIC ROCKS (OLDER PRECAMBRIAN)

The metamorphic rocks outcrop on the eastern margin of EL 47/70 (map 2) and are chiefly strongly deformed metasediments with a low to moderate grade of regional metamorphism; some metamorphosed basic rocks are now amphibolites; post metamorphic

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dolomites and lamprophyres.

The succession between Mt. Mary and Mt. Fincham is as follows (Spry 1957b).

| | |
|--|----------|
| Younger basic igneous group - dolerites (Devonian) | |
| Frenchman Orogeny. | |
| Older Basic Igneous Group - amphibolites | |
| Fincham Group - Massive schistose | |
| quartzites and phyllites | 3,400'+ |
| Franklin Group - mica, garnet and | |
| albite - schists with quartzites | |
| and amphibolites | 5,000' |
| Mary Group - massive and schistose | |
| quartzites and phyllites | 8,000' |
| Joyce Group - mica and garnet | |
| schists with quartzites | |
| and amphibolites | 5,000' + |

The succession around Mt. Mullens (Spry and Zimmerman 1959) is as follows:

| | |
|---------------------------|---------|
| Jane Dolomite | 3,000 + |
| Frenchman Orogeny | |
| Older Basic Igneous group | |
| Scotchfire group | 3,000 + |
| Franklin Group | 12,000 |
| Joyce Group | 5,000 + |

Joyce Group

This Group consists chiefly of garnet mica schist and mica quartzite with a little pyroxene - amphibolite. The rocks are recrystallized and regionally metamorphosed to the albite - epidote - amphibolite - chloritoid - almandine sub facies of Turner (1951) with the development of a new fabric. This rock lacks the hornblende amphibolite, and albite schists of the Franklin Group.

Garnet - mica schist is the most abundant member of this group. It is a grey, medium grained schistose rock consisting chiefly of muscovite and quartz with porphyroblasts of garnet giving the rock a knotted appearance.

The muscovite quartzite is a white, thinly bedded laminated quartzite containing abundant muscovite flakes giving a schistosity parallel to the bedding. It shows tight isoclinal folding in some

localities with a lineation parallel to these fold axes.

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The Mary Group

The Mary Group consists of three main rock types (a) massive quartzite (b) quartz schist (c) phyllite. They consist almost entirely of quartz and sericite and the rocks differ mainly in grainsize and the relative proportions of the two minerals. The Group differs considerably from the Joyce and Franklin Group in that it is dominantly silicious and contains rocks which show only a low grade metamorphism and much less deformation (Spry 1957b).

(a) Massive Quartzites

These are massive white quartzites thickly bedded and are the only rocks to contain bedding. Some specimens are fine grained massive, well bedded rocks with cross bedding and ripple marks. Thin sections show the rock to be generally a pure quartzite with only a little muscovite, tourmaline, zircon and iron ore, (Spry 1957b).

(b) Quartz Schists.

These are the most common rock type in the Mary Group. They are mica - rich quartzites with a characteristic platy appearance in outcrop. In some outcrops it is light grey to yellow with a phyllitic appearance whereas in others it is less schistose and rather massive. The schistosity is parallel to the bedding which is usually contorted and tightly folded.

The quartz schists may have been derived from quartz sandstones or it is possible that they may have been formed by silicification of the phyllites (Spry 1957b).

(c) The Phyllites

The phyllites are light to dark grey rocks which are fine-grained, soft and lustrous with a strong cleavage. The cleavage is generally parallel to the poorly developed bedding.

Thin sections show them to be fine - grained and rich in quartz and muscovite with accessory tourmaline, zircon, rutile, iron ore and rare chlorite. Quartz lenses found in them are of a replacement nature (Spry 1957b). chemical analysis shows specimens to have the composition of a siliceous siltstone, a mature sediment from a stable tectonic environment (Spry 1963).

Although mineralogically and chemically simple, the phyllites are structurally complex and have attributes of phyllonites. They are tightly contorted into recumbant folds a few inches across, with sheared out limbs, fold mullions, quartz rods and quartzite boudins.

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The Franklin Group

The rocks of this group are products of medium-grade regional metamorphism on a mixture of sandstone and shales with some pre-metamorphic basic intrusions. Muscovite and garnet rich schists are common with knotted albite schists, garnet - gneisses, muscovite - quartzites and garnet - quartzites.

The minerals present are almandine, muscovite, biotite, quartz, albite, chlorite, actinolite, rare kyanite and pyroxene and accessory tourmaline rutile zircon, magnetite, pyrite and zoisite. (Spry 1963).

Normal amphibolites are found in the Cardigan Schist and Quartzite of the Franklin Group in the Mt. Mary area. Pyroxene amphibolites are also found in the Cardigan Schist. These amphibolites are thought to be of an intrusive nature, being metamorphosed basic intrusions (Spry 1957b).

The Fincham Group

The Fincham Group is a belt of quartzites and phyllites outcropping mainly along the Engineer range. The Group is overlain unconformably by Ordovician Owen Conglomerate at the Engineer Range and appears to rest on schists of the Franklin Group (Spry 1963).

The rocks are similar to those of the Mary and Scotchfire Group and the group consists of phyllites and quartz - schists with rare massive quartzites. The quartz - schists and phyllites are commonly contorted on a small scale and contain isoclinal folds.

The Scotchfire Group.

This group consists of pale - green, lustrous phyllite with strong lination and thin silicified oolitic dolomites. Thin quartzites and calcareous schists also occur.

The stratigraphic position of this group is not clear, but it is probably equivalent to the upper part of the Fincham Group (Spry 1962).

2. THE UNMETAMORPHOSED ROCKS (THE "YOUNGER" PRECAMBRIAN)

The Younger Precambrian rocks do not outcrop in the area of EL 47/70 and thus will not be treated here at length.

At Zeehan these rocks are of great thickness. Their structure is complex and stratigraphy uncertain.

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The succession near Zeehan is as follows:

Precambrian (Crimson Creek Argillite
to (Unconformity
Cambrian (Carbine Group

(Oohan Slate and Quartzite
Precambrian (Unconformity
(Whyte Schist

The succession at Dundas given by Elliston (1954) was:

Dundas Group
Unconformity?
Carbine Group
Unconformity
Quartzite and Schist

This has been modified by Blissett (1962) who suggest the following:

| | | |
|-------------------------------------|-------------------------|---------|
| "Middle to Upper Cambrian | Dundas Group | 9,000'+ |
| ? Lower to Middle Cambrian | Crimson Creek Formation | 10,000' |
| ? Lower Cambrian | Carbine Group | 2,000' |
| Unconformity or metamorphic contact | | |
| Schists and quartzites. | | |

The succession at Tim Shea is as follows (Spry 1962).

| | |
|-----------------------------|---------|
| Stevens Dolomite | 4,000'+ |
| Humboldt Slate and Dolomite | 1,800' |
| Needles Quartzite | 1,500' |
| Laminated Quartzite | 150' |
| Laminated Grey Dolomite | 150' |
| Green Greywacke Sandstone | 500'+ |

Thick dolomites at Smithton, Jane River, Tim Shea and Hastings appear to be the youngest formation in the sequence of unmetamorphosed Precambrian sediments. The dolomites rest on different rocks or are immediately underlain by conglomerate suggesting that some kind of tectonic movement took place immediately prior to the deposition of the dolomite. This possible unconformity may represent the Penguin Movement (Spry 1962). (See Fig. 17 for correlations).

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Relative Distribution of the "Older" and "Younger" Precambrian Rocks.

The "younger" Precambrian sediments are thick across the Rocky Cape Geanticline and at Tim Shea, but have not been found between the "older" Precambrian and the lower Palaeozoic rocks across most of the Tyennan Geanticline. Spry (1962) suggests that there was a land mass coinciding in part with the Tyennan Geanticline in late Precambrian times (Fig.2). Current directions suggest derivation from the south.

The lack of Dundas Group in many of the places (Rocky Cape Geanticline, Tim Shea) where the "younger" Precambrian is thickest and vice versa suggests that there were differences in

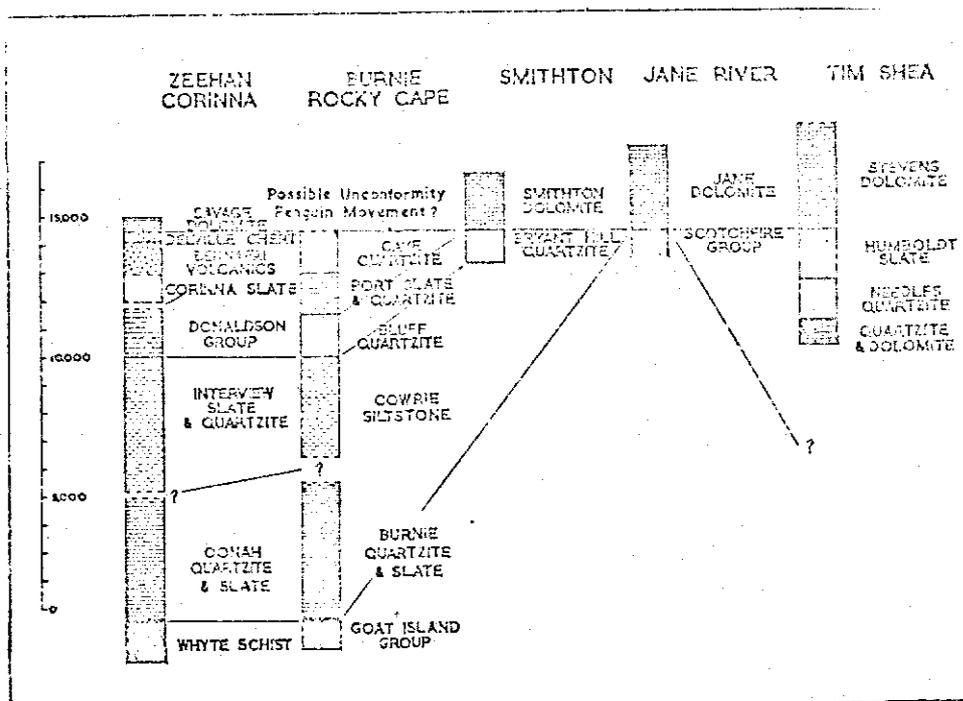


Fig. 17 Stratigraphic sections through some younger Precambrian successions (Spry)

the shape of the basins in the late Precambrian (or earliest Cambrian) and Mid - to Upper Cambrian times. The Penguin Movement probably caused this change and may also have resulted in there being no sedimentation during the Early Cambrian.

D. THE CAMBRIAN SUCCESSION

The rocks of the West Coast Range, particularly around Dundas (five miles east of Zeehan) have been used as a local standard of reference for the Cambrian System in Tasmania.

The Cambrian sediments and volcanic formations lie as a belt of very thick deposits between the Rocky Cape and Tyennan Precambrian elements. The geosynclinal nature of this zone has been recognised by Carey and Banks (1954), Banks (1956), Campana et al (1958), Campana and King (1963), Solomon 1960 and 1965). From the tectonic viewpoint, the evolution of this belt in post-cambrian time is not quite comparable with the normal cycle of Geosynclinal Zones, for no geosynclinal chain can be specifically related to the folding of the belt. The geosynclinal characteristics of the West Tasmanian Cambrian trough (Dundas Trough) were confined to the subsidence and infilling stage, which ended in Upper Cambrian time. This stage was not followed by the uplift of the belt, but by movements which were in the main vertically directed (Campana et al 1963).

Three main lithological assemblages have been recognised:

- (1) Lower Cambrian.
- (2) The Dundas Group, the most widespread and best known of the Cambrian succession, ranging through the Middle and Upper Cambrian.
- (3) The Mt. Read Volcanics, which are considered to be correlatable with the Dundas Group but however form a distinct lithological assemblage.

On the West Coast, firstly in Cambrian time a basin of neritic sedimentation formed. This basin was marked by arenaceous and carbonate deposits; the basin then evolved into a eugeosynclinal belt flanked to the west and east by two Precambrian geanticlines and comprising a volcanic arc (Mt. Read Volcanic Arc) and a deep depositional furrow (The Dundas Trough), (Campana and King 1963, and Solomon 1965).

1. THE LOWER CAMBRIAN

There are differences of opinion as to where to place the Cambrian Precambrian boundary. Elliston (1954) and Spry (1962) consider the Carbine Group as Precambrian. The Carbine Group is a distinctively arenaceous and dolomitic succession, containing tuffaceous layers at intervals. The Group outcrops at Dundas. Solomon (1965) assigns an age of Late Proterozoic or Early Cambrian to this group and Campana et al (1963)

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| GROUP | FORMATIONS | FACIES | AGE |
|---------------------------------|---|---|---|
| JUNEE GROUP | GORDON LIMESTONE CAROLINE CREEK SANDSTONE MARINE TRANSGRESSION | MIOGEOSYNCLINAL SEDIMENTATION | LOWER TO UPPER ORDOVICIAN |
| | CONFORMITY (MISERY HILL) | | |
| DUNDAS GROUP | DWEN CONGLOMERATE CONFORMITY AND LOCALLY DISCONFORMITY JUKES BRECCIA DISCONFORMITY | CLASTIC AND RED-BEDS TERRESTRIAL SITE MOLASSIC FACIES POST-OROGENIC SEDIMENTATION IN RIFT VALLEYS | LOWER ORDOVICIAN |
| | (IN ZONES OF ORDOVICIAN FAULTING) GREYWACKE, CONGLOMERATES, SLATES, SHALES AND PEBBLE BEDS PURPLE, GREEN & GREY SHALES SANDSTONES AND TUFFS | GREYWACKE- CONGLOMERATIC SUITES FLYSCH FACIES | |
| | CHERT CRIMSON CREEK ARGILLITES UNCONFORMITY | ARGILLITE-EUXINIC MARINE FLYSCH FACIES SYN-OROGENIC SEDIMENTATION IN EUCEDSYNCLINAL FURROW | MIDDLE TO UPPER CAMBRIAN |
| MOUNT READ VOLCANICS | SLATES AND TUFFS LAVA FLOWS KERATOPHYRES PORPHYRIES AND MASSIVE PYROCLASTICS VOLCANIC AGGLOMERATE FELDSPATHIC TUFF TECTONIC ZONE SCHISTS OF MT LYELL, HERCULES AND ROSEBERRY MINE AREAS | VOLCANIC SUITE: LAVAS AND EJECTAMENTA PILES ALONG VOLCANIC ARC | LATE LOWER CAMBRIAN TO MIDDLE CAMBRIAN (INF) |
| EARLY CAMBRIAN? SEQUENCES | GREY AND BLACK LAMINATED SLATES QUARTZITE, COMMONLY MICACEOUS DOLOMITIC BRECCIA CONGLOMERATE DOLOMITE AND DOLOMITIC SILTSTONE PURPLE AND GREEN SLATES AND SILTSTONES UNCONFORMITY | QUARTZITE-CARBONATE SUITE, WITH VOLCANIC MEMBERS IN UPPER PORTION | EARLY CAMBRIAN (INFERRED) |
| | QUARTZITES AND SLATES | PRECAMBRIAN | |

Fig. 6. Stratigraphic and facies succession of early palaeozoic rocks of the West Coast Range Area. (Campana and King).

2. THE DUNDAS GROUP

The Dundas Group is of particular interest in that it is host to the Mount Lyell copper deposits and contains a variety of rock types which have puzzled geologists for many years.

The Group was defined by Elliston (1954) as the sequence of sediments and volcanics exposed near Dundas township, underlying the Junee Group (Ordovician) and overlying the Carbine Group (Precambrian). Correlations within the Group have been done largely on lithological grounds, but occasionally on Palaeontological evidence.

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The fossils collected show a range from the Ptychagnostus gibbus zone to the Glyptagnostus reticulatus zone, of approximately Upper Middle Cambrian to basal Upper Cambrian (Banks 1956). (Fig. 7 and 8).

The sediments and volcanics of the Dundas Group are thought to have been deposited in a eugeosynclinal basin, which extended over at least western Tasmania and part of Victoria (represented there by the Heathcote Series).

The Group unconformably overlies the Precambrian Carbine Group, the unconformity making the Stichtan movement of the Tyennan Orogeny (Banks 1956), or Penguin Orogeny of Solomon (1965).

Campana et al (1958) distinguished and mapped two major Cambrian divisions on their mineral characteristics, facies and origin.

(a) The volcanic assemblage (Queenstown - Rosebery area)

(b) The bedded fossiliferous formations (Dundas-Zeehan area)

Campana et al (1958) assigned the bedded fossiliferous formations to the Dundas Group and the Volcanic assemblage to the Mt. Read Volcanics and separated them by an unconformity. Carey (1953), Banks (1956), Solomon (1960) and (1965), on the other hand include the Mt. Read Volcanics in the Dundas Group.

Campana et al (1958) regarded the Dundas Group as older than the Mt. Read Volcanics as being more or less contemporaneous with the Dundas Group. Campana and King (1963) consider the Mt. Read Volcanics to post-date the deposition of the Cambrian basal sequence, and pre-date the Conglomerate Greywacke suite of the Dundas Group, dating the volcanics as Lower to Middle Cambrian.

Elliston (1954) described the succession at Dundas (see table 1.) as consisting of tuffs, breccias, lavas, conglomerates and slates. Tuff beds occur on all horizons from bottom to top, reflecting periods of volcanic resurgence. Banks (1956) has also described the section at Dundas and considers many of Elliston's (1954) tuffs to be subgreywackes (Pettijohns (1949) sense). (See table 1). Campana and King (1963) describe the Dundas sequence as beginning with a markedly argillaceous sequence passing upward into a greywacke suite and ending with gritty and conglomeratic deposits.

Elliston (1954) described thirteen formations and Banks (1956) described twelve. Banks (1956) considers the Curtin Davis Volcanics as contemporaneous ("probably") with the Brewery Junction Slate and Tuff as both overlie the Razorback Conglomerate, and both are volcanic.

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(1) The Judith Slate and Tuff or Greywacke

This is the basal bed of the Group and is estimated at 200 feet thick, it is a yellow micaceous gritty greywacke or tuff. The basal unit is not very thick and consists of tuff interbedded with slate, which has a distinctive purple colour, is a very fine silt which has numerous tuff beds in it. Fossils are found in the basal tuff, the fauna including Lorezella, Pachyaspis, Peronopsis, Ptychagnostus, Pagetia and Triplagnostus (Opik 1951 a and c and Opik in Banks 1956). The fauna is correlated with the Scandinavian Middle Cambrian Ptychagnostus gibbus zone (Banks 1956).

TABLE (1) THE DUNDAS SECTION

| Elliston (1954) | Banks (1956) | Thickness |
|----------------------------------|---|-----------|
| Gordon Limestone (Ordovician) | | |
| Fault | | |
| Misery Conglomerate | Misery (Sub-greywacke) Conglomerate | 500 |
| Climie Slate and Tuff | Climie Slate and Tuff | 2,000 |
| Fernflow Conglomerate and Tuff | Fernflow Sub-greywacke and Conglomerate | 470 |
| Comet Slate and Tuff | Comet Slate and Sub-greywacke | 1,050 |
| Fernfields Tuff and Conglomerate | Fernfields Sub-greywacke and Conglomerate | 1,950 |
| Brewery Junction Slate and Tuff | Brewery Junction Slate and Tuff | 2,450 |
| Curtin Davis Volcanics | | |
| Razorback Conglomerate | Razorback (Sub-greywacke) Conglomerate | 225 |
| Hodge Slate | Hodge Slate | 530 |
| South Comet Grit | South Comet Greywacke | 160 |
| Judith Slate and Tuff | Judith Slate and Sub-greywacke | 200 |
| | Unconformity | |
| | Carbine Group | |

(2) The South Comet Grit or Greywacke

This formation is a grey, highly siliceous grit, estimated at 150 feet thick. It is composed of small angular fragments of grey and black chert set in a matrix of feldspathic tuff. (Elliston 1954, Banks 1956).

(3) Severn Slate

The Severn Slate consists of interbedded purple and black slates interbedded with tuffs Elliston (1954) (or greywackes and sub-greywackes Banks (1956)). Many thin tuff bands alternate with slate, giving a laminar

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appearance. Thick beds of light grey dolomitic tuff, both fine and coarse also occur. Intra formational brecciation is also common.

The South Comet ore body occurs in these slates.

(4) The Read Lead Conglomerate and Tuff

The conglomerate horizon is 250 feet thick and consists of rounded siliceous pebbles of quartzite and chert, set in a gritty purple tuff matrix. The conglomerate contains dark-grey banded chert, tuffaceous yellow sandstone, grey chert and banded slate fragments. The pebbles are subangular, angular and rounded. The whole is banded, stratified, graded and crossbedded. Banks (1956) considers it to belong to the subgreywacke suite.

The conglomerate is not persistent and in some places is represented by a coarse gritty purple tuff, sometimes with occasional sparse pebbles.'

(5) The Hodge Slate

This is a micaceous, carbonaceous slate with thin beds of greywacke and tuff.

The slates contains cystoids and dendroids such as archaeolofocaea serialis, archaeocryptolaria skeatsi and trilobites, Solenoparia sp, Bathyriscidae and perhaps Homagnostus (Opik 1951 a and b).

Flows and tuffs of vesicular and scoriaceous character are found within the slates.

The Hodge slate fauna has been correlated with fossils obtained from a slate band in the keratophytic succession west of the Zeehan basin. The age is Upper Middle Cambrian (Elliston 1954 and Banks 1956).

(6) Razorback Conglomerate

This is a coarse grey conglomerate containing cherty and jasperoidal fragments, quartzite, black slate and rarely basalt. The fragments are both angular and rounded, occurring in a fine silicified tuff matrix. Some of the larger pebbles are pink quartzite. The tuff beds contain occasional volcanic bombs.

(7) The Brewery Junction Slate and Tuff = Davis Creek Volcanics

Elliston (1954) separated these two formations. Banks (1956), however, considers the two as being correlatable as they both overlie the Razorback conglomerate.

These volcanics consist of a thick interbedded series of

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flows, breccias, slates and tuffs. The margins and scoriaceous zones are mineralised and altered. The vesicles are filled with chlorite and dolomitisation, silicification and pyritic mineralisation are common.

Several mines and adits have been opened in pyritic ore bodies at the margins of the flows. Tetrahedrite, chalcophrite, galena, sphalerite, bismuthinite and native copper have been won as ores.

The lavas approximate picrite basalts, (Elliston 1954), and Banks (1956) has observed relatively thick beds of keratophyric tuff at the base of the formation. Silicification of the basalt has produced a rock approximating a pyroxene andesite (Elliston 1954).

(8) Fernfields Conglomerate and Tuff (or Greywacke)

The unit consists of volcanic breccias near the base and passes up into a conglomerate at the top, which resembles the Owen Conglomerate (See Ordovician, Junee Group). Elliston (1954).

Banks (1956) describes the formation as being composed of a sub-greywacke conglomerate near the base becoming finer grained upwards, where sparse boulders occur in a sub-greywacke matrix. Higher still it passes into slates with occasional pebbles. The slates are purple and contain tuff bands and fragments of volcanic ejectamata.

(9) The Comet Slate and Tuff (Sub-Greywacke)

The formation consists of very thick beds of light-grey shales and tuffs with occasional purple beds. Fossils have been found in siltstones within the formation and include Blackwelderia c.f. biloba Kobayashi, Conocephalites (?) and Anomacarella (?) and Oidalagnostus (Opik, 1951A).

(10) The Fernflow Conglomerate and Tuff

This is a sparsely siliceous and tuffaceous conglomerate in a coarse tuff matrix. Purple and brown slates with sparse pebbles and water - sorted volcanic material also occur. Elliston (1954) suggests that dropped pebbles occur in the formation and that it may represent a glacial horizon.

(11) The Climie Slate and Tuff

Light-grey slate, purple slate, tuff, pyroclastic breccias and conglomerates are the predominant rock types of this formation.

(12) The Misery Conglomerate

The lower beds of the Misery Conglomerate interdigitate with

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green chloritic tuffs and grits. It occurs in lenses and beds which grade out to practically nothing and are interbedded with thick tuffs.

Elliston (1954) believes the succeeding limestone (June Group Gordon Limestone) is faulted or transgressive, and that the conglomerate is merely a very thick development of one of the conglomerates in the Dundas Group. In this case the top of the Dundas sedimentation is missing.

Campana and King (1963) consider the topmost beds of the Misery Conglomerate exhibit typical facies characteristics of the Owen Conglomerate and are thus transitional to it. (Fig. 6).

3. THE MOUNT READ VOLCANIC ARC

The Mount Read Volcanic Arc forms a sharply N - S zone, while the Dundas Group occurring to the west is essentially a sedimentary sequence (i.e. Dundas Group).

The amount of volcanic material in the Dundas Group decreases southwards from Mt. Tyndal. At Mt. Sedgwick equal proportions of volcanics and sediments occur (Solomon 1960).

Campana et al (1963) related this zone to the early phases of rift valley formation and Carey (1953) considered that the volcanics marked a line of Cambrian volcanoes in a eugeosyncline.

Fossils have not been found in the Volcanic sequence in the Queenstown area. Correlation is made by continuity of outcrop from areas to the north, by lithology, and by relationships to overlying beds. The base of the Group is not exposed in the Queenstown area. Mapping carried out by Bradley (1954) and by the B.H.P. Co. Ltd. (1969) indicates that areas of Mt. Read volcanics and "undifferentiated Dundas Group" occur in the northern section of EL 47/70. (See map 1 and 2)

There is wide variance of opinion on the nature of the Dundas Group in the Queenstown area and the stratigraphic position of the Mt. Read Volcanics. These opinions varied from intrusive complexes with sedimentary roof pendants, to volcanics with minor sediments. Bradley (1954) postulated that many of the igneous rocks were a result of metasomatism of greywacke sediments and basic lavas, the metamorphic process being of Tabberabberan age and related to the sulphide mineralisation. He envisage the extensively developed quartz and feldspar porphyries as originating by "porphyritization" involving growth of feldspar and quartz in situ. These views have been criticised by Banks (1956), Wade and Solomon (1958), Solomon (1960, 1962, 1965) Campana et al (1958) and Campana and King (1963). At present, however, the intrusive and pyroclastic origin of most of these rocks is

generally accepted. (Banks, 1956; Wade and Solomon, 1958; Campana et al 1958; Campana and King 1963; Solomon 1960, 1962, 1965).

Solomon (1960) suggests that the Dundas Group comprises a suite of only slightly metamorphosed lava flows (varying from rhyolites to basalts), agglomerates, tuffs, conglomerates, sandstones and slates. There may be instances of intrusive bodies, however, the field relationship, similarities to other flows, and both macro and microscopic textures indicate that the "porphyries" are lavas (Campana et al 1958, Wade and Solomon 1958).

The Mt. Read volcanics, the volcanic assemblage of Campana et al (1958) is one of the most important rock units for mineral search on the West Coast of Tasmania. Numerous mineral deposits of the replacement type occurring in the slaty and tuffaceous members of the suite. Campana et al (1958) estimates the thickness from 8-10,000 feet being derived from repeated volcanic ejections along the Owen Rift Fault.

In the Queenstown area, the Dundas Group is exposed as a continuously variable series of volcanic rocks ranging from basalts through andesites to rhyolites. The alkali content is equally variable, potash-rich rhyolites being associated with soda-rich keratophyres and relatively alkali poor basalts. The dominant primary feldspar type varies from Ab50 to Ab98 in composition, apart from potash rhyolites. Most of the rocks have undergone varying degrees of albitization.

These rocks were predominantly extrusive. Some contacts are discordant, however, suggesting that some of the occurrences are actually intrusive, in the form of small sills, plugs, or vent fillings.

The dominant volcanic rocks are spherulitic potash rhyolites, quartz keratophyres, sodi potassic rhyolites, keratophyres, augite trachyte, andesites and basalts.

Spherulitic potash rhyolites outcrop on Mt. Darwin, Intercolonial spur, Whip spur and Mt. Sedgwick, as massive, jointed, pink haematitic feldspar porphyry.

Outcrops vary from circular (discordant) to concordant with one dimension larger than other. Solomon (1960) suggests that the former one could represent volcanic rocks of Pelean cores and the latter, flows.

The groundmass of these porphyries (this term used here to describe a rock showing porphyritic texture) is aphanitic with pinkish feldspar laths up to 3 m.m. long and sparsely distributed. In places the rock is laced with haematite magnetite veins which are up to two feet wide, lenticular and of random orientation.

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Microscopic study shows the phenocrysts to be subhedral laths of plagioclase feldspar. Alteration of some crystals is slight but in others alteration has been so intense that the crystal is merely an outline in a microcrystalline "felt" of sericite and calcite. The groundmass, which may form more than 90% of the rock is composed mainly of crudely developed spherulites. Chemical analysis (table 2) suggests that much of the groundmass is potash feldspar.

A variant of this rock type is host to the Lake Jukes copper orebody. It is a dense, mottled, pink and grey "felsite" showing micrographic texture between quartz and potash feldspar.

The outcrops of the pink rhyolites are confined to a narrow zone roughly coincident with the axis of the westcoast range between South Darwin and Mt. Sedgwick (FIG 11).

This localisation suggests the existence of a narrow zone of distinctive volcanic centres in Cambrian times from which acid potash-rich lavas were erupted. (Solomon 1960). The major part of the only granite of proved Cambrian age in the Queenstown area (Mt. Darwin) is of similar composition to these rhyolites and is intruded into them.

Quartz Keratophyres

Quartz feldspar porphyries outcrop in the West Queen River, at Harris' Reward Pack Bridge (over the King River), in the Garfield River, west of Mt. Sedgwick, north of Darwin and at many other places within the Queenstown area. Similar rocks occur near South Mt. Farrell, Lake Dora and over a wide area north of Boko Siding on the Emu Bay Railway.

The boundaries and precise shapes of these outcrops are always difficult to define, though generally the bodies conform to the local structural trend.

The porphyry exposed in the Queen River has an elliptical outcrop roughly concordant with the regional strike, but its southern margin appears to cut across steeply dipping sandstone beds (Solomon 1960). The porphyry is pink or grey, with phenocrysts of both clear quartz and feldspar set in an aphanitic groundmass. The quartz phenocrysts show some well defined crystal faces but most are corroded and embayed and frequently maintain inclusions of groundmass. Some crystals show fuzzy, poorly defined boundaries.

Bradley (1957) has discussed similar observations on this and other quartz porphyries and he considers they indicate that the phenocrysts have grown "in situ" by a metasomatic process involving solid diffusion. Solomon (1960) considers that these porphyries have not arisen due to

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solid diffusion but all are typical of present - day and ancient acid eruptives.

The feldspars in the porphyry occur as hypidiomorphic crystals in approximately equal quantities in the quartz, the phenocrysts of the two minerals forming 60% of the typical rock. Some of the crystals are clear unaltered albite but the majority are banded by alteration products and have composition of about Ab 90. Ferromagnesian minerals are scarce, chlorite and haematite being confined in idiomorphic lath outlines suggesting that some ferromagnesian mineral was once present in the rock. The Groundmass is a microcrystalline aggregate of feldspar, chlorite, and haematite of which the texture is obscured by alteration products.

A chemical analysis is given in the Table 2 No. 3, Soloman (1960) suggests the rock should be identified as a quartz keratophyre.

A quartz keratophyre which outcrops in a small quarry west of the Zeehan road, three miles from Queenstown, is speckled with pyrite grains. These form part of the groundmass of the rock.

Sodi-potassic rhyolite

This volcanic forms bold outcrops in the west side of the East Queen River. The rock shows banding, the colours of the individual bands varying from pale to medium grey. Phenocrysts, enclosed by a quartzose microcrystalline groundmass average 2 m.m. across and show vestiges of multiple twinning.

This rock was described by Bradley (1954 p. 223) as a soda trachyte, but chemical analysis table 2 No. 5 shows high silica content and equal amounts of soda and potash. This led Solomon (1960 p.37) to term the rock a sodi-potassic rhyolite with reservations.

Keratophyres

Sodic feldspar porphyries occur throughout the Dundas Group and are the most common of the lava-types in the Queenstown area. These are well exposed east of Mt. Sorell and at other localities. Similar rocks make up the bulk of the "volcanic assemblage" (Of Campana et al, 1958) which outcrops between Rosebery and the Sterling River valley.

Deeply weathered lavas of this type occur at the northern end of the Queen River gorge where these are interbedded with beds of slate several feet thick. At their base the flows have picked up and incorporated fragments of the underlying sediments.

These volcanics are characterised by subhedral feldspar lathes up to 1 cm. long, very fine or microcrystalline matrices and

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"clots" of albite-chlorite crystals which are taken as evidence of deuteritic action (Solomon 1962).

Most of the feldspar porphyries can be classed as keratophyres, assuming that term to include trachytic rocks characterised by a relatively high soda content, the presence of abundant albite or oligoclase and intense alteration of the small amounts of ferromagnesium minerals that may have been present.

Augite Trachyte

Tors of feldspar pyroxene rock outcrop on grass-covered hills east of the Queenstown-Lynchford road. The rock contains fragments of sedimentary rocks and basic lavas. It is related to the keratophyres and andesites of the area, and many occur as an intrusive, a pyroclastic or as a lava flow. The rock has a high abundance of albite and a high soda content, however, the presence of augite invalidates the term keratophyre and augite trachyte is preferred. (Solomon 1960).

Andesites

Hill-tops in the Comstock-Crown Hill area are capped by tors of hornblende and augite porphyry. These rocks are grey or pinkish brown and composed of phenocrysts of feldspar and ferromagnesian minerals (up to 3 x 1½ cm) set in an aphanitic groundmass.

The texture of these porphyries varies from seriate to porphyritic and the dominant mineral is feldspar occurring as phenocrysts in a very fine grained groundmass. It is generally clouded and partly chloritized. The crystals are zoned and have composition Ab 70 core with an albite fringe.

Hornblende occurs as pale green, deeply embayed crystals containing inclusions of the groundmass. Some have a dark rim and a core of chlorite, others are represented by chlorite-haematite aggregates.

There is every variation from hornblende porphyry without augite to augite porphyry with little hornblende. Quartz occurs sparsely as shards or in clusters of fragments showing unit extinction. The remainder of these rocks is usually made up of a dark, partly feldspathic matrix, fragments of feldspar pyroxene lava, and ragged crystals of calcite, albitization of these rocks varies from slight to intense. In some cases a brecciated appearance results.

The chemical analysis (Table 2 No. 8) taken in conjunction with petrographic data suggests a suitable name for the rock is a hornblende (or augite) andesite.

TABLE 2

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|--------------------------------|--------|--------|--------|--------|---------------|--------|-------|--------|--------|-------|--------|-------|
| SiO ₂ | 73.44 | 73.76 | 70.60 | 72.7 | 72.88 | 56.80 | 58.6 | 61.58 | 58.08 | 46.72 | 47.6 | 50.6 |
| TiO ₂ | 0.33 | 0.12 | 0.40 | .. | 0.37 | 0.35 | n.dt. | 0.49 | 0.42 | 0.48 | .. | 0.5 |
| Al ₂ O ₃ | 14.18 | 11.98 | 13.31 | 15.6 | 13.76 | 17.11 | 15.7 | 16.96 | 16.32 | 18.25 | 17.7 | 20.3 |
| Fe ₂ O ₃ | 1.46 | 1.14 | 1.54 | Fe:4.2 | 0.89 | 2.12 | 8.9 | 1.75 | 2.00 | 2.38 | 13.7 | 10.7 |
| FeO | 0.55 | 2.40 | 2.36 | .. | 3.44 | 5.26 | n.dt. | 2.85 | 5.53 | 7.73 | n.dt. | n.dt. |
| Mno | Tr. | .. | 0.05 | .. | 0.02 | 0.28 | n.dt. | .. | 0.12 | 0.07 | n.dt. | n.dt. |
| MgO | 0.43 | 0.76 | 1.75 | 0.9 | 0.94 | 3.61 | 3.6 | 3.67 | 3.98 | 7.81 | 6.55 | 4.4 |
| CaO | - | 0.32 | 1.68 | 0.4 | 0.16 | 4.20 | 2.8 | 6.28 | 7.32 | 7.86 | 8.2 | 6.6 |
| Na ₂ O | 0.16 | 0.53 | 4.44 | 2.8 | 2.86 | 4.47 | 5.8 | 3.94 | 2.16 | 2.64 | 2.0 | 2.3 |
| K ₂ O | 8.05 | 7.38 | 2.03 | 0.8 | 2.63 | 2.75 | 1.8 | 1.28 | 1.30 | 1.32 | 1.3 | 1.8 |
| H ₂ O+ | 1.38 | 1.65 | 1.46 | .. | 2.04 | 2.58 | | | 2.74 | 0.11 | | |
| | | | | | | | 1.0 | 1.30 | | | 1.5 | 1.9 |
| H ₂ O- | 0.08 | 0.10 | 0.06 | .. | 0.06 | 0.04 | | | Nil | 4.43 | | |
| P ₂ O ₅ | 0.10 | 0.16 | 0.08 | .. | 0.09 | 0.35 | n.dt. | .. | 0.18 | n.dt. | .. | .. |
| CO ₂ | 0.38 | - | 0.73 | .. | 0.31 | 0.44 | 0.7 | 0.25 | 0.38 | - | 0.6 | 0.4 |
| S | Tr | 0.09 | 0.07 | .. | Tr. | Nil | n.dt. | .. | Nil | - | - | - |
| Other Consts. | .. | 0.09 | .. | 1.2 | (Ig. Loss) | .. | .. | .. | .. | .. | .. | .. |
| SO ₃ | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1,1 | 1.0 |
| Total | 100.54 | 100.48 | 100.56 | 98.6 | 100.45 | 100.36 | 98.9 | 100.35 | 100.53 | 99.80 | 100.25 | 100.5 |

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KEY FOR TABLE 2

1. Potash rhyolite, Intercolonial Spur (near Mt. Jukes).
2. Potash rhyolite, Cwm Caregog, Snowdon.
3. Quartz keratophyre, West Queen River.
4. Analysis of rock from Lyell-Comstock tram line.
5. Sodi-potassic rhyolite, Lyell Comstock tram line.
6. Keratophyre, Lake Margaret tram line.
7. Augite trachyte (?) near Lynchford.
8. Hornblende andesite, Crown Hill.
9. Hornblende andesite, Mount Shasta, California (H. N. Stokes), as quoted in Hatch, Wells, and Wells, 1949, p. 271.
10. Augite basalt from Lynch Creek, South Queenstown.
11. Augite basalt from Lynch Creek.
12. Basalt near Miners Ridge, east of Lynchford.

Basalts

Basalts outcrop along Lynch Creek between 1,000 and 4,500 feet east of Lynch Creek bridge. Individual flows are limited in extent, in both horizontal and vertical direction and these are associated with tuffs, siltstones and volcanic breccias. Red and brown clays are exposed along Lynch Creek in the walls of open cuts made during the pursuit of quartz-gold veins. These clays are probably tuffs and lavas that have been altered as a result of the mineralisation and since deeply weathered.

The table 2 No. 10, 11, 12 show chemical analysis of some of the basalts. In places they show autobrecciation. The lavas are green in colour and porphyritic, with phenocrysts of dark green pyroxenes up to 2 cm. long and smaller pale grey feldspar laths set in an aphanitic groundmass.

These basalts have strong spilitic affinities and are similar to spilites from King Island, Penguin, and Zeehan. Some of these have "pillow" structures and are in all probability of submarine origin.

THE DISTRIBUTION OF LAVA TYPES

A notable feature of the lava distribution in the Queenstown-Darwin area is the concentration of the Potash rhyolites along a narrow N. - S. belt which coincides with the axis of the West Coast Range and locally with the Great Lyell fault zone. The Darwin Granite, of very similar composition, also occurs along this fault zone between Mt. Darwin and South Darwin.

Away from this belt the lavas vary from basalts to rhyolites but are characterised by dominance of soda over potash.

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Solomon (1960) views a tripartite division of lava types from the narrow relatively insignificant potash rhyolites occurring within a wider zone of variable but soda-rich volcanics, which is in turn flanked on the west by a still wider area in which the majority of the lavas are basic and sodic. (Fig. 9 and 10).

Pyroclastic and Sedimentary Rocks

The main pyroclastic rocks are conglomerates, breccias, agglomerates and tuffs. There are many pyroclasts which contain varying amounts of sedimentary material such as siltstone and sandstone fragments. Lenses of agglomerate and breccia composed almost completely of volcanic fragments could be due to autobrecciation of nuee ardente type eruption (Solomon 1960). Coarse breccias occur in the potash rhyolite assemblage on Mt. Darwin and also in the granophyric host to the bornite veins at Lake Jukes.

Solomon (1960) suggests that the Queenstown district in Cambrian times was one of considerable volcanic activity with eruption taking place from numerous centres of ephemeral nature. The constantly changing conditions resulted in the re-working of both land and water-deposited pyroclastic and igneous material and would have produced a complex, rapidly varying suite of sedimentary and volcanic rocks.'

The relative proportions of sedimentary and volcanic rocks in the Cambrian sequence near Queenstown vary considerably but have been estimated at about 50%. The sedimentary rocks include conglomerates, paraconglomerates, sandstones, siltstones and slates.

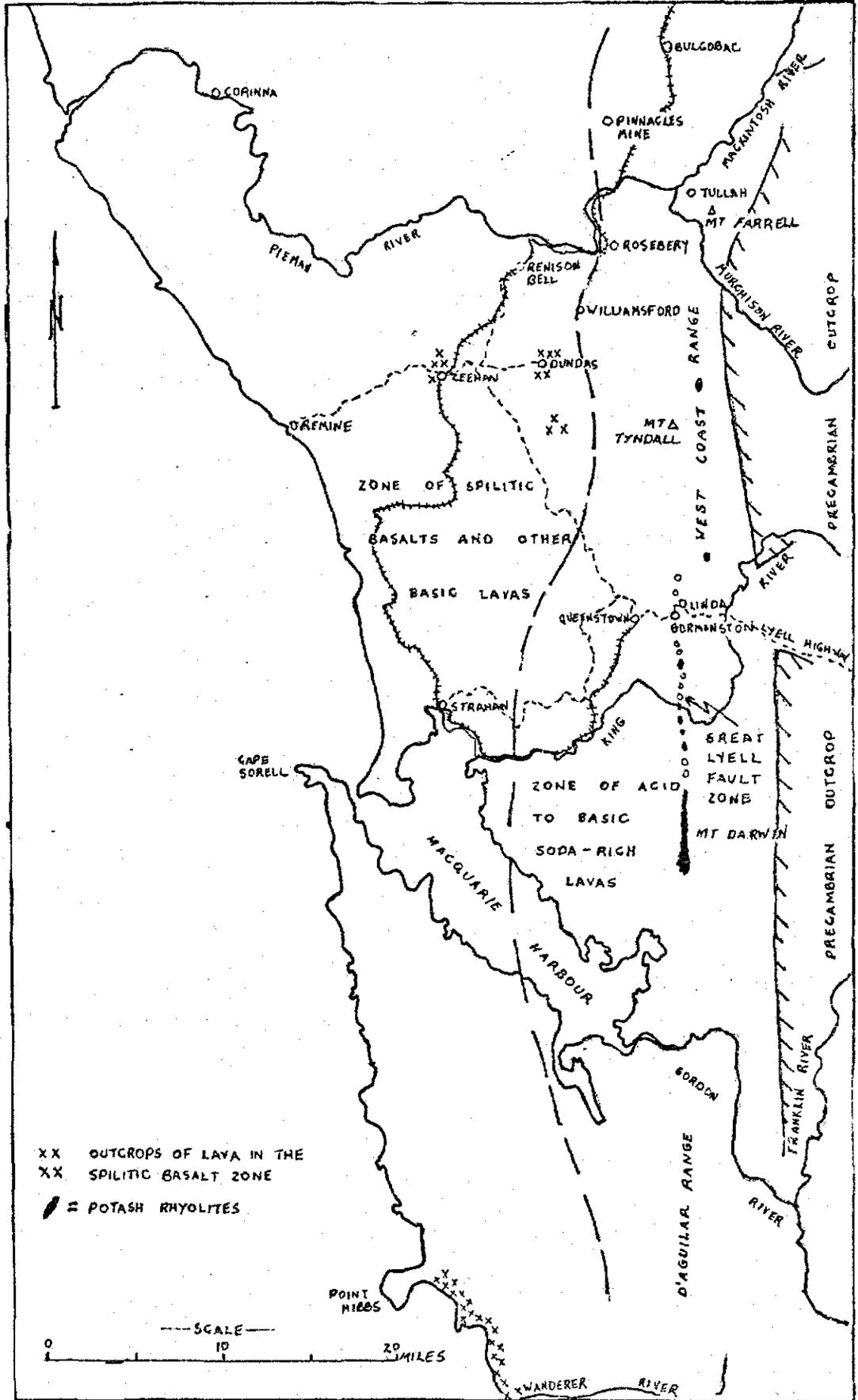
Lenses of conglomerate occur in fine, grey sandstone in the Queen River gorge (south of Lynchford); an interesting type consists of small ovate pebbles of grey chert of very fine quartzite lying with long axes on the bedding planes, the plentiful interstitial material ranging from pebble size to microscopic and comprising "chert", quartz and rounded fragments of keratophyre. This evidence and other evidence of conglomerates similar to the Razorback Formation at Dundas (Elliston 1954) suggest that a Precambrian source was intermittently feeding material in limited amounts into the Cambrian eugeosyncline. Density currents sweeping off the Precambrian shoreline (to the east) and also off the unstable volcanic belt probably carried much of the material into the "bedded series" depositional area. (Solomon 1960).

Greywacke sandstones also outcrop in the Queenstown-Darwin area. They are of variable character, lenticular, "dirty" or "muddy" and they are hard to differentiate from tuffaceous sandstones. A clean quartz sandstone outcrops along the crest of Miners Ridge east of Lynchford. It is about 100 feet thick, is interbedded with slates and is useful as a marker horizon.

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FIG.9

THE DISTRIBUTION OF LAVA TYPES IN THE DUNDAS GROUP

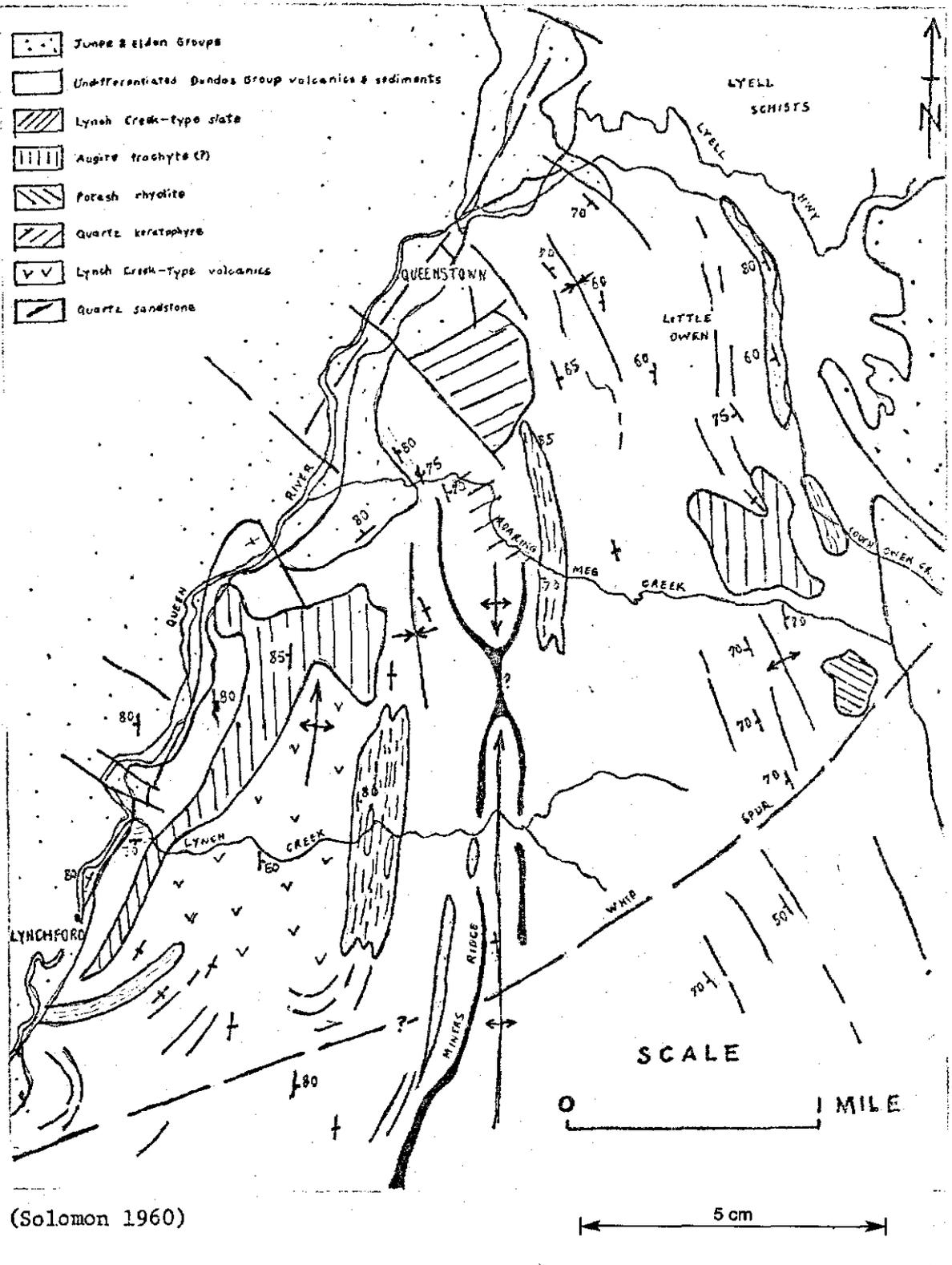


(Solomon 1960)

5 cm

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FIG. 10.
GEOLOGICAL SKETCH MAP OF THE LYNCH CREEK AREA.



The mudstones and slates consist of finely, irregularly alternating bands of coarse siltstone (or very fine sandstone) and claystone.. The claystone bands are thickest and consist of argillaceous material studded with quartz grains of silt grade; the narrower siltstone bands are usually composed of angular and subangular quartz grains of silt grade. Locally there is a tendency to grading in the bands and thus look similar to varves. Very fine ripple markings, erosion of tops of layers, and slump structures are present. Solomon (1960) suggests that mud and silt developed in local, ephemeral basins through a considerable range of the Cambrian.

The slates of the Tullah area and of the Rosebery and Hercules mines are very similar in lithology to these slates. At Rosebery they are often pyritic and form the host rocks of important lead-zinc ore bodies.

(Campana and King 1963).

Metamorphism

In contrast to the "bedded series" of the Dundas Group, which are virtually unaltered, the Mt. Read Volcanics are frequently stressed and brecciated. In some places they have undergone severe alteration illustrated by the embayment of sulphides, mainly pyrite and chalcopyrite. The alteration involved sericitization, chloritization, prophyllitization and hydration producing sericite and chlorite schists. At Mt. Lyell the process reached a peak and the West Lyell open cut area is the centre of an aureole of alteration extending outwards for three quarters of a mile. The mineralisation with which the aureole is associated is of Devonian or Carboniferous age. (Wade and Solomon 1958 and Solomon 1960).

Other important areas of hydrothermal alteration apart from West Lyell are concentrated on the N.-S. line of copper deposits that mark the Great Lyell Fault Zone between Comstock and South Darwin. The metamorphics (schists) also occur at Red Hill - Hercules Mine - Rosebery Silver Falls Zone. These also lie on the Great Lyell shear which Campana and King (1961) give the genetic connotation. The Owen Rift fault, of Cambro-Ordovician age.

The Lyell schists are a series of quartzose sericitic chloritic schists, strongly developed at Lyell but also occurring at several places along the Lyell shear where mineralization is intense. They are not necessarily typically developed where mineralization occurs as at Lake Jukes, where the host rock is a dense blocky felsite.

The schists gradually change in character to the west and pass into unaltered porphyries and sediments of the Dundas Group. They are extremely variable in nature but may be divided into three groups: Quartz - sericite schists; Quartz chlorite schists; Quartz - sericite-chlorite schists. (Wade and Solomon 1958).

1. Quartz - sericite schists

These are developed in the north western part of the West Lyell open cut. They are grey or yellowish in colour but are locally pink due to the presence of very fine hematite, and are essentially coarsely microcrystalline aggregates of quartz and sericite.

Sericite schists are most common adjacent to the contact between schist and Owen Conglomerate and form a quartz sericite zone. (Fig. 11)

2. Quartz - chlorite schists.

These schists are dark grey-green and are composed of quartz aggregates, chlorite wisps and a fair proportion of Na or K - mica.

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They alternate with quartz sericite schists that show pronounced banding similar to stratification. This parallels the margin of chloritic zones and suggests they may have been basaltic tuffs or basic lavas. (Wade and Solomon 1958).

3. Quartz - sericite - chlorite schists

Many of these intermediate types are greyish green in colour and chloritic, but contain a fair percentage of micaceous minerals.

4. Marginal schists

Passing west from the main area of mineralisation at Mt. Lyell the schists become more susceptible to erosion and merge to the typical Dundas rocks exposed in the East Queen Rivers.

These schists represent an intermediate or marginal zone between the ore zone and the unaltered material of Dundas rocks.

All these schist types are host rocks for ore, though generally the sericitic types are more strongly developed within the ore bodies. as a general rule, it can be said that sericitic schists are more common near to the contact with Owen Conglomerate and the chloritic schists increasing in importance outside the sericite zone (Fig. 11).

The schist - Owen Conglomerate contact is in the Mt. Lyell mines area, irregular and intricate. Wade and Solomon (1958) suggest that some of the schist has been derived from the quartzose Owen beds, they also suggest that facies changes account for some of the intrusions and replacements of schist. Wade and Solomon state:- "That during Owen Conglomerate deposition, islands of Dundas rocks along the shear zone remained elevated and shed greywacke type detritus around their margins. These islands were slowly buried, with the Owen beds gradually overstepping the greywacke detritus until they rested on the original Dundas surface".

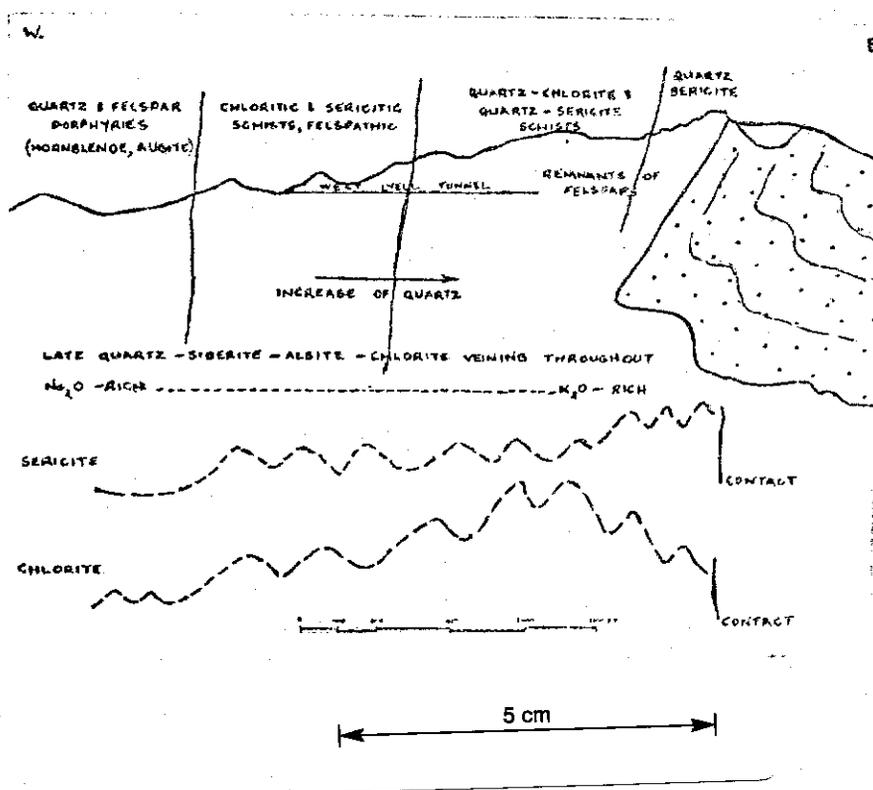
The Darwin Granite

The granite occurs as a vertical tabular body aligned north-south and extending from Mt. Darwin to South Darwin. Its outcrop is roughly three miles long and half a mile wide. The adjacent rocks to south and east contain pebbles of granite and are therefore younger, but to the west and north consist of pink potash rhyolites and tuffs, pre-granite in age.

The granite body is complex, being composed of parallel sheets of differing composition with a predominance of granitic types, chief of which are a pink orthoclase-quartz rock and a white plagioclase

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FIG.11- Distribution of schist types across Lyell-Owen Divide.



quartz rock (Solomon 1960).

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Bradley (1954) has suggested that the Darwin Granite is a metasomatic replacement of sedimentary rocks, describing palimpsest pebbles. He states that "they are sufficiently clear to show the granite conglomerate to be made of large rounded ellipsoidal pebbles from six to nine inches long". Bradley asserts that it is Devonian. Solomon (1960) has noted the similarity in composition between the pink Darwin Granite and the potassic rhyolites and the white granite and the keratophyres, which suggests a genetic relationship. Solomon concludes that it is highly probable that the granites and lavas represent the intrusive and effusive phases of a single late Cambrian unwellung of acid magma, and that the granite core of the volcanic pile rose up at a late stage to become emplaced among the products of earlier eruptions.

Within the granite complex are thin sheet-like tongues of sedimentary material trending parallel to the length of the granite. Between the pink and white granites is a long zone of schists showing patchy mineralisation, and in the pink granite occur dark-grey, sharply defined hornfelsic, lenses which have probably been derived from slates.

The outer portions of the granite are not now exposed. Hills (1914) states the "Boundary line between granite and the felsites which it has intruded is sharp and well defined. This line of contact has been opened up in several places by trenching, and the granite can there be seen in contact with the felsite, being quite as coarse grained as in the interior of the mass, no transition into finer grained varieties being observable at the margins".

The lack of apophyses, aplite or pegmatite veins, lack of contact, metamorphism, complex composition and tabular shape distinguish it from the massive, irregularly shaped stocks and batholiths of Devonian age such as occur at Mt. Heemskirk and Mt. Meredith. The Murchison Granite which outcrops in the gorge south of Mt. Farrell, is similar in form to the Darwin Granite and even more variable in composition.

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E. THE ORDOVICIAN SYSTEM

THE JUNEE GROUP

The Ordovician rocks of Tasmania are known as the Junee Group which may be defined as consisting of the following formations or their correlates:

- Fenestella Shale
- Gordon Limestone (Lower to Upper Ordovician)
- Florentine Valley Mudstone
- Caroline Creek Sandstone
- Owen Conglomerate
- Jukes Conglomerate

The Jukes conglomerate, Owen Conglomerate, Caroline Creek Sandstone and Gordon Limestone outcrop in the area of EL 47/70 (see map 1 and 2).

Sedimentation ceased abruptly in the Upper Cambrian with the onset of the Jukesian Orogeny. Gentle folding of the Cambrian and older sediments occurred on trends parallel to the margins of the Tyennan Geanticline. Major faulting of similar trend uplifted the Rocky Cape and Tyennan Geanticlines and produced an inter-geanticline depression. The depression was split by an axial ridge of Cambrian rocks (The Dundas Ridge, Bradley 1954, Porphyroid anticlinorium of Carey, 1953) into two elongate basins of which the biggest was the Owen Basin on the west and north flank of the Tyennan mass. The Owen Basin is regarded as a rift valley (the Owen Rift Valley) by Campana et al (1958). The Dundas Ridge forms a sharp western wall to the Owen Basin from Queenstown to Tullah, the wall marking the line of the prominent West Owen Rift or Great Lyell Fault Zone (Solomon 1965).

1) The Jukes Conglomerate

The Jukes Conglomerate, may be defined as the formation dominantly composed of conglomerate and breccia consisting of fragments of lava and other Cambrian rocks exposed in the cliffs near Lake Jukes. It rests on Cambrian rocks and is overlain conformably by the Owen Conglomerate. (Wade and Solomon 1958).

The Conglomerate consists of angular, subangular or sub-rounded fragments up to four feet long, of underlying sediments and lavas, haematite and haematitic sandstone with rare quartz and quartzitic fragments (Hills 1914). Campana and King (1963) described the Jukes Conglomerate as a greywacke Breccia Conglomerate.

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Textures of the Jukes Conglomerate:

- (a) Distinct stratification is uncommon.
- (b) Overlap of this unit by Owen Conglomerate suggests an initial restricted distribution.
- (c) It thins at a maximum rate of one in ten.
- (d) The Sorell and Dora Conglomerates are correlates of the Jukes (Banks 1962).

The Sorell Conglomerate rests unconformably on Pre-Ordovician sediments, lavas and granite, and is overlain by siliceous conglomerate in the area east of Mt. Sorell. It merges along strike into siliceous conglomerate and contains fragments of haematite, magnetite, Darwin Granite and quartz chlorite rock (Hills 1914, Bradley 1954). The granite boulders decrease in grain size from Mt. Darwin westwards. The formation is 300 ft. thick at Mt. Sorell. The Dora Conglomerate is 1,000 ft. thick. Campana and King (1963) state: "It is an unsorted, crudely stratified greywacke breccia-conglomerate with pebbles and boulders of porphyritic and pyroclastic material and fragments of quartz quartzite and haematite dispersed in a grey or dark micaceous feldspathic matrix".

High angle unconformities exist between this unit and underlying Cambrian volcanics. In some areas, however, a gradation from the underlying volcanics to Dora Conglomerate seems to occur. Bradley (1957) suggested that this gradation is due to permeation of the feldspathic greywacke conglomerate by feldspathising solution during a period of post-Ordovician progressive metamorphism. However, fragments of schistose porphyries, keratophyres and pyroclastic rocks occur in unaltered layers of the sediments of the Dundas Group, and in unaltered layers of the Jukes Breccia and Lower Owen Conglomerate. The gradation is due to exfoliation and disintegration of the underlying volcanic and pyroclastic material with little or no transport of material (Banks 1962b, Campana and King 1963).

The Jukes, Sorell and Dora Conglomerates are similar in gross lithology, all containing fragments of local derivation and having similar texture, structure and stratigraphical position.

Bradley (1954) considered the Jukes and Dora Conglomerates to be deposits flanking and derived from the coasts of a strait (the Jukes Trough) separating the Dundas Ridge from the Tyennan Geanticline. Under this hypothesis, the Jukes Conglomerate would have to be a talus deposit formed below wave base at the foot of steeply-cliffed coasts and steep submarine slopes. According to this view, uplift of the Tyennan Geanticline bordering

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the strait on the east initiated deposition of the Owen Conglomerate and the main distribution of the conglomerate east of the Jukes and Sorell conglomerates would be expected. However, the main distribution and thicknesses are not in accordance with this. (Fig. 13).

The sections shown in (Fig. 12) Campana and King (1963) show a westerly derivation of the Jukes breccia, however, Banks (1962b) can see no evidence for fanglomerate derivation from a westerly direction. This reconstruction suggests that the main tectonic event immediately prior to deposition of the fanglomerate (Jukes breccia) was uplift of the

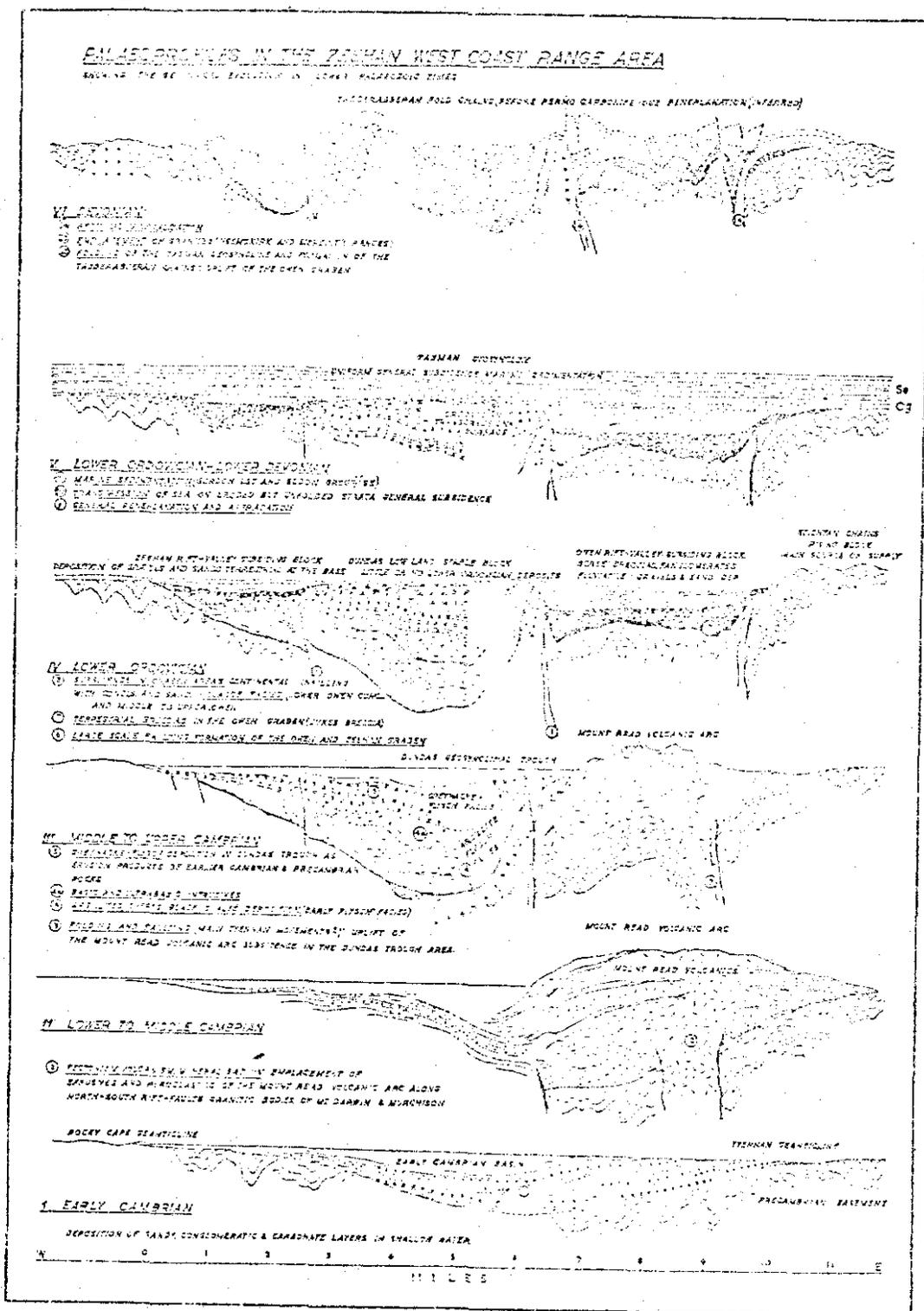
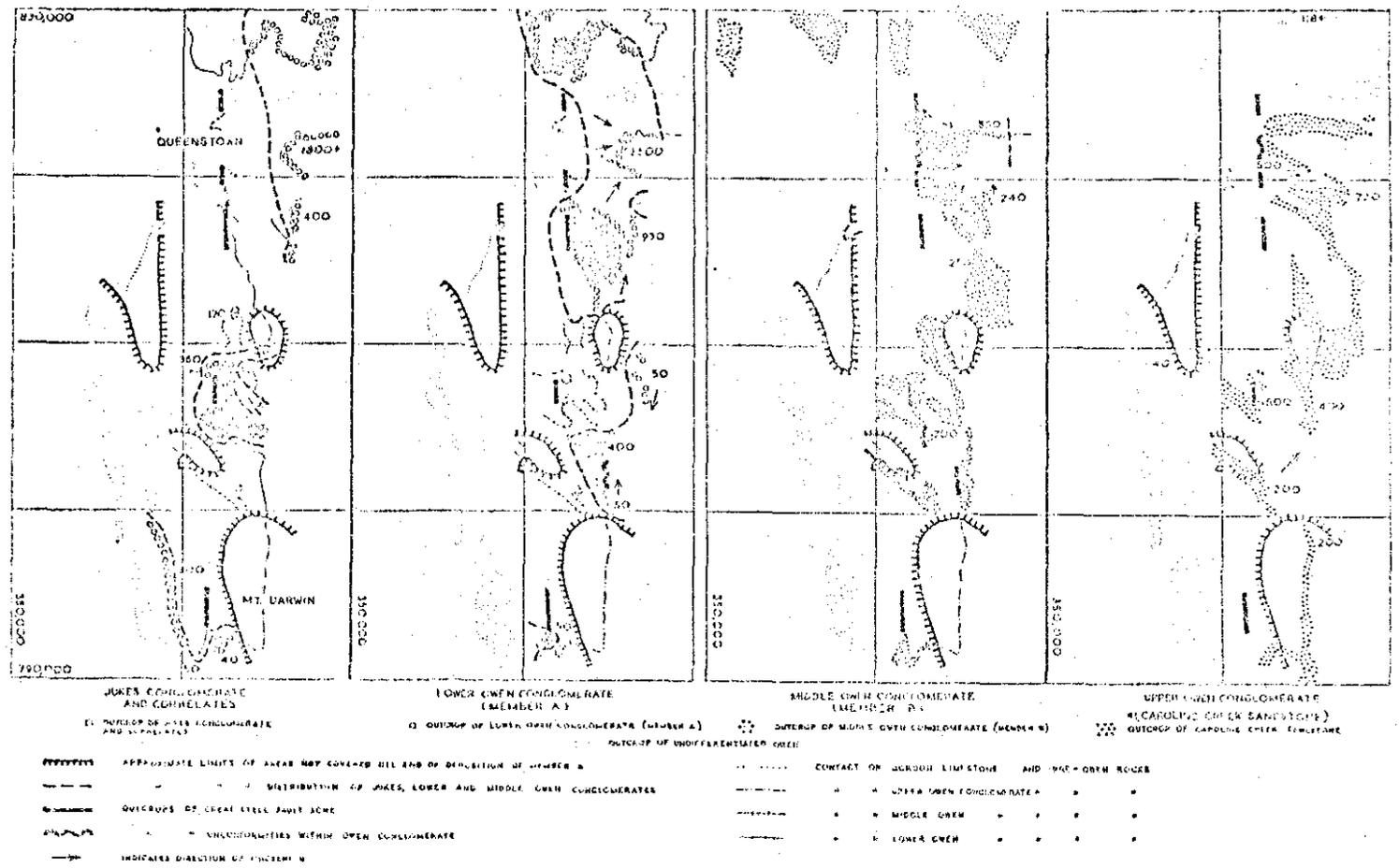


FIG. 12
 GEOLOGICAL EVOLUTION OF THE WEST COAST REGION IN LOWER TO MIDDLE
 PALAEOZOIC TIMES (Campana and King).

5 cm

FIG.13
 Distribution of Jukes and Owen
 Conglomerates (Banks based on mapping
 by Solomon).



FIELD NOTES AND ORIGINAL MAPS BY W. SOLOMON (1952)

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Tyennan Geanticline, the most intense movement being in a zone a few miles wide bordering the geanticline. Within this zone the Cambrian rocks were steeply tilted. The conglomerates were then deposited as fanglomerates on the eroded upturned edges of the Cambrian rocks producing Jukesian unconformities.

2) The Owen Conglomerate

"The Owen Conglomerate is that formation of siliceous conglomerate and quartz sandstone which outcrops on Mt. Owen and nearby mountains near Queenstown. It rests unconformably on Jukes Conglomerate or equivalents and overlaps onto older rocks unconformably. It underlies the Caroline Creek Sandstone and correlates. At the type section on the northern face of Mt. Owen it is 1,180 feet thick. Figs. (14, 15, 16). It is Lower Ordovician" (Banks 1962b).

These quartzose conglomerates were deposited after the initial infilling of the Owen Basin by the Jukes conglomerate.

Solomon (1957b), divided the Owen Conglomerate into three stages, the Lower, Middle and Upper Owen (table 2). Banks (1962b) however, has correlated the Upper Owen with the Caroline Creek Sandstone which carries arenigan marine fossils. The Upper Owen is marine in character whilst the Middle and Lower Owen are of fluvial origin. Banks (1962b) suggests that the terminology (Lower, Middle, Upper Owen) are thus not to be used, and proposed the terms "Member A" (Lower Owen) and "Member B" (Middle Owen).

The formation is dominantly siliceous with fragments of vein quartz, quartzite, quartz schist, chert and rarely other rock types in a matrix of quartz grains with a siliceous and/or ferruginous cement. The colour varies from white or grey to purple or greenish. The larger fragments, with a maximum length of about two feet in Member A are characteristically well-rounded but the sand grains in the matrix are angular or sub-angular. Sorting is good, both in the conglomerates and sandstones and the framework is closed. Member A is poorly bedded, no cross-bedding has been recorded, but imbrication may be present. Member B is more clearly bedded and shows cross-bedding and cut-and-fill structures. The beds, especially those of the conglomerate tend to be lenticular (Banks 1962b).

The Owen Conglomerate has been considered by some writers as a marine shallow water formation representing a shore deposit around an emergent Precambrian core (Tyennan mass), which at present flanks the conglomerate to the east and forms the Sticht Ranges.

Campana et al (1958) and Campana and King (1963) suggest that the Owen Conglomerate is a continental formation brought about by the gravelly and sandy infilling of an ancient rift valley. (The Owen Rift Valley). They envisage a piedmont valley flat deposition in a rapidly

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TABLE 3.

SECTION NEAR MT. OWEN

Central part of Owen Spur.

Upper Owen:

720 Caroline Creek Sandstone.

Middle Owen

| | |
|--|---------|
| Yellow, medium grained, thickly bedded siliceous conglomerate: | 40 ft. |
| Red sandston. | 200 ft. |

Below summit of Mt. Owen -

Middle Owen

| | |
|--|---------|
| cross bedded, red sandstone with pebble bands becoming more conglomeratic upwards: | 160 ft. |
|--|---------|

Member B.

| | |
|--|--------|
| Dark medium-grained conglomerate, mainly yellow siliceous pebbles in haematitic matrix | 40 ft. |
|--|--------|

| | |
|---------------|--------|
| Red sandstone | 50 ft. |
|---------------|--------|

Lower Owen

| | |
|---|---------|
| Coarse - grained, grey, siliceous conglomerate with red sandstone beds mostly less than 2 ft. thick; sandstones commoner in upper part of unit than lower; pebbles mainly banded quartzite, vein quartz: quartzite chert etc. | 340 ft. |
|---|---------|

| | |
|---|--------|
| Very coarse grained conglomerate boulders up to 2 ft. long. | 40 ft. |
|---|--------|

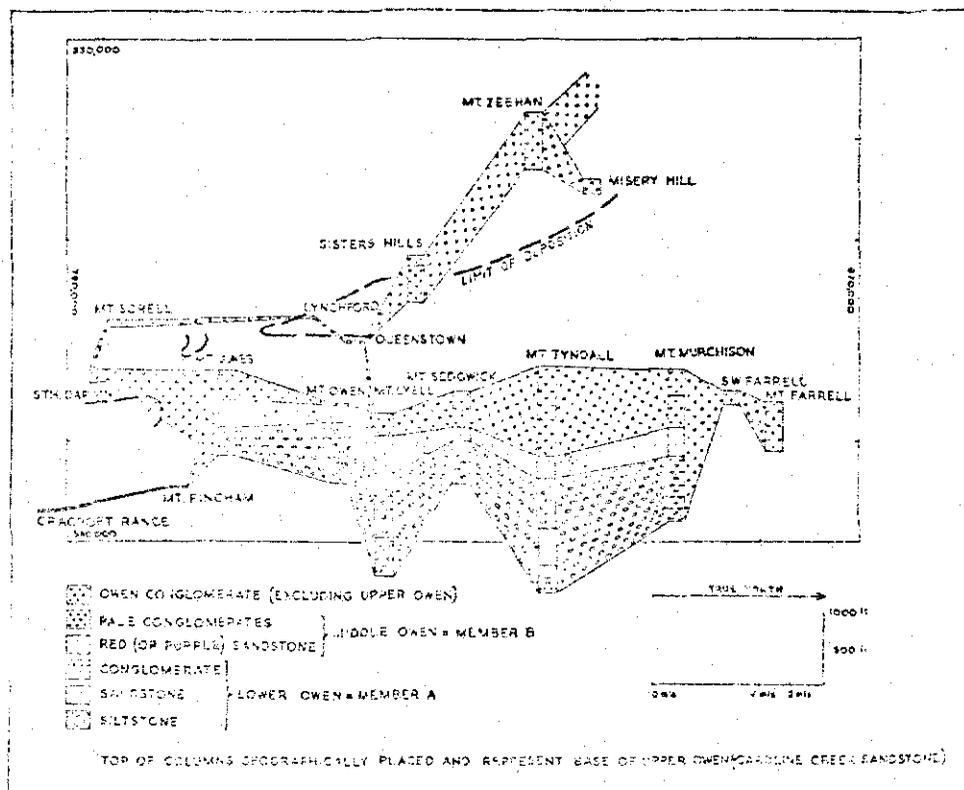
Member A.

| | |
|--|---------|
| Yellow grey, coarse grained siliceous conglomerate with lenticular sandy beds. | 350 ft. |
|--|---------|

| | |
|--|---------|
| Pink - grey, very coarse grained siliceous conglomerate with thin sandstone beds; pink sandy matrix. | 200 ft. |
|--|---------|

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FIG. 14. THE OWEN CONGLOMERATE BETWEEN THE WEST COAST RANGE AND ZEEHAN (BANKS).



5 cm

FIG. 15. THE OWEN CONGLOMERATE NEAR QUEENSTOWN.

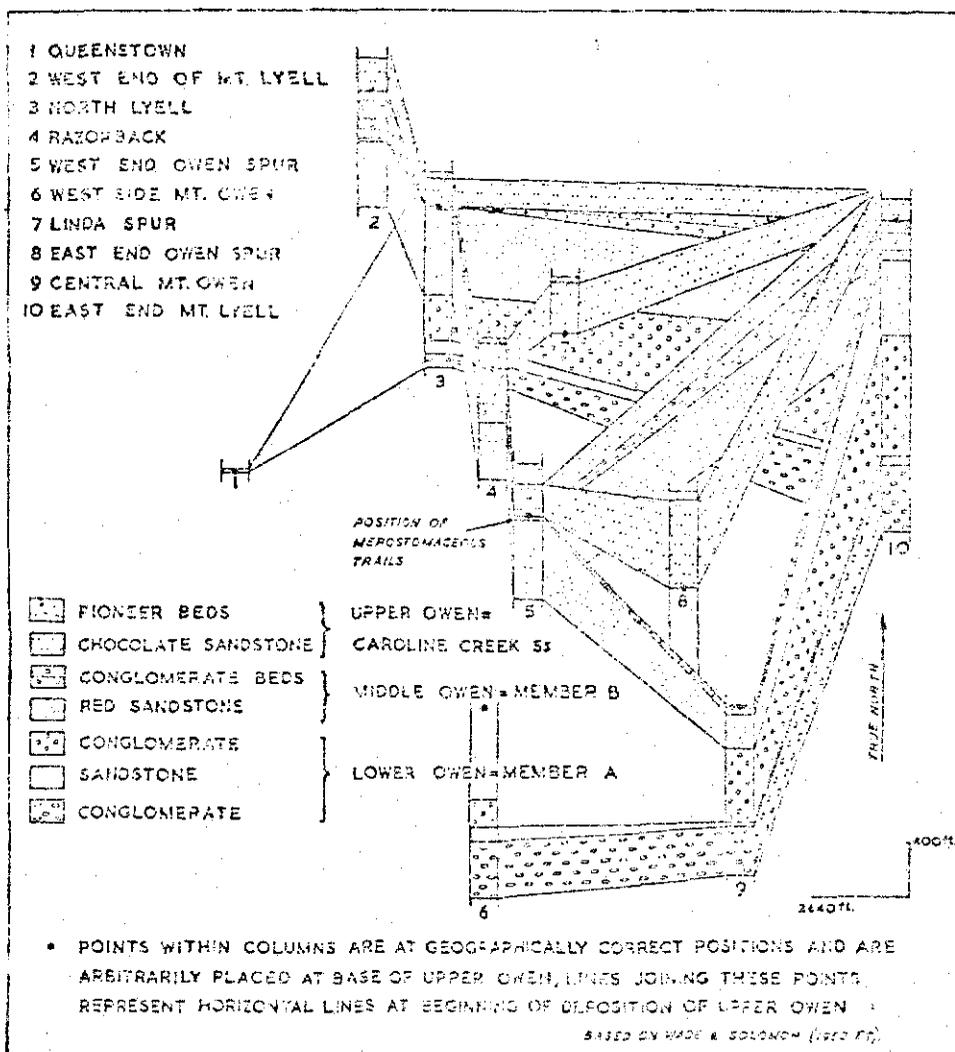
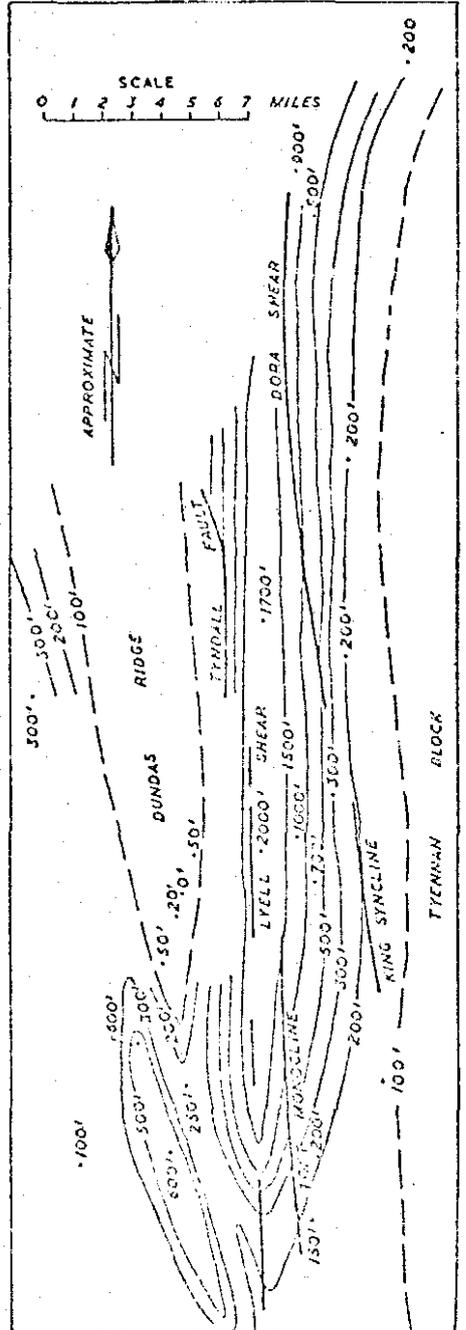
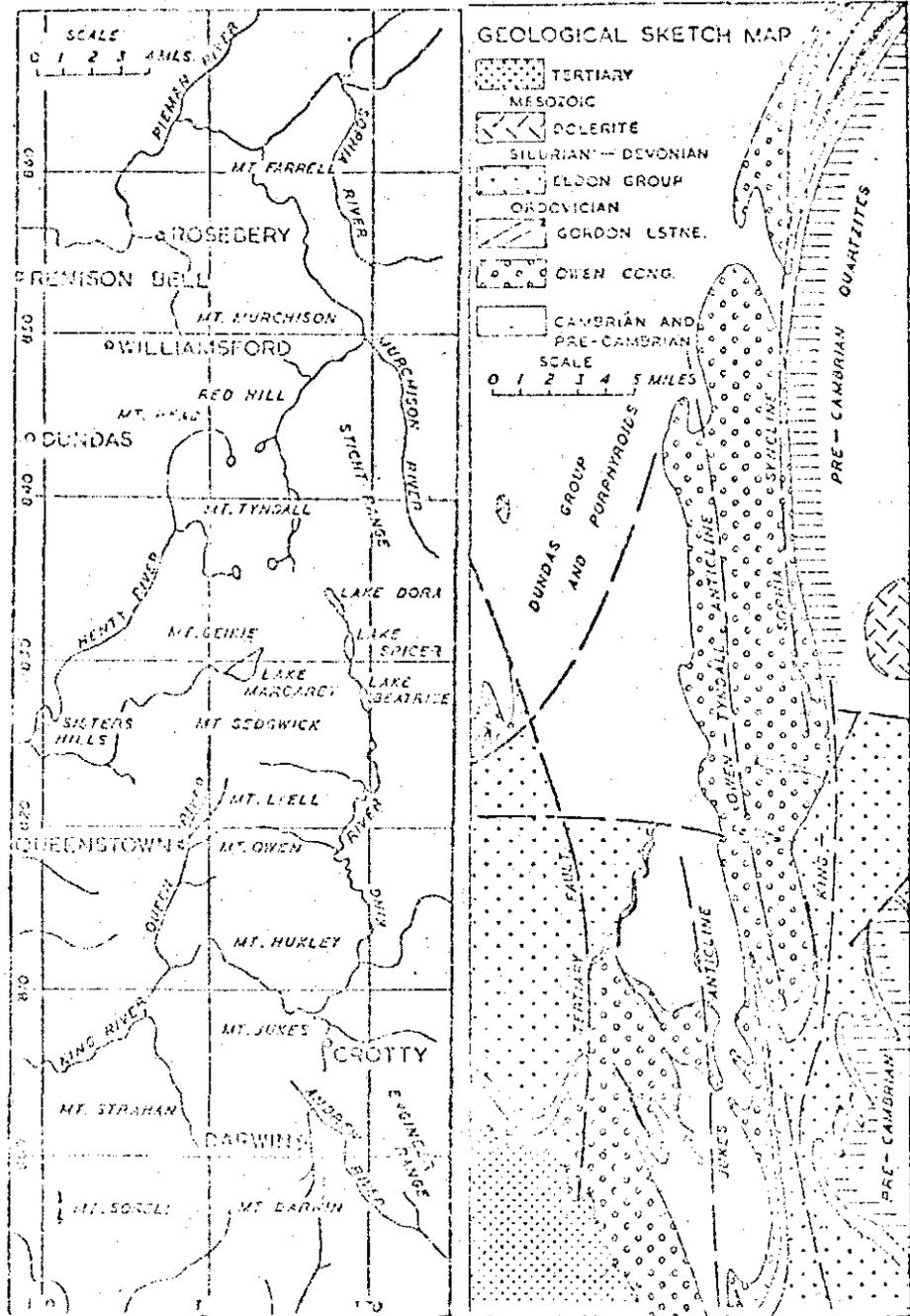
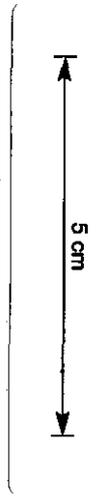


Fig. 16. Isopach and Geological Sketch map of the Owen Conglomerate in the West Coast Range Area.



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subsiding landlocked graben under a dry climate.

Campana et al based their views on the narrow elongate distribution, rapid lateral variations in thickness, the coarse grained unstratified, unsorted nature of the lower portion, the "red beds" in the succession, violent lateral and vertical variation in lithology, interfingering of beds, local angular unconformities, cut-and-fill structures, steep cross bedding, and the absence of claystone and limestone. Banks (1962b) does not consider a graben necessary, nor proven, during deposition of the Owen Conglomerate. Banks suggests that after deposition of the conglomerates (Jukes Conglomerate and correlates) close to the steep western slope of the Tyennan Geanticline, erosion of the uplifted block continued and streams cut into the Precambrian rocks. Streams draining the Geanticline carried a load of siliceous sand and gravel, debouched onto the lowland and deposited their load as alluvial fans and sandy plains. During deposition of Member B, the relief of the source area decreased on the whole but minor uplifts (or increased rainfall) increased the competence of streams flowing over the sandy plains and caused formation of the interbedded conglomerates. The sea then encroached over the sandy lowlands and onto the highland areas which were by then greatly reduced in relief.

3) The Caroline Creek Sandstone.

The Caroline Creek sandstone rests conformably on Owen Conglomerate, or equivalents, or unconformably on older rocks. It overlaps the Owen Conglomerate onto the western, northern and eastern margins of the Tyennan Geanticline, onto a high area north of Zeehan and south of Duck Creek and it rests on Cambrian rocks near Queenstown.

The formation consists mainly of well - sorted, siliceous sandstones, coloured white, yellow, pink, red, chocolate, brown or greenish..

Fossils are common and include fucoidal bodies, costate orthids, strophomenids, euomphalid and other gastropods, cephalopods, annelid worms, trilobites, cystoids and hyolithids. The Caroline Creek trilobitic fauna is considered to be upper Arenigan (Zone of D Hirundo). The overlying formation at Frodshams Gap is Middle Arenigan (Zone of D. Extensus) and this suggests that the Caroline Creek Sandstone is diachronous (Banks 1962b). Correlation of the "upper Owen" with the Caroline Creek sandstone is suggested by lithological similarity, abundance of worm castings and burrows in both, the occurrence in both of coarsely costate brachiopods and euomphalid gastropods, and

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the conformable succession from both through passage beds to the Gordon Limestone. Exact contemporaneity is not claimed but both are probably lower Ordovician (Banks 1962b).

In the central part of Owen spur the formation is at least 720 feet thick and the succession is as follows.

| Top. | | Thickness. |
|------|--|------------|
| G. | alternating shale, sandstone, tubicolar sandstone and granule conglomerate. | 20 |
| F. | yellowish conglomerate, haematitic at base with pebbles of brown iron oxide and much chromite in the matrix. | 40 |
| E. | haematitic tubicolar sandstone. | 60 |
| D. | pink, grey or purple thinly bedded sandstone with shale and haematitic bands. | 250 |
| C. | grey, fine, breccia-conglomerate with a few quartzite bands | 140 |
| B. | purple thin-bedded sandstone, red to pink pebbly sandstone and shaly beds. | |
| A. | grey quartzite, fine yellow conglomerate and green shale. | 100 |

4) The Florentine Valley Mudstone.

The Florentine Valley Mudstone is a formation consisting of siltstone, calcareous siltstone and calcareous sandstone which is transitional from the Caroline Creek Sandstone to the Gordon Limestone.

It contains Tritoechia lewisi, T? Careyi, Syntrophopsis Karnbergi, Lecanospira, Tentaculites, Asaphopsis florentinensis, Tasmanaspis lewisi, Pliomerops subquadratus, Dictyonema, Clonograptus, Tetragraptus, Didymograptus gracilus and Didymograptus of the Mundus type. The brachiopods indicate a middle lower Ordovician age, about the top of the Bendigonian or low in the Chewtonian. The trilobites show a middle Arenigan age (zone of D. extensus, O.P. Singelton, pers comm. in Banks 1962) and the graptolites a lower Ordovician age. The graptolites shows Chewtonian and Castlemanian age (Banks 1962b).

Map 2, (B.H.P. Co. Ltd.) shows the Florentine Valley mudstone as being younger than the Gordon limestone. In view of the above evidence and stratigraphic information on the Gordon limestone (below) this should be re-examined.

The Florentine Valley mudstone does not appear to outcrop in the Gordon river area. Here the Gordon limestone overlies the Caroline Creek sandstone (Rowe 1962). The section on the Gordon River is as follows (Rowe 1962).

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Siluro - Devonian - Eldon Group.

Ordovician) Gordon limestone.
)
) Caroline Creek sandstone
) Owen Conglomerate

- Tyennan Unconformity -

Precambrian Quartzite.

5) The Gordon Limestone

The Gordon limestone is a formation 5,000 feet thick, of limestone conformably overlying the Florentine Valley Mudstone (at Wherrets lookout) and conformably or disconformably overlain by the Eldon Group in the Tiger Range. It ranges in age from Upper Canadian to Upper Ordovician (Banks 1962b).

The Gordon limestone outcrops extensively in the area of EL 47/70, in the King River area, Bird and Nora Rivers, and along the Gordon River.

The Gordon limestone is typically medium to dark grey in colour but light-grey, pink and almost white varieties occur without, as far as is known any stratigraphic significance. They are compact rocks normally brittle, although some coarse - grained varieties tend to be tougher than others. The fine - grained limestones tend to develop conchoidal fracture, but coarser types usually have an even fracture. The rock is impervious in bulk, but due to the common presence of solution cavities and passages, allows ready passage of water. The limestone has a subdued topography, often close to base - level.

Dolomite is present in the limestone (up to 22% MgO) as irregular, yellow to buff, sandy looking patches. Other impurities are silica, iron and aluminium oxides, traces of phosphates, titania, manganese and sulphur. The silica usually occurs as chert nodules showing joint and bedding control. Nodules and spherulites of pyrite are found and chalcopyrite occurs in the Florentine Valley, and at Blenkhorns Quarry (Railton) where it is associated with sphalerite. Both of these areas are some miles from known areas of mineralization and the sulphides may be syngenetic (Banks 1962b).

The following variations in composition were found in samples collected in the Gordon River area (Rowe 1962).

CaO 29.8% to 54% (53.3% to 96.4% CaCO₃)

MgO 1.09% to 20.7% (2.3% to 43.3% MgCO₃)

Ignition loss 37.9% to 45.0%

SiO₂ 1.86% to 8.5%

Al₂O₃ 0.44% to 3.06%

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Fe₂O₃ 0.29% to 1.78%

TiO₂ 0.02% to 0.13%

S trace to 0.28%

MnO 0.01% to 0.08%

P₂O₅ 0.01% to 0.04%

The limestone horizons in the Florentine Valley are as follows Hughes (1957).

- Limestone with ostracodes, brachiopods and trilobites
- Limestone with Rhinidictya, strophomenids and trilobites.
- Limestone with cephalopods and ostracodes
- Limestone with Maclurites
- Limestone with Spanadonta
- Beds with Phyllograptus, ostracods trilobites and brachiopods
- Beds with Tritoechia

The Gordon River, below the Serpentine River flows for much of its course through limestone. Fossils are numerous but have not been zonally collected with the result the age of the base of the limestone is unknown in this area. High in the sequence a zone of Maclurites occurs which may be equivalent to that in the Florentine Valley. Gordonoceras hondi, Stromatoceras eximum, ephippiorthoceras decorum, anaspyroceras and Gasconsoceras insperatum. Hughes 1957 suggest that the top of the limestone here may be lower or middle silurian due to the presence of Gasconsoceras. The record of Hercophyllum shearsbyi and Entelophyllum suggests that the age may be as young as Upper Wenlock or Lower Ludlow (Hill 1942 in Hughes 1957 Banks 1962b) suggests that limestone lenses may occur in the Eldon Group (Siluro - Devonian).

The Gordon limestone occurs on both flanks of the West Coast Range. The limestone is impure or interbedded with shales and sandstone on the Kelly Basin Line, in the Clark Valley, on the Nora River and near Linda. Hills (1914) noted that limestone is represented by "black pug" in the Darwin area.

Limestone is interbedded with siltstone in the Andrew River near the Darwin Road, and at the Smelter Quarry near Queenstown. The Limestone in the Smelters Quarry, Queenstown, contains many corals and cephalopods of which the corals indicate an age between Trentonian and Richmondian (Hill 1955 in Banks 1962b).

Other fossils in the Gordon limestones are;

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Tetradium tasmaniense, T.conjugatum, T.dendroides, T.syringoporoides,
Alveolites, Protaraea cf. richmondensis and Acidolites and the
cephalopods Beloitoceras kirtoni and Anaspyroceras anzaas. Trilobites
found in associated siltstones include Ceraurus, Lichadids, harpids as
well as Rhinidictya like Bryozoa and rhynchonellids (Hughes 1957).

Limestone also occurs from Zeehan south, almost to the Henty River
and includes rocks of Trentonian age.

F. THE SILURIAN AND DEVONIAN SYSTEMS

The Eldon Group

Over 5,000 ft. of sediments were deposited in Silurian and Devonian time near Zeehan and over 12,000 ft. near Queenstown in a miogeosyncline. The sediments show a marked oscillation between sand and silt grade with a conglomerate member only in the lowest formation. The change from one formation to the next is distinct, so that the change in sedimentation was due to alteration in the environment, presumably by tectonic movements. The sediments consist of shelf-type deposits, the coarsest sediments belonging to disturbed near-shore and to moderately deep waters, and the finer sediments to deeper, quieter water. In the Zeehan area arenaceous beds predominate, being about twice the thickness of the lutaceous beds Banks (1962c).

The formations of the Eldon Group outcropping in the area of EL 47/70 are the Crotty quartzite, the Amber Slate, the Keel Quartzite, the Florence Quartzite, and the Bell Slate (Gill and Banks 1950, Bradley 1954).

1) Crotty Quartzite

This formation is underlain conformably by the Gordon River limestone and overlain conformably by the Amber Slate. It consists mostly of quartzites, which are of a light greyish colour which weathers white at the surface. Cross bedding is common.

The Crotty Quartzite is generally unfossiliferous, however poorly preserved brachiopods, lamellibranchs, crinoid stems, and tubicolar structures have been recognised (Gill and Banks 1950). The tubicolar structures are of the following types.

1) Tube structures at right angles to the bedding planes, straight, and unbranching are generally the tubes of marine worms.

2) Tube structures parallel to the bedding planes, sometimes straight and sometimes curved, but unbranching, are generally pieces of crinoid stem.

3) Tube structures which are branched. These are generally polyzoa.

The commonest fossil found in the formation is the coarse-ribbed, heavy Camarotoechia synchronoua, a shell typical of a sandy environment, available fossil evidence indicates a part Ordovician and pre-Ludlow age.

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2) The Amber Slate

The amber slate is approximately 800' thick and is underlain conformably by the Crotty Quartzite and overlain conformably by the Keel Quartzite. The Slates are generally highly fissile and on weathering turn to a yellowish-brown, sometimes with pinkish and purplish hues. The formation is very uniform in its lithology. The slates were probably siltstones before regional metamorphism. Fossil evidence indicates an Upper Llandovarian to Middle Wenlockian age (Banks 1962c).

3) The Keel Quartzite

This formation is poorly fossiliferous and is approximately 400' thick. The rock is a grey quartzite, and which weathers whitish in colour.

4) The Florence Sandstone.

This sandstone is usually light grey in colour, and is sometimes stained yellowish brown with iron oxide. The formation is highly fossiliferous so much so that Gill and Banks (1950) suggested that it must have been originally a calcareous sandstone, and even a sandy limestone in places. All the calcareous matter is now leached away, so that the fossils are preserved in the form of casts and moulds.

The formation is placed in the Devonian because it contains Maoristrophia, Protoleptostrophia, Eatonia, Notoconchidium, and Encrinurus. It probably belongs to the base of the Devonian (Banks 1962c).

5) The Bell Shale

The formation consists of approximately 1,400 feet of siltstones, commonly with shaly fracture, and with interbedded quartzite bands.

The Bell Shale is terminated above by a regional unconformity marking the Middle Devonian, Tabberabberan Orogeny. This diastrophism is responsible for the folding and emergence of the Eldon Group. There is a greater diversity of lithologies and faunal assemblages in this formation than in any of the others in the Group.

The fauna includes Fleurodictum, Lindstroemia, Australocoelia, Notoleptaena, Maoristrophia, and is considered as Lower Devonian in age (Banks 1962c).

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The following table gives a summary of the stratigraphy of the Eldon Group (after Banks 1962c).

STRATIGRAPHY OF THE ELDON GROUP

| | | FORMATIONS | THICKNESS |
|----------------|---------------------|--|-------------|
| LOWER DEVONIAN | EMSIAN SIEGENIAN | BELL SHALE <u>Pleurodictyum, Australocelia</u> | 1,400+ ft. |
| | GEDINNIAN | FLORENCE QUARTZITE <u>Pleurodictyum, Protoleptostropia</u> | 1,600 |
| SILURIAN | LUDLOW | KEEL QUARTZITE <u>Monograptus</u> | 200 |
| | WENLOCK | AMBER SLATE <u>Cryptograptus</u> | 800 ft. |
| | LLANDOVERY | CROTTY QUARTZITE <u>Gillatia</u> | |
| | | | (1,600 ft.) |

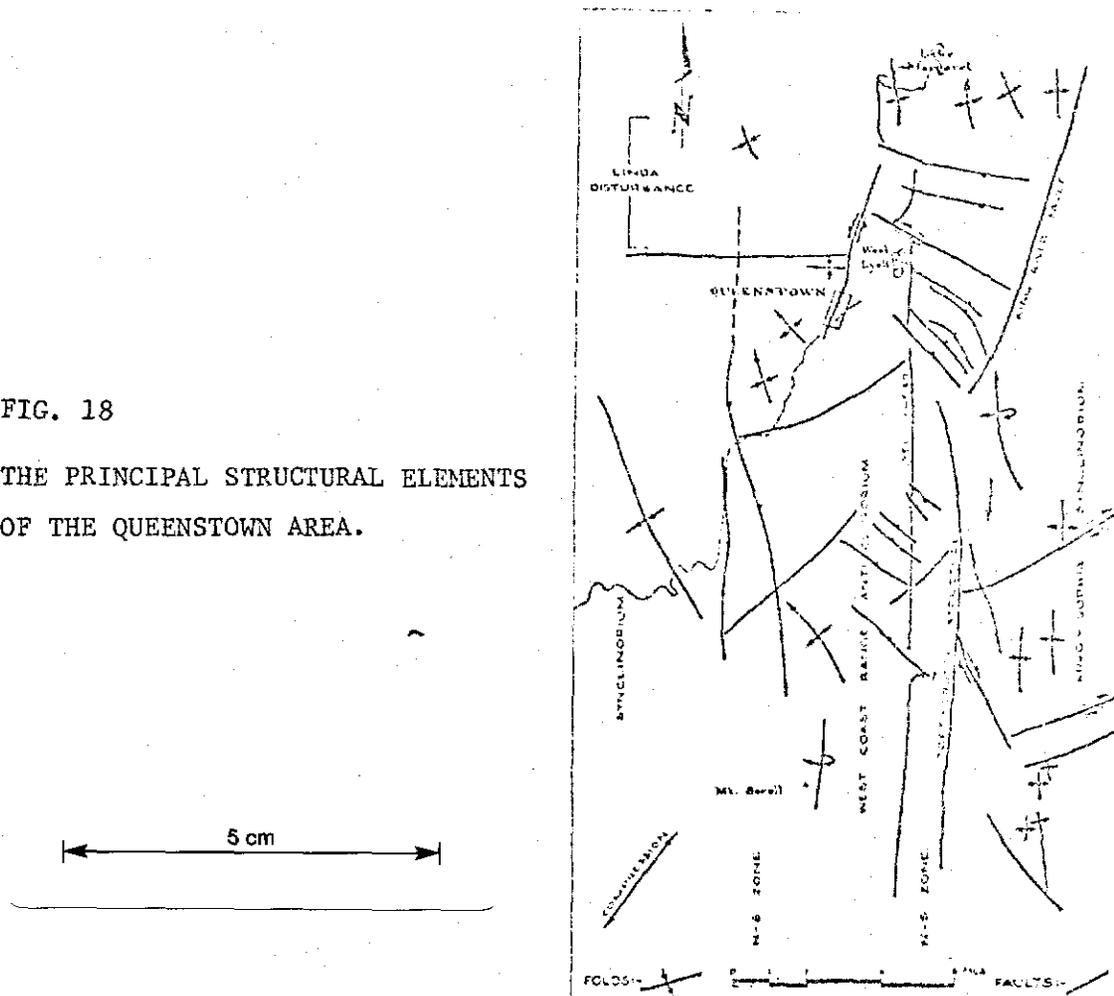
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G. THE STRUCTURE OF THE MT. LYELL AREA

The principal tectonic structures of the Mt. Lyell area are Tabberabberan in age; the earliest were major synclines and anticlines trending N - S to N.N.W. with wavelengths of 5-6 miles, their trend probably controlled by the physical discontinuity against the Precambrian at the western margin of the Tyennan Geanticline (Solomon 1966). The dominating structure is the West Coast Range Anticlinorium, the axis of which passes through Queenstown and continues north to Mt. Dundas.

The major factors controlling the development of the structural pattern have been:-

FIG. 18
THE PRINCIPAL STRUCTURAL ELEMENTS
OF THE QUEENSTOWN AREA.



- a) forces acting from the SW.
- b) the presence of the Tyennan massif to the east
- c) the increasing thickness of the geosynclinal sediments westwards from the margin of the massif.

There is a combination of a shearing couple and a westerly directed compression. The SW - NE compression resolves into components aligned parallel and perpendicular to the margin of the Tyennan block, resulting in E-W compression of the geosynclinal sediments and shearing west-side-north.

The principal structural elements are:-

- a) N-S West Coast Range Anticlinorium, the King Sophia

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Synclinatorium, and related secondary folds.

- b) The N-S Lyell Shear and Soft-Crotty structure.
- c) The NW fault - folds and NW schistosity
- d) The Linda Disturbance.
- e) The NE faults. (Figs. 18,19, 20 and 21)

a) The N - S West Coast Range Anticlinorium

This structure and its flanking synclinoria, is the major structure of the area. It has a N-S trend with the axis passing to the east of Queenstown. It is asymmetrical, the secondary "drag" folds showing vertical or overturned and commonly severely attenuated eastern limbs, and flat undisturbed western limbs. The King Sophia syncline is wedged between the West Coast Range Anticlinorium and the Tyennan block.

b) The Lyell Shear

This is a N-S feature paralleling the range from Comstock to South Darwin. It is associated with local overturning, attenuation and mineralization. Its points of conflict with cross - cutting structures are foci for ore deposition. Movement of the shear has been west - side up and north, combining vertical and transcurrent movement. The main shear movement took place during the Tabberabbern Orogeny. Its control over the distribution of the Owen Conglomerate near Queenstown is significant to the origin of the ore hosts at Mt. Lyell.

c) The NW fault-folds and NW schistosity

The NW faults have a strong influence on ore occurrence. They are NE facing folds in which the steep limb has been faulted out; hence the term fault folds. The down throw is to the north and they swing in strike from WNW to NNW. These faults mainly tend to occur in the competent, massive Owen Conglomerate and the softer, more yielding Dundas rocks, pressure is relieved by the development of NW schistosity.

d) The Linda Disturbance

This is an E-W or WNW Zone of faulting that may be traced for many miles east and west of the range. The Howards Plains fault is part of the Linda Disturbance. All the large, rich copper ore bodies of the Lyell area fall within the boundaries of this feature.

e) The NE faults

These are related to the N-S shearing couple and SW compression.

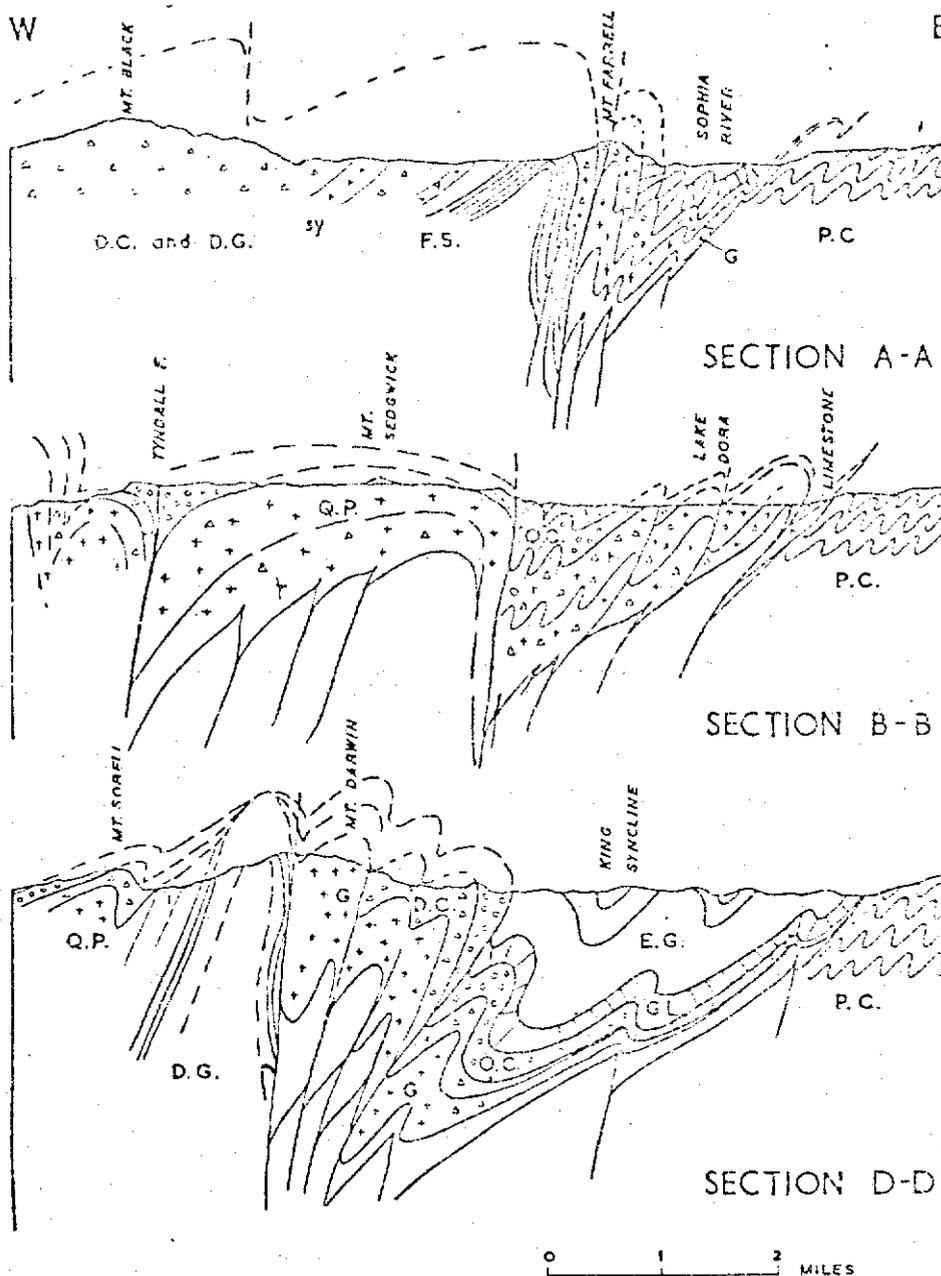
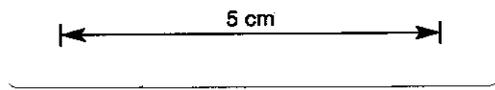


FIG. 20.

Sections across the King-Sophia Synclinorium.

- D.G. - Dundas Group.
- E.G. - Eldon Group.
- P.C. - Precambrian.
- O.C. - Owen Conglomerate
- D.C. - Dora Conglomerate
- G.L. - Gordon Limestone.
- G. - Granite.
- Q.P. - Quartz Porphyry.

(Bradley 1956).



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They show vertical throw, south side up. Bradley (1956) regarded these as major factors in ore control. Wade and Solomon (1958) however, consider them as insignificant.

Key to Fig. 21 (after Scott).

- (a) The geology of the Central West Coast.
- (b) The structure of the Central West Coast.
- (c) Sections shown in (a).

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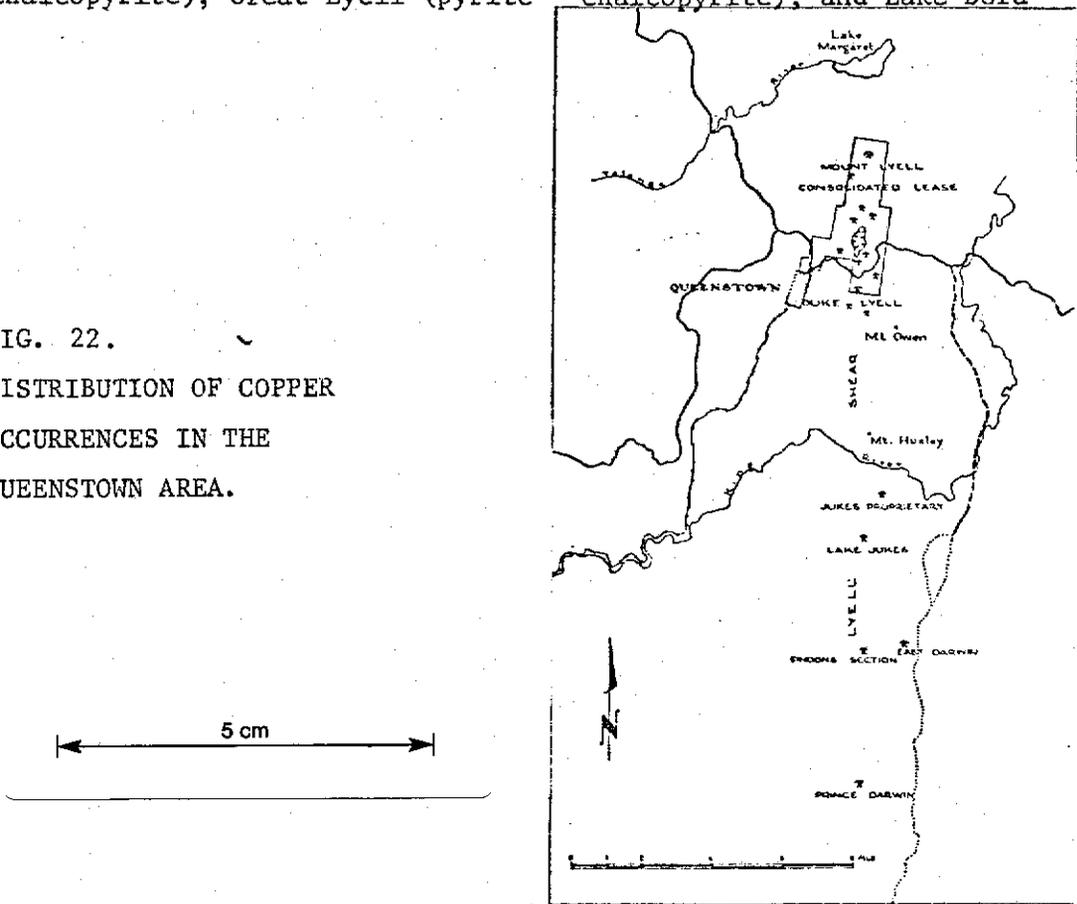
H. MINERALISATION

(1) The Mount Lyell Mines

Mineralization of the Lyell field took place towards the close of the tectonic activity of the Tabberabberan Orogeny. Ore deposition was controlled by structural channels and the sulphides are generally post - cleavage although on a few discrete cleavage surfaces post-ore movement has taken place (Wade and Solomon 1958 and Solomon 1965).

All the economic deposits, with the exception of Comstock, occur in a 14 mile wide strip on the divide between Mt. Lyell and Mt. Owen. However, sulphide mineralization is distributed along a narrow, straight N - S zone extending from South Darwin to Comstock and reappearing at Lake Dora. Of these uneconomic prospects, the largest, from south to north, are (Fig. 22) The East Darwin (pyrite - chalcoppyrite); Great Lyell (pyrite - chalcoppyrite); and Lake Dora

FIG. 22.
DISTRIBUTION OF COPPER OCCURRENCES IN THE QUEENSTOWN AREA.



(pyrite chalcoppyrite and some sphalerite and galena). These ore bodies occur in altered quartz keratophyres.

The ore bodies of the Mt. Lyell area are largely in altered Mt. Read Volcanics adjacent to the steeply upturned base of the Owen Conglomerate and they form a series of en echelon lenses extending up to 2,000 ft. from the Owen - Mt. Read contact. Throughout the mineralized area the volcanics are altered to sericitic and chloritic schists by recrystallization and hydrothermal alteration of the cleaved volcanics. The formation of these schists pre-dates

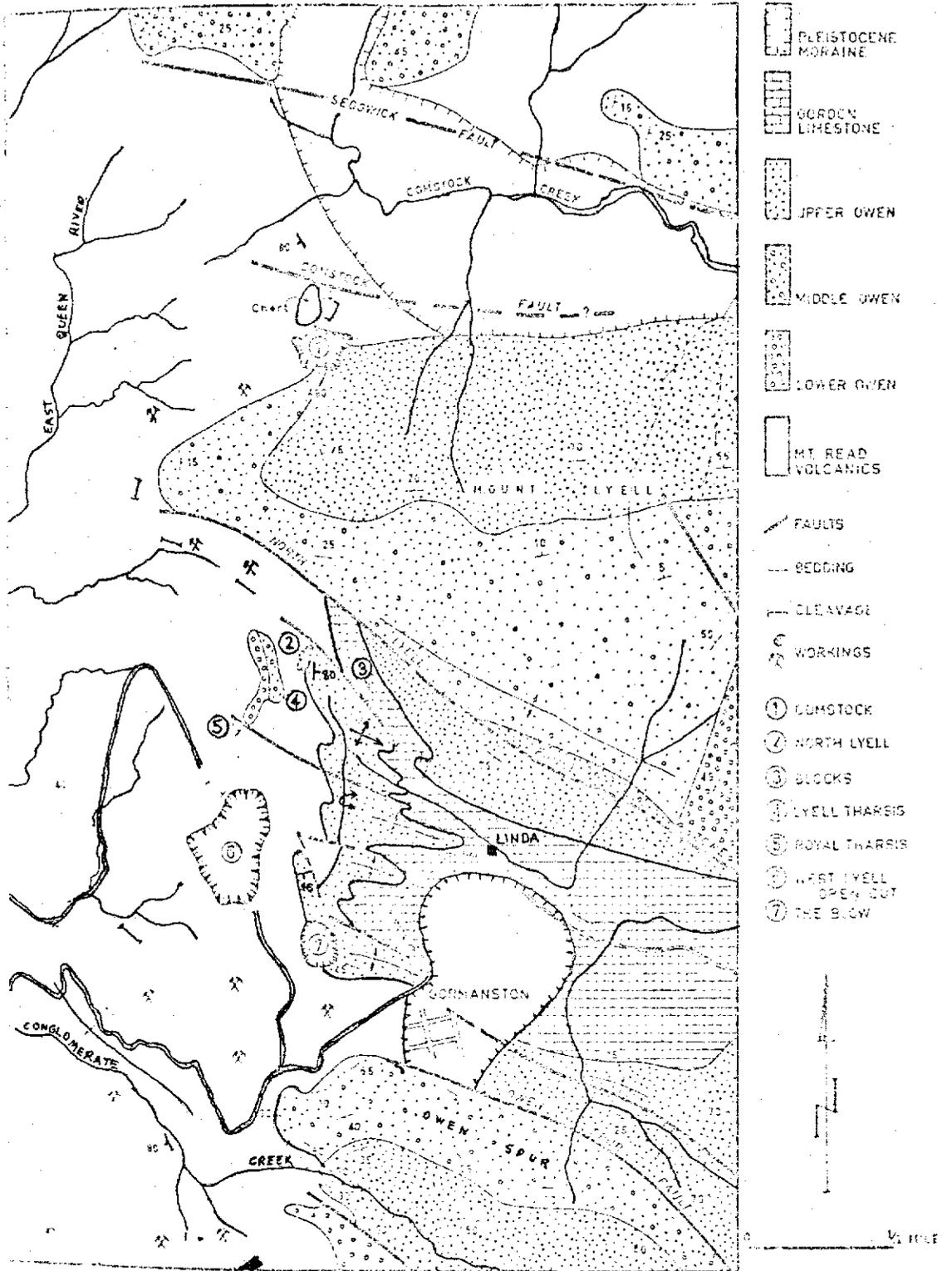
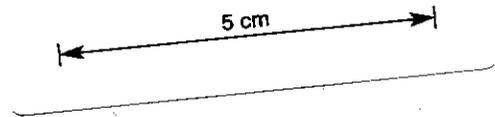


FIG. 23 THE GEOLOGY OF THE MT. LYELL AREA AND MINE LOCATIONS (SOLOMON)



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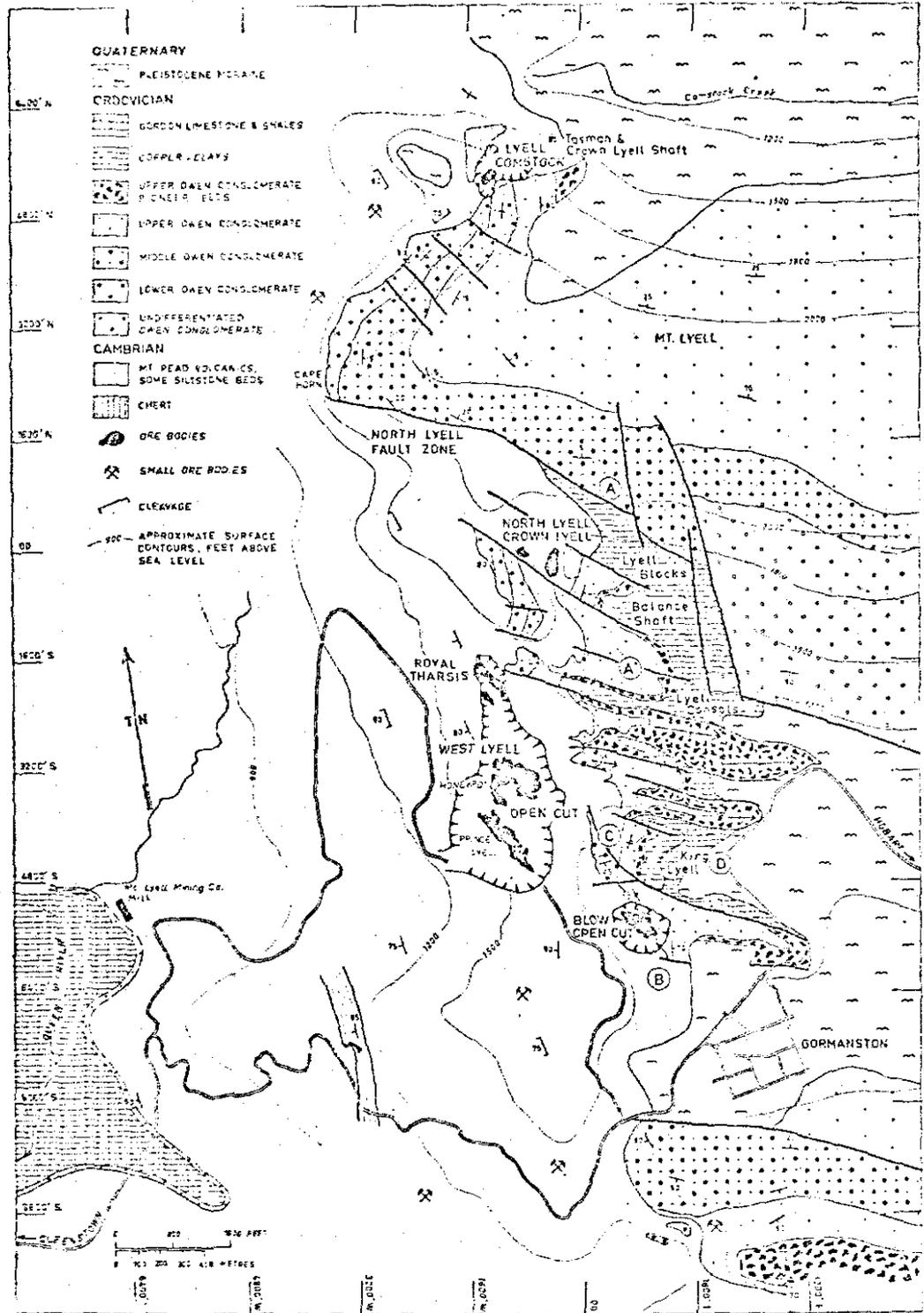


FIG. 24. THE GEOLOGY OF THE MT. LYELL AREA AND THE LOCATION OF THE COPPER CLAY DEPOSITS. (SOLOMON).

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sulphide deposition and they are known as the Lyell Schists. The economic deposits of the Mt. Lyell area (Fig. 23) consist of iron and copper sulphides and may be divided in general into the following types.

- a) massive pyrite - chalcopyrite
- b) disseminated pyrite - chalcopyrite
- c) chalcopyrite - bornite

In addition ore occurrences of galena and sphalerite at Comstock and native copper in the "copper clays" on the east flank of the Mt. Lyell Mt. Owen divide. (Fig. 24).

Bornite - Chalcopyrite Orebodies.

The North Lyell Mine.

The ore averaged 5.4% Cu and the mine produced 200 tons of copper per vertical foot. The mine ceased production in 1953 and published reserves were 3,000 tons of 3.6% Cu ore underground, and 2,500,000 tons of 0.8% ore available for open cutting (Wade and Solomon 1958). Mining recommenced in 1959 and reserves approximate 100,000 tons of 6% copper ore.

The outcrop of ore is in a schist corridor, 1,200 feet wide, and about midway between Conglomerate masses of Mt. Lyell and the Tharsis Ridge. At depth the ore impinges onto, and at places is actually in, hard Conglomerate. The general control is provided by the intersection of the Lyell Shear and North Lyell Fault, resulting in intense brecciation, silicification, and mineralization.

A notable feature is the presence of large masses of buff - coloured chert veined by hematite.

The bornite occurred in three different environments.

- (a) Grey quartzite containing appreciable quantities of pyrite and little or no chalcopyrite.
- (b) White or grey schists with little or no chalcopyrite.
- (c) In the conglomerate as solid bornite with no visible gangue and no chalcopyrite.

At depth the orebodies lie flatly, controlled by the attitude of the original bedding, but pass vertically up through the fold axis until they become small vertical pipes in the steeply upturned beds. Ore occurs in the upturned and replaced Middle Owen Conglomerate occupying the vertical limb of the Razorback fold

immediately south of the north Lyell Fault zone. (Fig. 25).

The ore was mainly bornite in a siliceous gangue, with chalcopyrite, pyrite, galena, hematite and barite. (Table 4).

FIG. 25. THE SECTION THROUGH THE NORTH LYELL AREA ON 400S (SOLOMON)

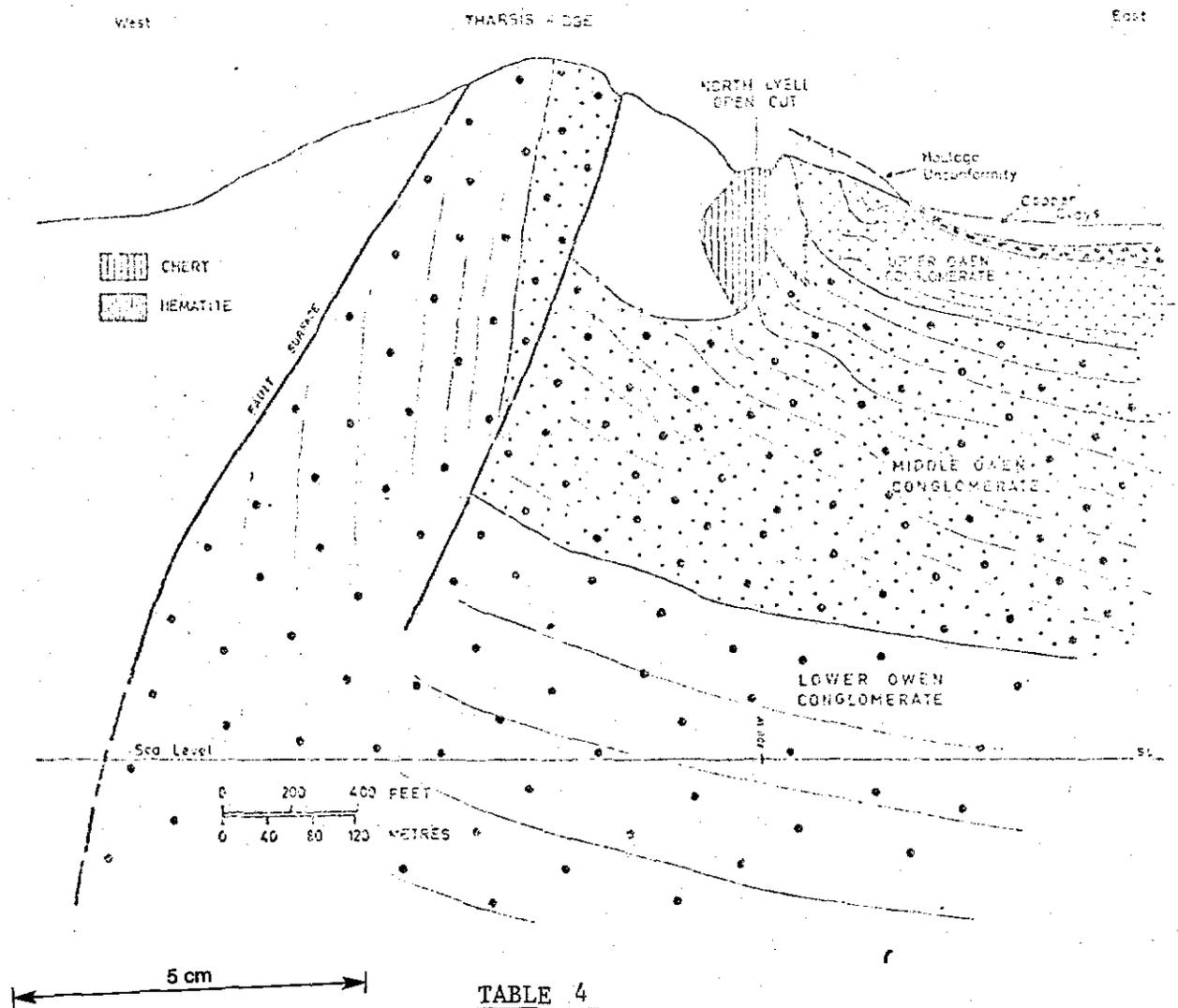


TABLE 4

(i) A typical analysis of Mount Lyell Mine (Blow) ore:

| | | | |
|---------|-------|---------|-------------------|
| Iron | 43.8% | Lead | 0.7 |
| Sulfur | 50.0 | Zinc | 0.3 |
| Silica | 2.6 | Arsenic | 0.33 |
| Alumina | 0.5 | Silver | 1.50 ozs. per ton |
| Barite | 0.5 | Gold | 0.04 oz. per ton |
| Copper | 1.0 | | |

(ii) A typical analysis of North Lyell ore in bulk

| | | | |
|---------|-------|--------|--------------------|
| Copper | 6.15% | Barite | 1.5 |
| Silica | 62.7 | Sulfur | Not determined |
| Iron | 9.1 | Silver | 1.3 ozs. per ton |
| Alumina | 7.5 | Gold | 0.015 oz. per ton. |

Chalcopyrite - Pyrite Orebodies

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The Mt. Lyell Mine or the Blow.

The Blow occupies a similar structural and stratigraphic position to the North Lyell orebodies. The ore occurs in schist occupying the position of the Middle Owen Conglomerate in the vertical limb of the Razorback upturn. The orebody lies between the crushed zones of the Gormanston and Owen Spur faults, the schist penetration along the Owen Spur fault at Gormanston being similar to that at North Lyell. In cross section (Fig. 26) the Blow was shaped like a banana, the upper richer portion lying flatly down the west dipping asymmetrical synclinal fold axis. Wade and Solomon (1958) suggest that the fall-off in grade with depth is related to this changing attitude. The orebody strikes NW and the dip is vertical in the upper part of the orebody but flat to the south west in the lower part.

The ore consisted mainly of pyrite, averaging 87% FeS₂. Chalcopyrite the most important copper mineral with enargite, tetradrite, bornite, and chalcocite. Gangue consisted of a little quartz, barite and unreplaced schist. (Table 4).

West Lyell Mine

This is the main copper producer in the field. It consists of the Royal Tharsis, West Lyell Nos. 1, 2 and 3 and the Prince Lyell orebodies, besides numerous small rich zones. Around these orebodies are low grade "halos" which in some cases merge into each other to form a large low-grade disseminated copper deposit capable of being mined in a single open cut.

The West Lyell orebodies consist of a series of lenses averaging 1.0 to 1.5%Cu in quartz - sericite schist and quartz-chlorite - sericite schist. Some of the schist is fine grained, dark, and very chloritic, some is coarsely nodular and rich in quartz and sericite, and all gradations between these extremes occur. Within any single richer oreshoot strips of lower grade ore are strung out along schistosity. Copper occurs mainly as chalcopyrite with a little covellite and rarely chalcocite; gold and silver values are low but significant.

Ore control at West Lyell consists of vertical east - west faulting intersecting the Razorback fold, the steeply upturned west limb of which consists of schists. It is thought that the wide zone of schists must occupy the original position of the Jukes conglomerate and probably part of the Dundas Group (Wade and Solomon 1958).

The strike of the individual ore - shoots is slightly oblique to and the dip is slightly steeper than, schistosity, and

FIG. 26 SECTION ALONG 5,600S THROUGH THE BLOW
(WADE AND SOLOMON)

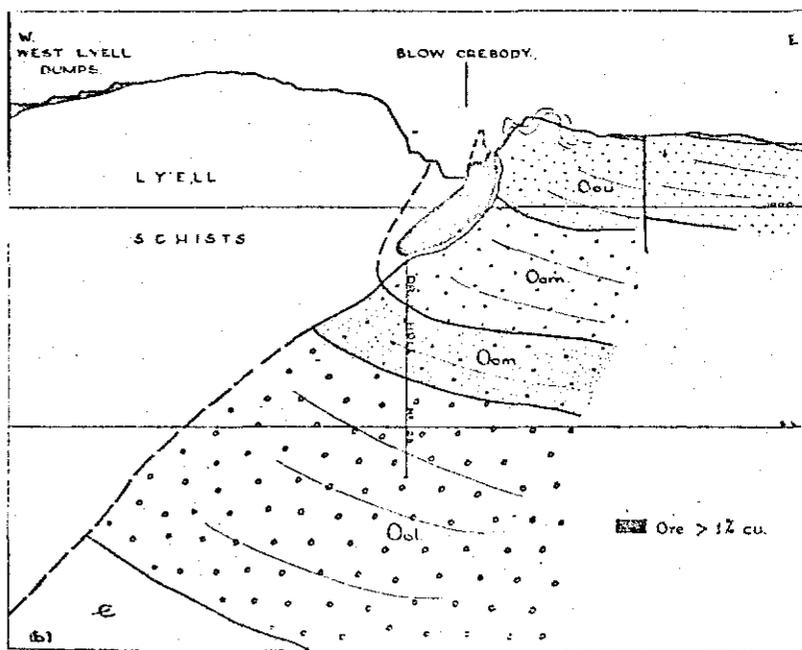
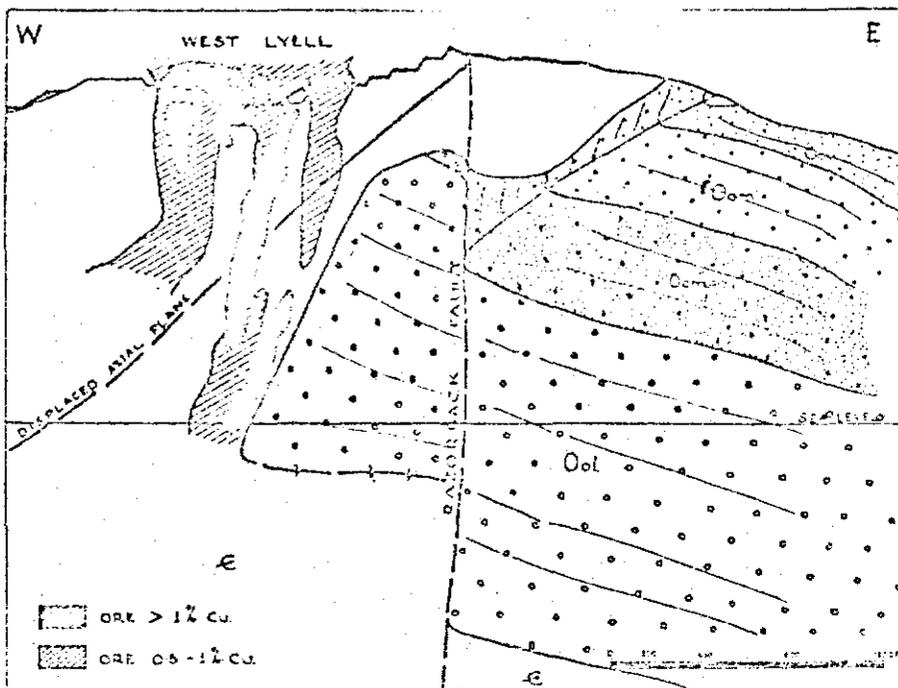


FIG. 27. E-W SECTION THROUGH WEST LYELL ALONG 3,100S.
(WADE AND SOLOMON).



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each ore shoot tends to approach closer to the conglomerate contact at depth. (Fig. 27). The dip is steep to the south-west and pitch variable and steep.

Crown Lyell

This orebody was relatively small, varying in length from 150 to 290 feet at 30 to 70 feet wide. The ore occurs in schists, replacing the ore horizon of the middle Owen Conglomerate and is on the steep west limb of the Razorback fold adjacent to the North Lyell fault zone.

Royal Tharsis

The Royal Tharsis is a member of the West Lyell group of orebodies that extend en echelon to the southwest from the Tharsis Ridge and are separated by low-grade zones. The ore occurs in a sericitic quartz schist with pyrite and chalcopryrite. Of all the West Ryell bodies it is the closest to the conglomerate, being within 100 feet of the Conglomerate on the Tharsis Ridge and separated from the sediments by schists carrying low copper values. The orebody is elongated along the schistosity, and the grade improves steadily with depth.

Lyell Tharsis

This deposit is in an environment similar to that at North Lyell except that it is south of the North Lyell fault and is associated with a strong E-W fault. The ore is predominantly chalcopryrite with some bornite and galena and is in schist separated from the Owen Conglomerate by a thin strip of hematitic schist. The ore occurs in the steep west limb of the Razorback fold in the Middle Owen horizon. The schist does not extend far down the steep limb and mineralization cuts out 400 feet below outcrop. The strike follows NW schistosity and the dip is vertical.

The Comstock Mines.

The Comstock group of orebodies is situated in the Comstock Valley, on the northern side of Mount Lyell.

The orebodies at Comstock occur in Lyell Schists near the contact of schist and Conglomerate. They are located on the intersection of the Lyell Shear and the E-W Comstock fault and the degree of brecciation and the grade of ore is second only to that at North Lyell. The ore is associated with the development of massive chert bodies veined by hematite.

The Middle Owen Conglomerate passes along strike into schist

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containing the Comstock orebodies. Four separate orebodies have been located and their arrangement in section is roughly an echelon, although individual orebodies connect at certain levels.

The ore consists of disseminated chalcopyrite in schist with some bornite in the first and fourth echelons. Other minerals are pyrite, magnetite, galena, copper carbonate, and free gold.

The Tasman and Crown Lyell Extended

This mine lies immediately east of the Lyell Comstock mine. Two ore bodies have been worked. The orebodies are approximately 200 feet apart, one containing patchy bornite in schist and brecciated quartzite and the other a small but rich lode containing lead, zinc and silver.

The workings are in schist along the strike of steeply upturned Owen Conglomerate.

Pyrite Orebodies.

Several fairly large pyritic lenses occur in the Lyell area, they contain little or no copper. They are similar to the orebodies of West Lyell and are elongated along the schistosity and contain large tonnages of ore assaying as high as 80% FeS₂.

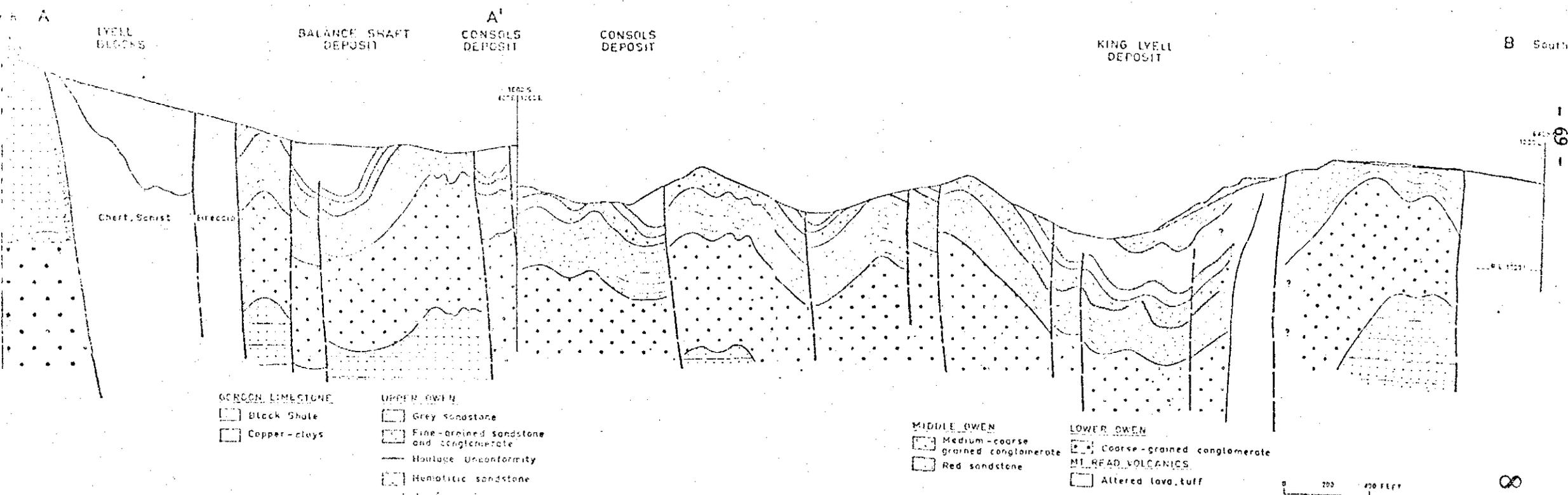
The Copper Clays

The Copper Clays occur at the base of the Gordon limestone. They are underlain by schistose volcanic rocks or Owen Conglomerates and overlain by dark grey, siliceous shales of the Gordon limestone. Almost all the occurrences lie between North Lyell and Gormanston or the east side of the ridge joining Mt. Lyell and Mt. Owen, and the main deposits are King Lyell, Lyell Consols, Balance Shaft, and Lyell Blocks (Fig. 28 and 29.) There is also an occurrence of similar but barren clay west of the Mt. Lyell Mill at the base of the Gordon limestone. In the Lyell Blocks area the copper-clays lie within the North Lyell Fault zone and are locally mixed with altered volcanic rocks and Owen Conglomerate in a highly viable tectonic me'lange.

The clays reach several hundred feet thick and consist mainly of grey or brown clayey mudstone and goethite and are interbedded with carbonate rocks. Bore - holes in the King Lyell deposits have shown a decrease in clay eastwards and this is probably true for all the copper - clay deposits east of the mine area. (Solomon 1969).

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FIG. 28. N-S SECTION TO ILLUSTRATE THE WNW FOLDING AND THE FORM OF THE COPPER CLAY DEPOSITS. (SOLOMON)



GORCON LIMESTONE
 Black Shale
 Copper-clays

UPPER OWEN
 Grey sandstone
 Fine-grained sandstone and conglomerate
 Haulage Unconformity
 Hematitic sandstone

MIDDLE OWEN
 Medium-coarse grained conglomerate
 Red sandstone

LOWER OWEN
 Coarse-grained conglomerate
 NI READ VOLCANICS
 Altered lava, tuff

0 200 400 FEET

5 cm

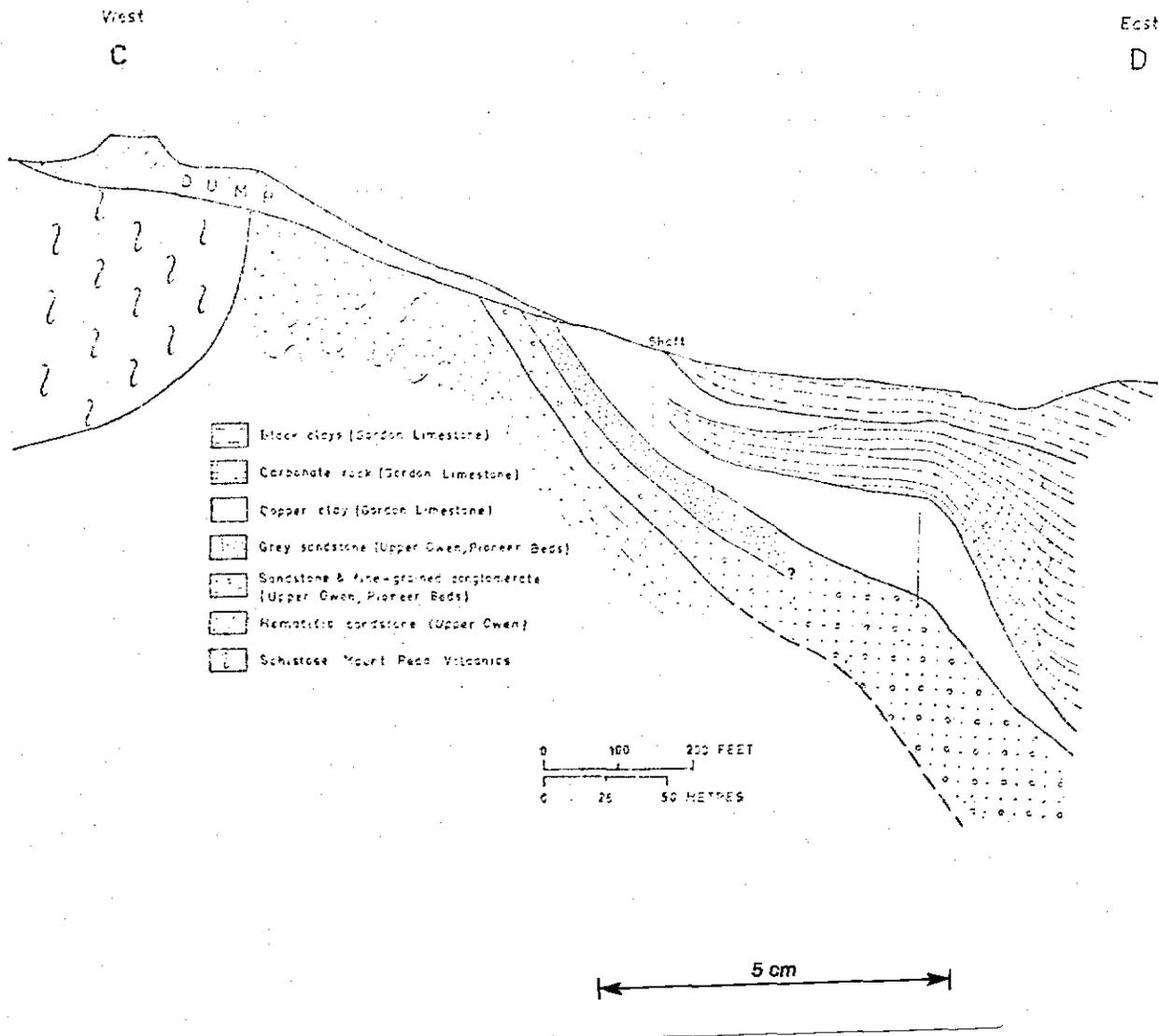
SEE FIG. 23 FOR POSITION OF SECTION.

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Fig. 29. East-West section through the King Lyell Deposit (Solomon 1969).



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(2) The Jukes Darwin Mining Field

The field is bounded on the north by the King River and the Mt. Lyell Mining field, on the east by the north Mt. Lyell railway (now disused). The mining area extends from this line westwards onto the north eastern boundary of EL 47/70 along line 360,000 E. The greatest portion of the field is now held by the BHP Co. Ltd.

The following description has been taken from Loftus Hills' (1914) paper on the Jukes Darwin Mining field in the Geological Survey Bulletin No. 16 of the Department of Mines, Tasmania.

The Geology and stratigraphy of the area has already been dealt with (map 1 and 2) and the following is a description of the mineral occurrences.

a) Mineralogy of the Ore Deposits

The Copper - Silver - Gold Ore bodies.

There are two distinct varieties of ore occurrences in this field which contain the three metals copper, silver and gold.

1) Magnetite hematite ore bodies - these will be discussed under a section on their own.

2) Chalcopyrite bodies.

This class is of the greatest importance and is characterised by the occurrence of chalcopyrite and the absence of hematite and magnetite. These are generally the richer deposits. These ore occurrences are fairly varied as regards the amount of valuable minerals present. All gradations may be traced from the schistose rock carrying a few grains or veinlets of pyrites or chalcopyrite distributed along the planes of a schistosity, to deposits consisting of practically pure pyrite or chalcopyrite.

The boundaries of the ore bodies are irregular, and limited in width by a boundary line separating schist from felsite. There is also a diminution of sulphides along the strike.

The East Darwin orebody occurs in grey schist, and has its western boundary hard, dense, red felsite, against which the ore body ends abruptly.

On sections 6012-M, 5923-M 3107-M, 4655-M, and 1594-M the ore consists of a mixture of pyrite and chalcopyrite. The sulphides are

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arranged along the planes of fissility in the schist, in the form of irregularly - shaped masses connected by a thin film or veinlet of sulphides traversing the planes of schistosity. Generally there is developed a ramifying system of bulging veins of pyrite and chalcopyrite, totally enclosing roughly circular or polygonal masses of schist.

Chlorite is always associated (except at East Darwin) with the sulphides.

A great amount of silicification has taken place in the East Darwin ore body. In the mineralized zone the schist is almost completely replaced by silica. The sulphides occur in this silicified schist.

The gold and silver values are contained in the chalcopyrite and perhaps also with the pyrite. No free gold or silver is found.

B) The Hematite and Magnetite Bodies

The predominating mineral constituents are magnetite and hematite. Pyrite and chalcopyrite also occur. The gangue minerals are quartz and chlorite.

The general outlines of these masses are irregular. The ore bodies of South Darwin are irregular, with their greatest lineal measurement parallel to the granite contact (Darwin Granite).

The magnetite ore bodies decrease in mineral content towards the margins whereas the hematite bodies have sharper contact with the surrounding rock. Sulphides occur in crystalline aggregates within the magnetite mass.

C) The Blue Hematite - Bornite Veins

These veins are wholly confined to the Lake Jukes, area on Section 4811-M and 4812-M. They consist of mixtures of hematite, bornite and quartz. The striking feature is the presence of bornite and copper glance, as well as the bluish grey hematite. Bornite does not occur in any other parts of the field.

The Bornite and copper glance occur as blebs and larger masses in the hematite. The bornite masses are practically pure, no gangue minerals being present.

The veins are simple fillings of irregularly oriented veins occurring at the summit of the Hogback at Lake Jukes. The width

079

varies from a few inches to a few feet, but the dimensions in other directions are limited, the deposits being lense like. They occur in felsite.

D) The Barytes Lodes

Barite is the predominant mineral with small amounts of pyrite and chalcopyrite. The chalcopyrite shows in places a thin coating of covellite. In clean samples the Barytes lodes assay as high as 97 per cent, of barium sulphate and seldom lower than 80 per cent.

These lodes are fissure fillings, the most important occurrence being on W.H. Taylor's barium reward section.

C) The Quartz Lodes

These are of subordinated development in the field. The mineralogical characteristics are the predominating quartz gangue with associated pyrite and chalcopyrite, chalybite, specularite and limonite. There is a variant characterised by an abundant development of chlorite. This type carries free gold as well as pyrite and chalcopyrite. They occur at South Darwin and Lake Jukes.

D) Detrital Gold Deposits

These deposits are of good quality the fineness being very high. These deposits are confined to the vicinity of Mt. Darwin, one small patch has been worked at Lake Jukes. The deposits have been worked on the following sections: -5207M, 3295-M, 2581-M, 3196-M 1203-M, 3352-M 4812-M and in the northern portion of the Clark Valley.

The metal occurs in creeks and alluvial terraces. A reef or lode has not been found.

The Mining Sections.

(i) Section 6012M

On this property exist several outcrops of ore bodies. Ore outcrop forms a prominent brown ridge, the colour being due to the oxidation of pyrite to limonite. The outcrop strikes slightly east of north. The orebody is 18 feet wide and at depth gained a width of 24 feet, and consists of veins, bunches and blebs of chalcopyrite and pyrite in dark chloritic schist (map 1).

At this section green and red felsites have been explored

080

with little success. The bulk of the mineralization occurs in dark soft green chloritic schist with marked fissility and schistosity. However, there are belts of replacement deposits consisting of pyrite, a little chalcopyrite in places, and hematite and magnetite in hard felsite.

Ore from the schists assayed:

| | |
|--------|------------------|
| Copper | 4.10% |
| Silver | 0.53 oz per ton. |
| Gold | 0.27 oz per ton. |

(ii) Section 5936-M

An adit was driven on a definite band of mineralization which followed the strike of fracture planes which strike slightly west of north. It was thought the mineralization occurred as vein fillings and was not extensive.

(iii) Section 5241

On this section crags of red hematite in felsite were explored (by tunnelling) but no ore mineralisation of value was encountered.

(iv) Sections 4811-M and 4812-M

The ore deposits on these sections are confined to a prominent ridge of granophyre. The main workings are in Section 4812-M.

In parts of the area blue hematite - bornite veins occur as irregular fissure fillings. In one adit a bornite vein 2 ft. wide proved to be phenomonally rich, but petered out in every direction. This happened in all of the veins. This section proved uneconomic.

(v) Section 1594 - M

Good chalcopyrite mineralization has been exposed in a band of green chloritic schist. The schist belt strikes north west.

(vi) Section 4414 - 93M

Crags of massive red hematite outcrop on this section and were taken as the oxidised portion of a pyritic ore body. A tunnel was driven through the hematite but no sulphides were encountered.

(vii) Section 3568-M

A Barytes lode was the main objective on this section.

081
The width of the lode varies from 8 feet to 1 foot, The lode is in the form of a fissure filling in felsite. At its western end the lode carries a considerable proportion of sulphides, both chalcopyrite and pyrite being present.

(viii) Section 4655-M

Schists with veins and masses of chalcopyrite and pyrite. Picked samples gave high values in copper, gold and silver.

An adit located an ore body in green felsite. The ore body was associated with a make 4 feet wide of quartz and hematite carrying chalcopyrite and pyrite.

(ix) Sections 4615-M and 4654-M

Good orebodies occur in a belt of grey schist which can be traced for more than half a mile in the direction strike. The width of the mineralized belt varies from about 5 feet at the highest levels to 40 feet in the bottom workings. Some of the mineralization appears to occur near the contact of grey schist and felsite. Assay values show a range from 6 to 9.0%, copper, trace to 10 dwts. Silver, and trace to 8 dwts. of Gold.

(x) Section 2101-93M

This section lies close to the boundary of EL 47/70 and just inside BHP Co. Ltd. area. Trenching has been carried out and green chlorite schists and "porphyroids" were exposed. These rocks showed splashes of pyrite, chalcopyrite, specularite and red hematite. Assays from 5 per cent copper downwards and one ounce of gold per ton downwards were reported. Loftus Hills (1914) however, was not impressed at the prospects of the section.

(xi) Section 3107-M

On this section (Findon's Section) a chloritic schist has been worked for copper. The width of the schistose formation varies from 20 to 60 feet, strikes about 30° west of north and dips at approximately 60° and is impregnated with copper and iron pyrite. For some feet below the surface the greater part of the copper has been leached out, leaving small iron-stained cavities.

(xii) Section 1203-M

The country rock is hard felsite which is slightly schistose in patches. Patches of native copper are sparsely scattered through the rock. Hematite and pyrite are also present.

082

(xiii) Section 3867-M

The country rock is hard dense felsite with the development of some igneous breccia. The ore deposit is seen at the surface, and consists of a large belt of magnetite and hematite carrying some pyrite and chalcopryrite traversing the section from north to south.

This deposit is 15 chains from the Darwin Granite. Hills suggests that it is a metasomatic replacement of the felsite.

(xiv) Section 5560-M

On this section and neighbouring sections occur a large number of magnetite or hematite ore bodies some of which carry sulphides. This form of ore body has already been described. Ore body of magnetite with some pyrite and chalcopryrite had been tested. Assays were from 0.5 to 1.0 per cent copper.

083

1. CONCLUSION AND RECOMMENDATIONS

The ore deposits of the Lyell-Darwin area occur as replacement bodies in the sheared Mt. Read Volcanics of the Dundas Group. They occur in quartz sericite, sericite and chlorite schists adjacent to the Mt. Read Volcanic - Owen Conglomerate unconformity. All the major deposits occur along the Lyell shear zone. Foci for ore deposition occur where the Lyell shear is intersected by crosscutting structures eg. The Linda Fault Zone.

The copper clay deposits are the exceptions. They occur at the base of the Gordon Limestone east of the Lyell Mine area. It was noted that none of these deposits have been discovered on the western side of the Mt. Lyell Mine area.

In the main the ore deposits consist of chalcopyrite, pyrite, bornite and galena in association with haematite, baryte and chert. Hills (1914) noted that the pyrite bodies in the Jukes-Darwin Field oxidised to limonite.

In view of the above the areas of EL 47/70 above 790 N (map 1 and 2) where "undifferentiated" Dundas Group and Mt. Read Volcanics outcrop should be the prime targets for future exploration.

The following is a list of the areas of most interest.

- (1) Area of Haematised rock on the eastern flank of Mr. Sorell from 793000N, 339800E to 79700N, 55900E close to the Mt. Read Volcanic-Owen Conglomerate unconformity.
- (2) Areas of Feldspathised rock associated with the haematite and close to the unconformity.
- (3) Areas of quartz sericite schist near the Mt. Read Volcanic-Owen Conglomerate unconformity at 809300N, 359300E (associated with a W.E. striking fault) and at 813N, 358E.
- (4) Areas of chloritized and undifferentiated rock adjacent to the unconformity.
- (5) The area of undifferentiated Dundas Group near the mouth of the King River (map 3).

Discrepancies exist between maps 1 and 2, especially in the extent of outcrop of Dundas Group rocks and Owen Conglomerate. Map 1

084

(Bradley 1954) is the most detailed and a considerable amount of the area must have been mapped on location. Bradley notes that the area west of Mr. Sorell has been mapped entirely from airphotographs. These discrepancies between the two maps should be resolved.

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LEGEND

QUATERNARY SYSTEM.

Q ALLUVIUM AND MORAINES.

TERTIARY SYSTEM.

T_{mac} MACQUARIE BEDS

SILURIAN - DEVONIAN SYSTEMS.

ELDON GROUP.

- O_{tb} BELL SHALE.
- St FLORENCE QUARTZITE.
- Sk KEEL QUARTZITE.
- So AMBER SLATE.
- S₁ CROTTY QUARTZITE.
- S₂ UNDIFFERENTIATED.

ORDOVICIAN SYSTEM.

JUNEE GROUP.

- O_g GORDON LIMESTONE.
- O_{ot} TUBICULAR SANDSTONE MEMBER.
- O_{oc} OWEN CONGLOMERATE.

CAMBRIAN SYSTEM.

DUNDAS GROUP.

- Ec CONGLOMERATE AND BRECCIA.
- E UNDIFFERENTIATED.

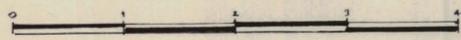
METAMORPHIC ROCKS.

- Q_z QUARTZ PORPHYRY MASSIVE.
- Q_p QUARTZ PORPHYRIFIED ROCK.
- F_{sp} FELDSPATHISED ROCK.
- Ch_l CHLORITISED ROCK.
- S_{ss} QUARTZ SERICITE SCHIST.
- H_h HEMATITISED ROCK.
- P_r PYRITISED ROCK.
- Cu_o CU ORE OF 1-5% CU.
- 2101. MINING SECTIONS - JUKES-DARWIN FIELD.
- ⊕ MINE LOCATIONS.
- Gr GRANITE.

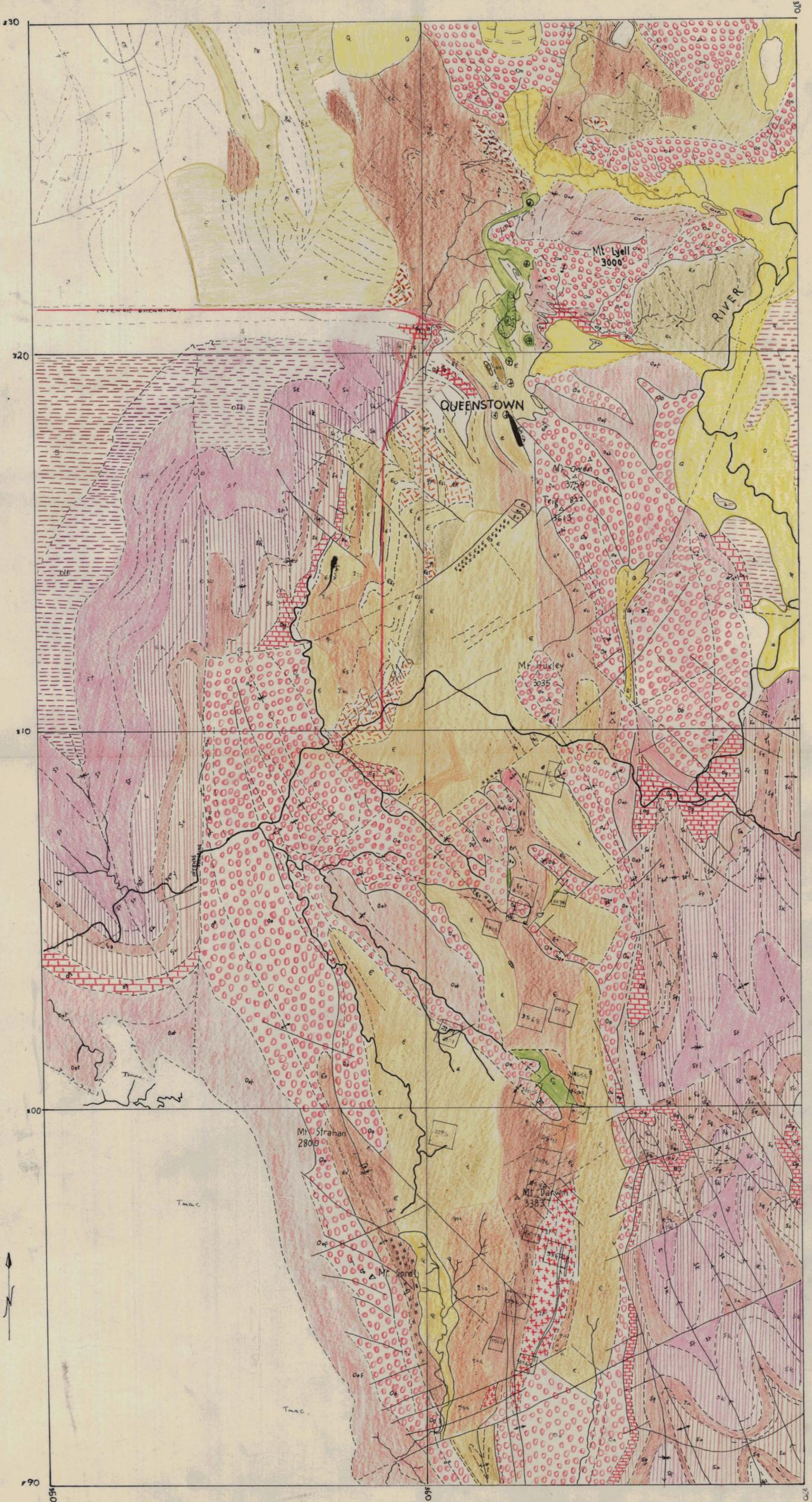
- F FAULT.
- A ANTICLINAL AXIS.
- S SYNCLINAL AXIS.

SEE MAP 3 FOR THE LOCATION OF THIS MAP.

SCALE 1 MILE TO 1 INCH



(MAP COMPILED AFTER BRADLEY 1954)

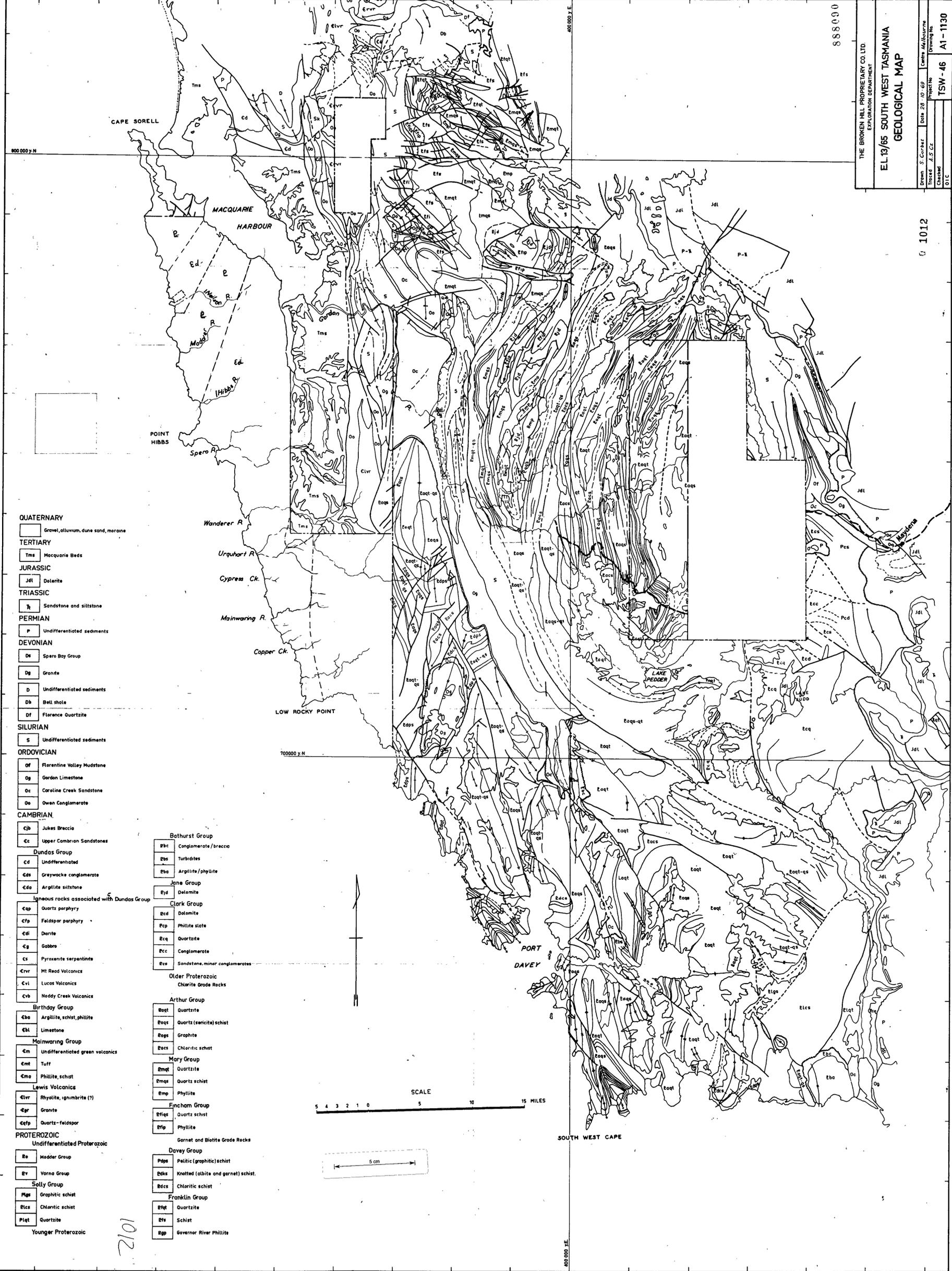


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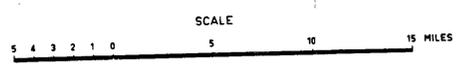
**EL 19/65 SOUTH WEST TASMANIA
GEOLOGICAL MAP**

Drawn: S. Corbett Date: 28/10/69 Centre: Melbourne
Traced: J.S.Cz. Project No. Drawing No.
Checked: D.I.C. TSW-46 A1-1130



- QUATERNARY**
Gravel, alluvium, dune sand, moraine
- TERTIARY**
Tms Macquarie Beds
- JURASSIC**
Jdt Dolerite
- TRIASSIC**
Ts Sandstone and siltstone
- PERMIAN**
P Undifferentiated sediments
- DEVONIAN**
Ds Spero Bay Group
Dg Granite
D Undifferentiated sediments
Db Bell shale
Df Florence Quartzite
- SILURIAN**
S Undifferentiated sediments
- ORDOVICIAN**
Of Florentine Valley Mudstone
Og Gordon Limestone
Oc Caroline Creek Sandstone
Oo Owen Conglomerate
- CAMBRIAN**
Cjb Jules Breccia
Cc Upper Cambrian Sandstones
- Dundas Group**
cd Undifferentiated
cds Greywacke conglomerate
cda Argillite siltstone
- Igneous rocks associated with Dundas Group**
cqp Quartz porphyry
csp Feldspar porphyry
cdi Diorite
cg Gabbro
cs Pyroxenite serpentinite
crr Mt Read Volcanics
cvi Lucas Volcanics
cvb Noddy Creek Volcanics
- Birthday Group**
cbo Argillite, schist, phyllite
cbl Limestone
- Mainwaring Group**
cm Undifferentiated green volcanics
emt Tuff
cma Phyllite, schist
- Lewis Volcanics**
clvr Rhyolite, ignimbrite (?)
cgr Granite
cgp Quartz-feldspar
- PROTEROZOIC**
Undifferentiated Proterozoic
Eo Meador Group
Ev Varna Group
- Solly Group**
Egs Graphitic schist
Ecs Chloritic schist
Eqt Quartzite
- Younger Proterozoic**

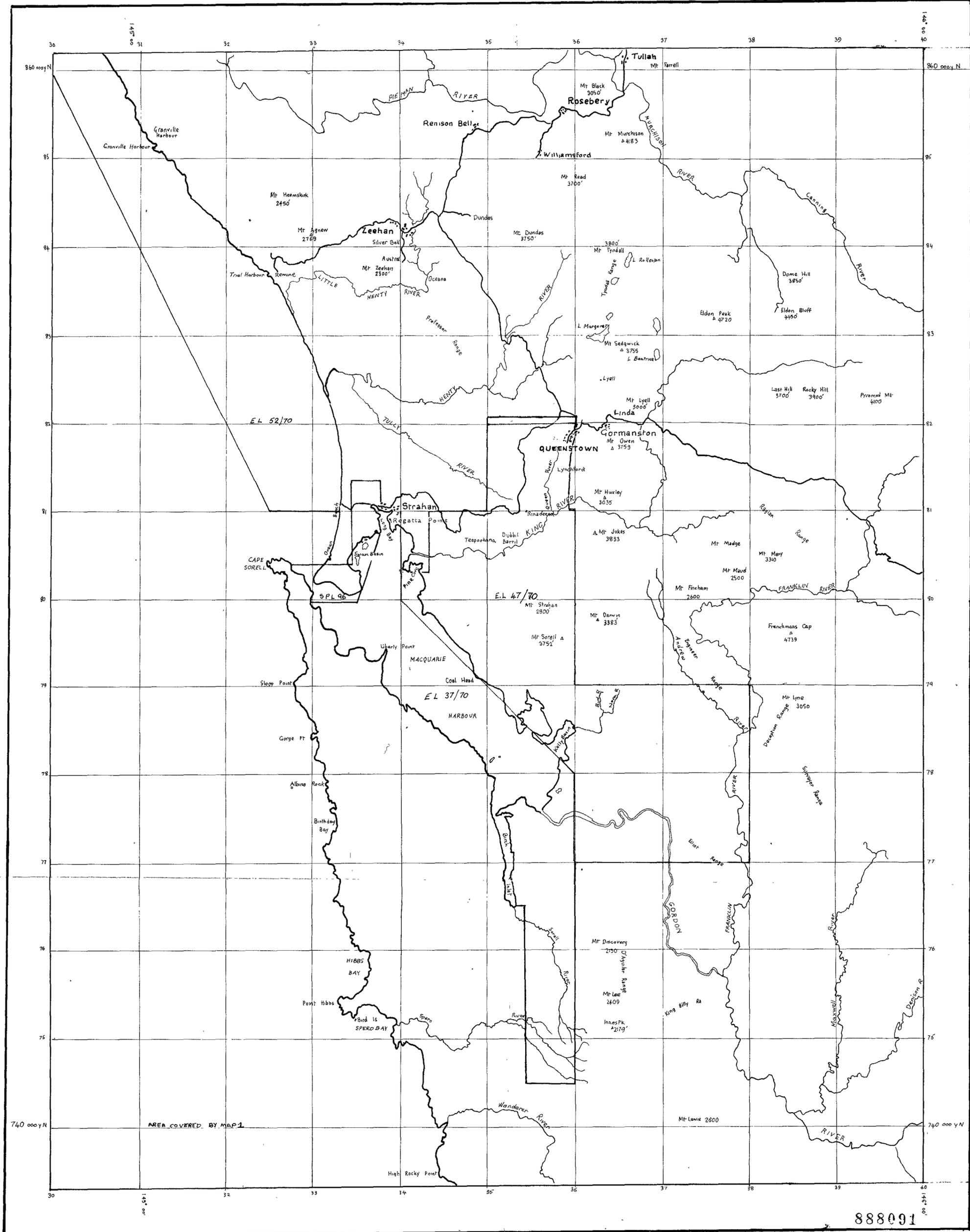
- Bathurst Group**
Bbc Conglomerate/breccia
Bbs Turbidites
Bbo Argillite/phyllite
- Jane Group**
Ejd Dolomite
- Clark Group**
Ecd Dolomite
Ecp Phyllite slate
Ecs Quartzite
Ecc Conglomerate
Ecs Sandstone, minor conglomerates
- Older Proterozoic Chlorite Grade Rocks**
- Arthur Group**
Eaqt Quartzite
Eaqs Quartz (sericite) schist
Eags Graphite
Eact Chloritic schist
- Mary Group**
Emqt Quartzite
Emqs Quartz schist
Emp Phyllite
- Fincham Group**
Efiqs Quartz schist
Efipt Phyllite
- Garnet and Biotite Grade Rocks**
- Davey Group**
Edds Pelitic (graphitic) schist
Edks Knitted (albite and garnet) schist
Edcs Chloritic schist
- Franklin Group**
Eftq Quartzite
Efts Schist
Efp Governor River Phyllite



1012

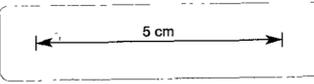
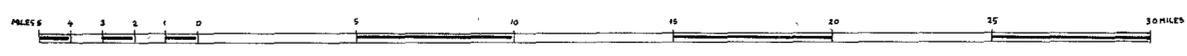
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4 = 1 m.k



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SCALE
3.94 Miles to 1 inch



SCALE 1:63,360.

OVEN CONGLOMERATE

CAMBRIAN SYSTEM

5 cm

PUNDAS GROUP

UNDIFFERENTIATED

METAMORPHIC ROCKS.

QUARTZ PORPHYRY

QUARTZ SERICITE SCHIST

PORPHYRITISED ROCK

KEMATISED ROCK

FELDSPATHISED ROCK

PYRITISED ROCK

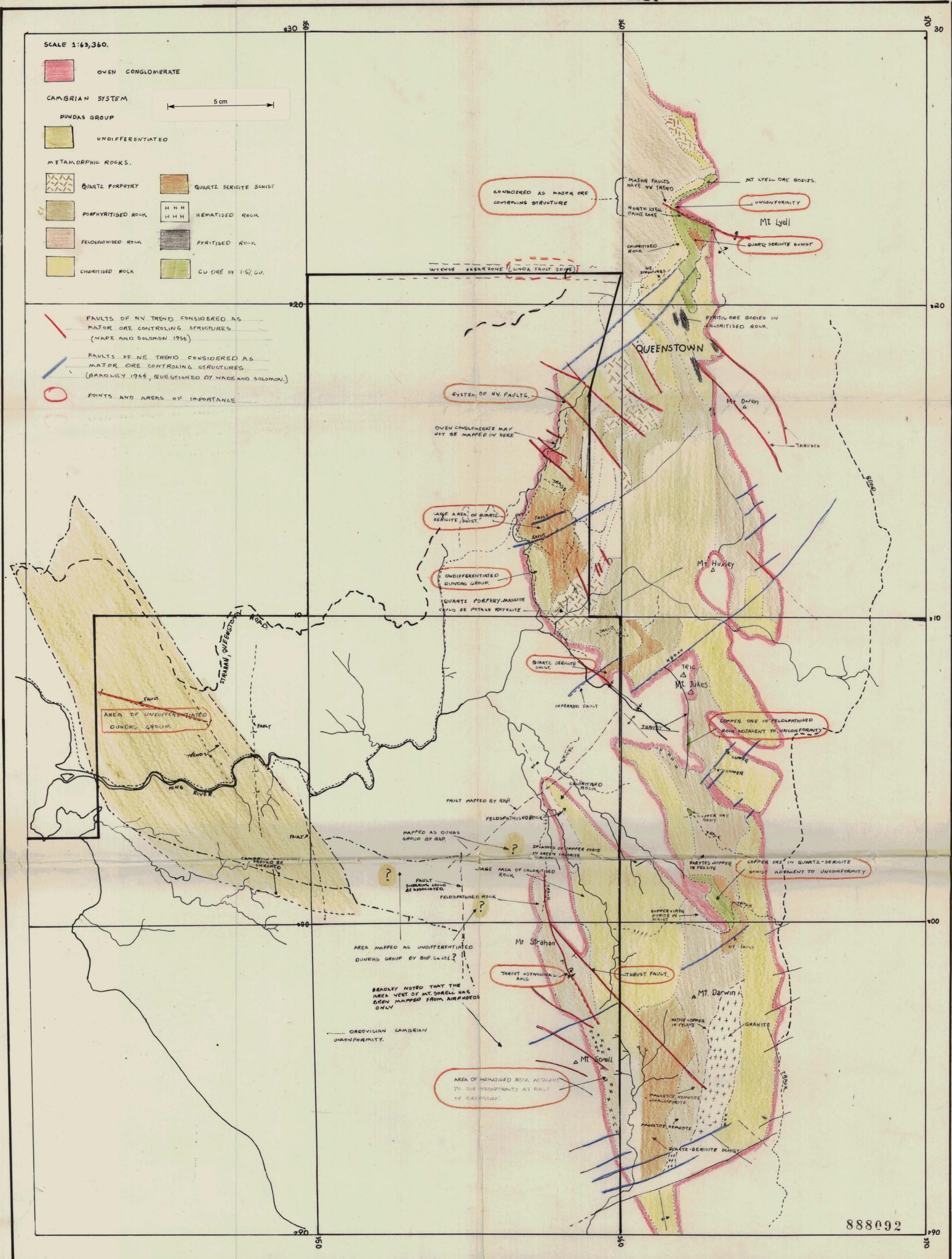
CHLORITISED ROCK

CU ORE OF 1-16% CU.

FAULTS OF NV TREND CONSIDERED AS MAJOR ORE CONTROLLING STRUCTURES (WADE AND SOLOMON 1956)

FAULTS OF NE TREND CONSIDERED AS MAJOR ORE CONTROLLING STRUCTURES (BRADLEY 1954, QUESTIONED BY WADE AND SOLOMON.)

POINTS AND AREAS OF IMPORTANCE



888092