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CAMBRO-ORDOVICIAN SEDIMENTATION

& TECTONISM IN WEST TASMANIA

AGE & CONTROL OF MINERALIZATION

& RESULTS OF THE EXPLORATION

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CAMBRO-ORDOVICIAN SEDIMENTATION & TECTONISM IN WEST TASMANIA

by B. Campana and D. King

with contributions by D. McKenna, R. R. Fraser & J. Atkinson

INTRODUCTION

The area dealt with in this article extends from the latitude of Queenstown (42° 05') to the upper reaches of Que River and Huskisson River (41°35'). It includes to the east the northern segment of the West Coast Range, between Mt. Lyell and Mt. Cripps, and it extends westerly up to the latitude of Zeehan (145°20').

In the later decades of the past century numerous mineral deposits have been discovered in this area. The more important ones, i.e. the copper ore bodies of Mt. Lyell and the lead-zinc lodes of the Rosebery zone, are still worked at present and rank among the largest producers of Australia. A more modest output of lead is also obtained from the Zeehan area, once a major mining field; and tin deposits are still exploited at Renison Bell, between Zeehan and Rosebery.

The ore bodies of these fields, together with many other deposits of less importance, are confined to Cambro-Ordovician formations which form the country rocks over large tracts of the area. In the course of three field seasons, from 1957 to 1960, these formations have been therefore geologically investigated by the writers and other geologists of Rio Tinto Australian Exploration Pty. Limited, in connection with a large exploration programme jointly financed by this Company and by Electrolytic Zinc Company of Australasia. These investigations were chiefly related to the geological control of mineralization, and included detailed mapping at a scale 4 inches = 1 mile, comprehensive stratigraphic and structural studies and palaeo-tectonic interpretations.

Certain conclusions thus reached have been epitomized in a preliminary publication (Campana et al., 1958) and discussed by various authors in subsequent notes (Hall and Cottle, 1959 ; Scott, 1959; Solomon, 1959). It was pointed out that the West Coast Range represents, in our view, an uplifted graben of Cambro-Ordovician age, the marginal faults of which controlled the emplacement of major ore bodies.

The study of the West Coast Range was followed by investiga-
tions on the general tectonic and sedimentary history of the area,
including the nature and chronological succession of the early Palaeo-
zoic movements, their relations with sedimentation and their
palaeogeographic expression.

References to these movements and to the depositional
conditions to which they gave rise have been made by Hills (1915),
Carey (1953), Carey and Banks (1954), Banks (1957), Opik (1957),
Wade and Solomon (1958), and others.   It was, however, realised,
in the course of our work that the early Palaeozoic sedimentation
of West Tasmania had to be reconsidered in the light of its tectonic
controls and palaeogeographic environments. Indeed great differences
of facies, distribution, thickness, deformation and metamorphism
of the various rock units, marked and rapid changes in stratigraphic
relationships, superimposed structural trends of various ages and an
intense volcanism are clear evidences of rapidly-changing environ-
ments in the course of a sedimentation which was largely controlled
by contemporaneous tectonism.   It was therefore appropriate to
attempt a reconstruction of the palaeotectonic and environmental
framework as a guide for more satisfactory stratigraphic correlation
and structural interpretations.

PART 1

THE MAJOR PALAEOTECTONIC ELEMENTS & THEIR LITHOLOGICAL ASSEMBLAGES

The major structural elements and related rock assemblages
distinguished in the area of our investigations are shown in Plate 1,
which has been compiled on the basis of extensive regional investiga-
tions by the geological staff of the Rio Tinto Company [1], and
includes unpublished information provided by Electrolytic Zinc
Company in Rosebery and by the Mines Department in Hobart. Numerous
invaluable data have also been obtained from the published literature,
and are referred to in the text.

Each structural element is defined on the basis of both
palaeotectonic and sedimentological characteristics - i.e. age and
type of depositional trough, characters of their infilling, vertical
and lateral relation with adjoining elements and period of folding.

(1) The following geologists took part in the regional field survey carried out by this Company - Atkinson, Brooks, Campana, Clark, Drew, Fraser, King, McKenna, Solomon.

We have thus to consider two <u>Precambrian elements</u>; i.e. the Rocky Cape Geanticline to the west and the Tyennan Geanticline to the east; two <u>Cambrian elements</u>, i.e. the Dundas Geosynclinal Trough and the Rosebery Volcanic Arc; two <u>Ordovician elements</u>, described as the Owen Graben and the Zeehan Graben; some <u>Siluro-Devonian elements</u>, formed by synclinal outliers of the Upper Devonian orogeny; and various <u>post-Devonian elements</u>, represented by sub-horizontal remnants of Permian, Jurassic and Tertiary formations, dismembered and distributed at various topographic levels by the Mesozoic and Tertiary faulting phases.

(1) THE PRECAMBRIAN ELEMENTS

The more western portion of West Tasmania is largely occupied by a major structural unit, termed <u>Rocky Cape Geanticline</u> by Carey (1953). This element is still little known, but it appears to consist in the main of highly contorted fine-grained quartzites and slates. These sediments have proved, so far, unfossiliferous, but their unconformable relations with the overlying Cambrian beds and the low degree of metamorphism point out an Upper Precambrian age.

It is inferred that the Rocky Cape Geanticline formed in Cambrian time an emerging ridge or a pronounced oceanic swell flanking the Cambrian trough (Dundas Trough) to the west (Plate VI).

Likewise, the eastern part of the area, and in particular the Sticht Range, is occupied by an elongated core of Precambrian formations - mainly quartzites, slates and schists, forming the Tyennan Geanticline of Carey.

The relations of these rocks with the younger formations, discussed in the following paragraphs, show that the <u>Tyennan Geanti-cline</u> must already have existed in Cambrian time. It certainly comprised in the course of the Upper Cambrian-Lower Ordovician, prominent chains of mountains for which the term Stichtian Chains is proposed. (Plate VI).

Between the Rocky Cape and the Tyennan Precambrian elements lies a belt of very thick Cambrian-Lower Ordovician deposits, associated with volcanic formations, which undoubtedly reflect an early Palaeozoic zone of tectonic mobility. Carey and Banks (1954) have recognised the geosynclinal characteristics of the Cambrian sedimentation of this zone - an undisputable feature which we shall attempt to more closely scrutinise in this paper. However, from the tectonic view-point, the evolution of this belt in post-Cambrian time is not quite comparable with the normal cycle of geosynclinal zones, for no geo-synclinal chain can be specifically related to the folding of this belt. Indeed, its folding was largely due to the well known Devonian orogeny, which extended over the whole of Tasmania and over large portions of the eastern land mass of Australia. The geosynclinal characteristics of the West Tasmanian Cambrian trough were confined to the subsidence and infilling stage, which ended in Upper Cambrian time, with the deposition of the Upper Dundas beds. This stage was not followed by the uplift of the belt, but by movements which were in the main vertically directed and gave rise to a system of rift valleys, rapidly filled with terrestrial deposits of Lower Ordovician age.

1. THE EARLY CAMBRIAN BASIN:

(A) The Sedimentary Successions.

A distinctively arenaceous and dolomitic succession, containing tuffaceous layers at intervals, has been observed resting unconformably upon the older Precambrian terrains at Mount Dundas (Elliston, 1954) and in the Pieman River north-west of Renison Bell (Taylor, 1954). The present investigations have revealed that comparable sequences are represented in other parts of the mapped area where numerous sections have recently been studied.

In previous field studies and attempts at correlation, the arenaceous succession in some areas, as for example west of Rosebery, has been included in the Dundas Group, of Middle to Upper Cambrian age. However, this succession always features a markedly different facies and structural pattern from the Dundas Group of the type area, and has to be considered as older.

The following previously named rock groups and newly mapped sections are regarded by us as antedating the Dundas Group of the type area -

Success Creek (Success Creek Group of Taylor, 1954)
Western flanks of Mount Dundas (Carbine Group of Elliston, 1954)
West of Rosebery (Rosebery Series of Finucane, 1932).
Bobadil Plain Section
Moores Pimple Section
West of Pinnacles
Zeehan area, in part
Sections east of the West Coast Range.

The general characteristics of these sequences are represented diagrammatically in the accompanying stratigraphic chart (Fig. 2), supported in some cases by partial chemical analyses of the dolomitic members, as shown in the table below.

TABLE I

CHEMICAL COMPOSITION OF CARBONATE ROCKS FROM THE EARLY CAMBRIAN SEQUENCES

Ref.No.	$CaCO_3$ per cent	$MgCO_3$ per cent	$FeCO_3$ per cent	Insolubles
1	45.8	30.1	12.9	12.5
2	44.4	28.2	13.9	13.5
3	22.0	12.9	16.2	47.5
4	4.0	5.9	35.1	56.8
5	25.8	18.0	32.6	27.3
6	24.9	11.2	12.9	48.7

1. Grey dolomite at base of Fuchsite Breccia-Conglomerate, Moores Pimple.

2. Grey dolomite just west of Moores Pimple.

3. Fuchsite Breccia-conglomerate west of Rosebery.

4. Grey siltstone, Bobadil Creek, north west of Rosebery.

5. Grey dolomitic rock at base of Fuchsite Breccia-conglomerate from Pieman River west of Bobadil Plain.

6. Grey siltstone from the Pieman River, west of Bobadil Plain.

(a) Success Creek Area

Taylor (1954) adopted the name Success Creek Group to describe a sequence of quartzites, slates and breccias, some 8000 feet thick, which unconformably overlie the Precambrian basement rocks in the Pieman River and tributaries, about 5 miles north west of Renison Bell township.

Two principal beds of quartzite occur, each about 1000 feet
thick, grading by rhythmic alternations into the adjacent shales.
The uppermost shales are notable for the presence of interbedded
tuffs. These formations are succeeded by varicoloured argillites
featuring a much lesser degree of lithification and deformation.

Taylor described the relations between the basal arenaceous
beds and the argillites as conformable, but on regional evidence
and in agreement with Banks (1957, p.180), we consider that an
unconformity separates these two rocks sequences.

Another section of the early Cambrian beds has been studied
along strike north-west of Renison Bell and Argent Dam. Here quartz-
ites, slates and dolomitic beds are the main members, with a subordinate
amount of volcanic material as previously reported by Ward (1909)
and Conder (1918).

Dolomites which are exposed in the alluvial tin workings
at the Stanley Reward Claims (Waterhouse, 1914) may also be early
Cambrian in age.

(b) Western Flanks of Mt. Dundas:

Elliston (1954) described a sequence of dolomitic conglomerate,
black slate and micaceous quartzite which overlies Precambrian schists
of the Davey Group, and is in turn unconformably succeeded by the
Dundas Group of the same author. He named this sequence the Carbine
Group, and reported it to be about 2000 feet thick.

The stratigraphic subdivisions proposed by Elliston are
in general accordance with the observations and conclusions of the
present writers. The suggested correlation of the Carbine Group with
the rocks of the Renison Bell mine and Conliffe Creek areas (Elliston),
and the Success Creek Group (Taylor, 1954), are soundly based on
lithology and facies, while the same may also be correct for the Mt.
Bischoff Series as suggested by Reid (1925).

The writers consider that the Carbine Group is more widely
represented at Mount Dundas and environs than indicated on Elliston's
map. It would also occur, for example, in the Moores Pimple locality
which is dealt with in detail below.

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A partial section of the Carbine Group is also to be found three miles south of Mount Dundas along Howard's timber tram and Coleman's track. The Carbine Group beds are exposed along the tram formation over a distance of about two miles westerly of the landslide near the top of Dundas Spur. The outcrops consist of an alternating suite of black, grey and pallid shale-slates, grey tuff and micaceous quartzites, bounded to the west by a sequence of Dundas Group beds and to the east by a large mass of serpentinous basic igneous rock.

Along Coleman's track, one mile north of the tram, the Carbine Group is represented by dark blue, massive dolomitic slates associated with tuffaceous grits and bedded cherts.

(c) West of Rosebery:

In the area west of Rosebery, Finucane (1932) has distinguished on lithological grounds a pre-Dundas sequence of bedded rocks which he named the "Rosebery Series." These were stated to be conformably succeeded by purple slates and breccias of the Dundas Series.

Our observations confirm Finucane's conclusions on the stratigraphic position of the beds west of Rosebery. It is however considered that the pre-Dundas succession is overturned in this locality. Evidence of this reversal has been previously described (Hall & Cottle, 1953) and confirmed by our investigations,[2] which show a major thrust movement to be responsible for the reversal (Plate V).

The succession consists of several formations which, in descending order, are named and described as follows : -

Primrose (Footwall) Pyroclastics and Slates.

This formation consists dominantly of bedded tuffs and slate, measuring 4000 feet in thickness. The uppermost member comprises cream-coloured tuffs and tuffaceous grits with four discreet but narrow intercalations of grey or black slate, and passes easterly into schists of the Rosebery mine footwall. The lowest slate horizon

(2): The same beds have been recognised at Bobadil Plain and Moores Pimple, where they dip east and are in normal position.

is rhythmically banded with pale-coloured tuff partings (Plate 1 [B]).
A reversal of dip (to westerly) occurs at this position in the Rosebery
section and is maintained throughout the underlying beds of the
succession.

The lower slate is preceded in the new Primrose road cutting
by a narrow band of conglomeratic tuff rich in carbonate veining,
and with streaks of a green mineral resembling fuchsite, followed by
a persistent band of massive felsitic rock, possibly a flow, best
seen in the road metal quarry. Next in sequence are well bedded
tuffs, with minor shale and conglomeratic bands in the Black P.A.
Mine area and felsitic lava and breccia described petrographically
by Taylor (1954). These are succeeded to the west by laminated shales
which pass by rhythmic gradation into the quartzite formation described
below.

Stitt Quartzite

The Primrose pyroclastics and slates grade below into
white and grey gritty quartzites, which in the Stitt River section
are 1800 feet thick. The formation consists principally of a clean,
white quartzite with a pronounced saccharoidal texture, in places
exhibiting current bedding and ripple marks (Plate 1 [a]). Narrow
partings of grey shale and black carbonaceous shale are prevalent
in the uppermost levels and gradations to greenish tuffaceous quartz-
ite or greywacke occur both above and at the base. The quartzite
formation is regionally persistent and forms an important marker level.

Natone Volcanics

A white to cream coloured volcanic formation occurs below
the Stitt Quartzite in the vicinity of Natone Creek, being well ex-
posed over a width of about 400 feet in a cutting along the Emu Bay
Railway. Finucane (1932) and Taylor (1954), have described the
rhyolitic composition of this formation, Taylor's conclusions being
supported by petrographic descriptions. The rock is similar in com-
position and texture to the tuffaceous grits found higher in the
sequence easterly of Primrose, and is considered to be sedimentary,
not intrusive as proposed by Finucane.

Fuchsite Breccia-Conglomerate. This formation, which outcrops near Natone Creek, has been well described by previous workers, particularly by Finucane (1932). It consists of a poorly sorted accumulation of fragments and pebbles, chiefly vari-coloured cherts, and also some quartzite and slate pebbles similar to underlying beds. The matrix consists of detrital grains of quartz and felspar, fragments of chert, and occasional grains of zircon, tourmaline, rutile and muscovite. The detrital grains are set in a cement of carbonate, sericite, chlorite, quartz and pyrite. In places fuchsite (chrome-bearing mica) occurs freely in discreet masses which are usually elongated in shape.

A noteworthy feature of the formation here, and in other localities to be described, is the presence of sporadic grains of sulphides in the matrix, including pyrite, chalcopyrite, galena and molybdenite. A small percentage of tin is also reported to be present (Taylor 1954.)

Westcott Dolomitic Beds

A succession of purple slates and dolomitic siltstones almost 300 feet thick occurs to the west of the fuchsite breccia-conglomerate. They are mostly covered by alluvium in the Pieman River and in cuttings along the line of section, but are well exposed on the old Zeehan track and along the eastern slopes of Westcott Hill (Finucane, 1932).

Munro Creek Slates and Quartzites

The lowest exposed beds of the Rosebery Group are to be found on the ridge east of Munro Creek, just beyond the eastern boundary of the Rosebery golf links. These are alternating grey slates, black graphitic slates (10% carbon by assay) and thin quartzite members resembling in lithology the Stitt Quartzite. In the Pieman River gorge the beds are bounded to the west by argillites which are correlated with the younger Crimson Creek Group.

(d) Bobadil Plain

The formations described above are also partially exposed in the banks of the Pieman River, three miles north-north-east of Rosebery, near the Bobadil Plain. The sequence here can be readily correlated with the Rosebery section for no variation of strike occurs within this interval and the more typical formations of the sequence, i.e. the Fuchsite Conglomerate and the Stitt Quartzite, are present.

A thickness of about 1,000 feet of rhythmically banded light and dark grey shale with some fine grained tuffaceous partings is found beneath the Stitt Quartzite. Graded bedding and small cut and fill structures indicate that the prevailing easterly dip is normal. At least two conglomeratic shale bands are present, each 10 feet wide, with rounded and sub-angular pebbles of chert up to one inch in size embedded in a dark greenish grey argillaceous matrix.

These beds are well exposed in the Emu Bay Railway cuttings and in the Pieman River gorge. They have also been recognised two miles farther north at Holloway Rivulet near its confluence with the Marionoak River. Narrow dolomitic bands and small intraformational lenses of dolomite occur in the lower shale horizons.

The Volcanics of Natone Creek have not been recognised in the Bobadil Plain section.

The Fuchsite Breccia-conglomerate is represented over a width of 60 feet, being coarser than that of Natone Creek but otherwise identical. Argillaceous pebbles with a coat of grey chert were noted within the conglomerate, and dolomitic bands are present containing scattered grains of chalcopyrite. The upper limit of the formation is marked by a pyritic quartz fissure lode about 10 feet wide.

The Westcott Dolomitic Beds, about 800 feet in thickness, consist of well bedded purple shales and subordinate pale grey dolomitic siltstones, underlying the Fuchsite Breccia-conglomerate. Minor intraformational structures, including unconformities, brecciation, cut and fill and slumping, are a feature of this formation. These are underlain by black slates and quartzite bands as at Munro Creek, with a narrow conglomeratic shale bed near the top containing chert and quartzite pebbles.

(e) Moores Pimple

An orderly sequence of conglomerates, slates, quartzites and volcanics has been mapped by us in the vicinity of Moores Pimple and White Spur, south-west of the Hercules Mine. The facies, order of succession and structural disposition of this sequence are the same as west of Rosebery. We therefore differ from Elliston (1954) who ranged these beds in the Dundas Group, although he admits that a "rigorous correlation was not obtained" with the type section of the Dundas Group.

The upper portion of the section given hereunder is well exposed along the headwaters of White Spur Creek, from one to three miles south-east of Moores Pimple, and the lower part along the Hercules to Comet pack-track in the vicinity of Moores Pimple. Throughout the section the bedding mostly dips steeply to the east and is considered to be normal, but reversals occur near the shear zone which divides the upper members of the group from the massive volcanic group.

The Primrose Pyroclastics and slates are represented here by a sequence which reaches 4,800 feet in thickness. It extends westerly up White Spur Creek from the shear zone half a mile west of Dobson Creek to the saddle just east of Moores Pimple, and comprises an alternation of black and grey pyritic slates, greenish felsitic lavas and indurated tuffs in bands up to 300 feet wide, with minor intercalations of agglomerate, coarse tuff,

gritty tuffaceous quartzite and chert. These are under-
lain by a thicker bed (approx. 800 feet) of dark grey to
dark bluish laminated slate. The same rocks are to be
seen in places along the pack-track to Hercules on White
Spur, but the slatey members do not all outcrop on the
higher ground.

One of the coarse tuff members is described in
thin section as "a crystal tuff in which light grey mineral
.rystals are embedded in a fine grained, dark grey matrix.
It is largely composed of 2 - 3 mm. corroded crystals of
kaolinised orthoclase and plagioclase which contain in-
clusions of pyrrhotite. Quartz is clear and of irregular
or embayed form and constitutes some 15 per cent of tuf-
faceous fragments.

The matrix which cements these grains is ex-
tremely fine grained comminuted quartzo-felspathic material
mingled with clay and calcite. It contains disseminated
granular pyrrhotite."

The alternation of slate and volcanic members is
shown to scale in Fig. 2.

The Stitt Quartzite is represented by a grey
impure micaceous quartzite, tuffaceous quartzite and grey-
wacke, grading below into white saccharoidal quartzite,
aggregating about 600' in thickness.

The Natone Volcanics, are represented in this
area by grey porphyroidal fragmental volcanics.

The Fuchsite Breccia-conglomerate occurs as a
coarse and poorly sorted breccia-conglomerate which reaches
300' in thickness and is essentially composed of grey, red
and green chert and quartzite pebbles up to one inch in
diameter embedded in a matrix of mainly fragmental chert
and in places of dolomite. It is exposed on the ridge one
quarter mile east of Moores Pimple. A soft green mineral
resembling fuchsite is present within the conglomerate and
also occurs in exceptionally large masses at the same
stratigraphic level half a mile north of the pack-track,

previously mapped by Reid (1925) and Elliston (1954) as
serpentine.

In thin section this breccia-conglomerate is
seen to contain "rounded ovoidal or flattened rock fragments
up to 1.5 mm. in size which lie at random orientation in a
finer grained matrix."

The pebbles consist of fragments of various rock
types which include very fine grained quartzite, sericitic
quartzite, slate and crystalline felspathic base of volcanic
rock.

The matrix of finer components includes abundant
quartz, felspar and sericite with chlorite and haematite.

The rock is derived by erosion from an essentially
sedimentary rock terrain, but the presence of occasional
portions of volcanic rock indicates the existence of earlier
intercalated volcanics."

Dallwitz (1946) in an unpublished report to the
E.Z. Coy., was the first to suggest that the Mocares Pimple
breccia-conglomerate may be the same as the one found in
Natone Creek west of Rosebery. His inference has been
substantiated by our mapping work.

The Westcott Dolomitic Beds are represented by
sediments lying beneath the breccia-conglomerate which
have recently been mapped by Government geologists
A.H. Blissett and A.B. Gulline. They report (personal
communication) that "these sediments mainly comprise pale
greenish grey dolomitic (?) purple slates and siltstones,
grey dolomitic quartzites, cherts, greywacke and dark grey
limestone with interbedded black shales, resting upon quartz
schists and quartzites probably belonging to the Davey Group".

(f) Higgins Creek

A cross-section of the sediments lying to the
west of the volcanic rocks at Pinnacles was mapped in
Higgins Creek by M. Solomon in 1959 while in the employ
of the Rio Tinto Company. Proceeding westerly from the
edge of the button grass plain which marks approximately

the faulted boundary of the massive volcanic rocks, he
records an easterly dipping succession of quartzites,
slates, tuffs and conglomerates.   These dip consistently
to the east and are described by Solomon in order of
occurrence (and descending stratigraphic order) as follows:-

Grey quartzite, crudely bedded, with subordinate
purplish sandy shale, underlain by thinly bedded micaceous
sandstones (1,000 feet).

Bedded, grey ndurated shales, with some sandy
beds, and alternating shaley and sandy tuffs. Bands of
agglomerate (or conglomerate?) up to 10 feet wide and con-
taining angular and sub-angular pebbles of quartz, jasper,
quartzite, porphyry and shale, occur within shale and tuff
(1,000 feet). Brownish coloured slate-shales, purple
shales and tuffs (500 feet).

Fine grained agglomerate bed, succeeded down-
stream by brown slates, coarse pink-brown pebbly agglomerate,
and merging into a thick breccia conglomerate composed
largely of rounded and angular fragments of quartz, quart-
zite and jasper.   The pebbles measure up to 3 inches in
diameter and the matrix is composed essentially of angular
material (500 feet.)

Bedded purple shales with minor sandy shales,
tuffs and dark grey tuffaceous sandstone (1,400 feet.)

(g) Zeehan Area

A sequence of quartzites, slates and volcanics
which occurs in two of the principal mining   areas of
the Zeehan field may be regarded on facies and structural
evidences as early Cambrian in age.   These include the
Nubeena Quartzites, Montana Malaphyre Volcanics, Oonah
Quartzites, and associated slates.   According to Hills
and Carey (1949), these formations are within an "Upper
Proterozoic to Cambrian?" group (Pieman Group) which lies
unconformably above the Davey Group and unconformably be-
low the Junee Group.   In a later unpublished work, Carey
et al recognised that the Oonah Quartzites and associated

quartzites and slates underlie the fossiliferous Dundas
Group and suggested that they are correlates of the Carbine
Group.   We have independently reached the same conclusion.

The most extensive exposure of this group of
rocks is immediately north of Zeehan township, embracing
Queen Hill, Oonah Hill and the Montana Western Mine Leases,
where they comprise well bedded quartzites (Oonah Quartzites),
talcose quartzites, spilitic lavas (Montana Melaphyre
Volcanics), grey to black slates, and tuffs and breccias
found in the mine workings (Twelvetrees and Ward, 1910).
At Oonah Hill, they succeed stressed slates and quart-
zites of the Davey Group with apparent unconformity.   Four
miles northerly of Zeehan, they are overlain by argillites
which are correlated elsewhere in this report with a
Cambrian upper sequence.

Similar quartzites (Nubeena Quartzites) and
slates outcrop in the NubeenaHills, south-westerly of
Zeehan, where they form the host rocks of the Spray Lodes.
The occurrence forms an inlier surrounded by a less de-
formed and discordant bedded succession to be correlated
with the fossiliferous beds of the Dundas Group.

In both areas of outcrop, the quartzitic suc-
cession is intensely contorted and faulted, so that no
reliable subdivisions or stratigraphic relationship could
be established.   The thickness of the successions re-
presented at Zeehan has, therefore, not been determined.
It has been estimated to reach locally 2,000 feet (Fig. 2).

(h) East of the West Coast Range

The eastern boundary of the West Coast Range
formations (Owen Graben) is defined in most places by the
contact of the Cambro-Ordovician rocks with highly con-
torted quartzites and mica schists of the Sticht Range.
The metamorphic quartzites of the Sticht Range have been
correlated by Banks (1956) with the Carbine Group of Mount
Dundas (Elliston, 1954), but in our view they resemble
more closely the Pre-cambrian Davey Group rocks.   Like the

Davey Group, they show a dominantly siliceous composition, an abnormally high metamorphic grade and the characteristically stunted vegetation cover.

In the section exposed along the Quinn River east of Mount Murchison, the quartzites of the Sticht Range are locally overlain with apparent unconformity by a succession of crenulated dark blue slate, graphitic slates and quartzites, totalling about 1,000 feet in thickness which are tentatively regarded as early Cambrian in age.   This also applies to the narrow zone of chloritic argillites and interbedded quartzite and limestone which dip off the Sticht Range north-east of Lake Dora and which are succeeded to the west by the Cambro-Ordovician formations.

B.   Age and Correlations

The age of the preceeding sequences is believed by the present writers to be early Cambrian, for they are succeeded by fossiliferous beds of Upper Middle Cambrian to Upper Cambrian in age.   Furthermore, they are characterized in places by volcanic members which increase in frequency upwards, and would mark an early stage of the widespread volcanism which has been dated as Lower to Middle Cambrian in Victoria (Thomas and Singleton, 1957).   In West Tasmania, this epoch of volcanism is in our view represented by the assemblage of the Rosebery Volcanic Arc. A gradation from the basal sequence to the Rosebery Volcanics is observable west of Rosebery, as shown in Fig. 1.

The arenaceous early Cambrian sequences would include part of the quartzite-slate sequence defined as the Pieman Group by Hills and Carey (1949) which they describe as lying unconformably above the Davey Group and unconformably below the Junee Group, and is regarded by them as Upper Proterozoic to (?) Cambrian in age.   The similar sequence at Mount Dundas, named the Carbine Group by Elliston (1954), is considered by him to be "late Precambrian extending possibly into the Lower Cambrian",

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while the quartzite-slate suite of the Success Creek Group
(Taylor, 1954) is "presumed to be of Middle-Lower to Lower-
Lower Cambrian in age."

Thus, although no fossils are known to have been
found within the arenaceous-dolomitic beds, we have independ-
ently reached the conclusion that they chiefly represent
early Cambrian deposits.

2. THE ROSEBERY VOLCANIC ARC

A belt of volcanic and hypabyssal rocks which
flanks the Pre-cambrian formations of the Tyennan Geanti-
cline from the latitude of Macquarie Harbour to the
latitude of Bulgobac, beyond which these rocks are covered
by the sub-horizontal basaltic sheet of Waratah. They
reappear, however, in similar geological position further
afield in the Moina-Sheffield-Doloraine area, where iso-
lated bodies of keratophyres outline the arcuated dis-
position of the volcanic belt around the Pre-cambrian
geanticline. This belt is named, for the purpose of this
article, the Rosebery Volcanic Arc as it is in the Rosebery-
Tullah area that it shows its more typical and thicker
rock succession. We shall, on the other hand, refer to
this succession as the Rosebery Volcanics, whose distribution
roughly corresponds to the "porphyroids belt" of early
investigators.

(A) The Rock Assemblage - The Rosebery Volcanics

The Rosebery Volcanics, which consist in the
main of massive pyroclastic deposits and acid to inter-
mediate lavas, have been petrologically investigated by
several authors in the course of the last fifty years.

The early authors, and in particular Twelvetrees
and Petterd (1899), Ward (1908) and Hills (1915) have clearly
recognised the volcanic origin of these formations. At a
later date different views have been advanced. For Finucane
(1932) the acid igneous members of the suite are intrusive;
for Scott (1954) they would represent albitised and silici-
fied basaltic bodies; for Bradley (1954) they would derive

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in part from silicified and felspathised sediments. At
present, however, the extrusive and pyroclastic origin of
most of these rocks is generally accepted (Hall and Cottle,
1953), Carey (1947), Banks (1957), Wade and Solomon (1958),
Campana et. al. (1958).

In the Rosebery-Mt. Murchison area, the volcanic
suite consists of thick lava flows and pyroclastic deposits
reaching several thousands of feet in thickness.

(a) The flows

These are composed in the main of keratophyres,
rhyolites, quartz porphyries and felspar porphyries, the
latter grading locally into hypabyssal bodies of granitic
appearance.

These rocks are frequently metamorphosed and
show in places a strong schistosity and a greenish
coloration due to development of chlorite. Their
petrological characters and relations are thus obscured
over large portions of the area; but under the microscope
the origin of these rocks have been established, first by
Rosenbusch and Twelvetrees (1899), and by several other
petrologists at a later date.

The suite is well exposed along the Emu Bay
Railway north of Bulgobac, where quartz-felspar porphyries
are the predominant rock type. Quartz porphyries and
keratophyres form bold outcrops at Red Hill, Lake Dora and
west of Mt. Tyndall where they contain in places magnetite,
hematite and copper sulphides.

Under the microscope the quartz-felspar porphyries
are seen to consist of grains of quartz, orthoclase and acid
plagioclase up to 5 mm. in size, scattered through a base
of fine quartzo-felspathic grains of 0.05 mm. diameter.
The quartz phenocrysts show a few crystal edges, but are
mostly irregular in form; those of felspars are commonly
euhedral. A significant feature of the rock texture is
that, although the fine groundmass is evenly granular, a
great reduction in grain size occurs locally round the

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periphery of all large quartz and many of the large felspar grains. Thus each large quartz is encased in a rim some 0.1 mm. thick of extremely fine quartzo-felspathic material less than 5 microns in grain size. Moreover, throughout the granular groundmass are circular areas of about 0.2 mm. in diameter composed of this same ultrafine aggregate .

Evidences of the emplacement of the porphyries as flows have been found by Carey (1947) in the Farrell tramway, where "a clear exposure of the contact of two flows separated by a thin tuffaceous sandstone can be seen."

At a regional scale the emplacement of these igneous elements as flows is chiefly evinced by pyroclastics and slates which show over long distances concordant relations with the porphyry bodies and are therefore interpreted as inter-flow sedimentary intercalations (Plate V).

(b) The Sedimentary (and pyroclastic) Members

These consist of slates locally associated with well bedded tuffs and of massive pyroclastics.

The slates are grey, blue or dark in colour, often pyritic and well laminated and vary in thickness from a few feet to hundreds of feet. They no doubt represent terrigenous deposits under subaqueous conditions.

The more continuous bands occur northerly of the Pieman-Murchison River, where a mineralised band - known in the local literature as the Farrell Slates - has been recognised over 20 miles, from Sterling Valley to the junction of the Mackintosh River with the Southwell River.

Another persistent band has been traced by D. McKenna from Bulgobac Creek through the Upper branch of the Que River to the basaltic plateau west of Mt. Cripps.

South of the Pieman-Murchison River, slaty members occur near the base of the volcanic succession at Rosebery and south of Williamsford, where they form the host rocks of important Pb-Zn ore bodies (Hall & Cottle 1953).

These isolated occurrences would represent the same hori-
zon, disrupted however by a large transcurrent fault
causing a horizontal displacement of no less than 3 miles
(Plate V).

Another conspicuous and slightly mineralised
band of pyritic slates occurs south of Red Hill, between
Gooseneck and the Owen Conglomerate spur to the east.
On structural evidence it would appear that this band is
to be correlated with the Rosebery and Hercules slaty
horizon (Plate V).

The stratigraphic relations between various
slaty occurrences is not fully elucidated due to the dis-
continuity of outcrops, intervening faults, and lack of
reliable marker beds within the volcanic formations. The
Rosebery-Hercules-Gooseneck slates occur near the base of
the volcanic assemblage. They dip easterly at Rosebery
and Hercules, and vary in dip from easterly to westerly at
Gooseneck. The Farrell Slates, which dip westerly, may
well represent the same horizon in the eastern limb of
a suggested synclinal structure (Hall and Cottle, 1953),
which has been dismembered by large scale faulting. On
the other hand, D. McKenna suggests that the Mt. Farrell
Slates would join, west of Mt. Cripps, the Gold Hill-Balgobac
slaty band in anticlinal disposition (Fig. 3). If this is
correct the anticline has to be envisaged as overturned to
the east.

The pyroclastic members form the larger proportion
of the Rosebery Volcanics. As a rule they are unbedded,
dense, grey, pale green or dark in colour, stressed and
schistose. Coarse volcanic breccias, with fragments of
lava up to a few inches across, have been described by
Carey (1947) in the Farrell Junction area, and a rhyolite
breccia with flow structure in the fragment has been noted
by the same author between Boco and Farrell Junction. Tuffs
and ashbeds are also common. In places, as for example
west of Red Hill, fragments of keratophyre 12 inches across
are embedded in a tuffaceous matrix.

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Clear examples of "volcanic balls" have been observed by us on the western slope of Mt. Read and west of Farm Creek, between Farrell Siding and Tullah, where they are associated with the volcanic breccias noted by Carey (loc. cit.)

In some localities, and especially in the Mt. Read area, the ashbeds are well laminated and cross-bedded. A specimen collected in this area is seen under the microscope to consist of an extremely fine grained siliceous material, with a few crystals and rock fragments, and may be regarded as a lithic tuff. The crystals are of quartz, orthoclase and plagioclase. The rock fragments are very ragged in shape and consist of very fine grained quartz aggregates.

Another specimen of the same rock suite is a crystal tuff, largely composed of corroded crystals of kaolinised orthoclase and plagioclase, with inclusions and pyrrhotite. The matrix which cements these grains is extremely fine grained comminuted quartzo-felspathic material mingled with clay and calcite.

Common types of rhyolitic tuffs have also been found. A specimen from the Murchison River gorge consists of fine dust-like particles of quartz, felspar and clay with disseminated highly decomposed micaceous material and occasional magnetite. Irregularly shaped or euhedral crystals of quartz and felspar up to 3 mm across are scattered at random through this dust-like matrix. The composition is that of a rhyolite and the structure is typically pyroclastic.

From these various lines of evidence, and on the basis of detailed mapping, it appears that the bulk of the Rosebery Volcanics are pyroclastic rocks ranging from coarse volcanic breccias to extremely fine grained ashbeds.

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(c) <u>The Metamorphic Derivatives</u>

In contrast with the sediments of the Dundas Group, which are virtually unaltered, the Rosebery Volcanics are frequently stressed and brecciated, and in places dynamometamorphism has been so intense as to give rise to wide zones of tectonic schists. These have been described in the Mt. Lyell area as the Mt. Lyell Schists. There they comprise quartz-sericite schists, chloritic schists and hematitic-chloritic schists, considered to be derived from pyroclastic and porphyritic rocks, along the Great Lyell Shear (Gregory, 1905; Alexander, 1953; and others).

Schisted volcanics are found again westerly of Red Hills, in the footwall sequence of the Hercules and Rosebery Mines, and at intervals along a fault zone which has been mapped as far as Silver Falls, 11 miles north of Rosebery. As at Mt. Lyell the schists of these areas are quartzitic and chloritic and occur, as a rule, in intimate association with volcanic formations - massive pyroclastics, tuffs, porphyries, keratophyres - from which they usually derive. It has been pointed out in a previous publication (Campana et. al., 1958) that the Mt. Lyell Schists are equivalent to those of the Read Hill-Hercules Mine-Rosebery-Silver Falls Zone, for they mark in each case a major fault zone, described at Mt. Lyell as the Great Lyell Shear and named by us, with a more general and genetic connotation, Owen Rift Fault, of Cambro-Ordovician age.

(B) <u>Stratigraphic Position of the Rosebery Volcanics</u>

As the Rosebery Volcanics have proved so far unfossiliferous, it is only from their relations with the overlying and the underlying sediments that their age can be inferred.

<u>The Underlying sediments</u> are represented by members of an early Cambrian sequence already described (Figs. 1, 2 and 3). These members include the quartzites, tuffs, slates and conglomerates of the Rosebery-Moores

Pimple area, which are seen north of Rosebery dipping in
normal position beneath the Rosebery Volcanics.   Although
an important zone of shearing obscures the stratigraphic
relations, the Cambrian basal sediments are clearly over-
lain by the Volcanics.   The Volcanics are therefore con-
sidered by us to post date the early Cambrian beds.

The overlying sediments are in some areas Middle
to Upper Cambrian (Dundas Group), while in other areas are
Ordovician in age (Fig. 2).

The Middle Cambrian-Upper Cambrian sediments
which occur north of the Pieman-Mackintosh River rest on
porphyries of the Rosebery Volcanics with an angular un-
conformity.   As shown above, the contact points out a
marine transgression taking place on an eroded land surface,
the erosion period being evinced by the presence of porphyry
pebbles at the base of the sedimentary succession.   The
Rosebery Volcanics were thus forming a low land on which
the Middle-Upper Cambrian sea advanced.   However, part of
this land remained emergent throughout the whole Middle-
Upper Cambrian time, for, south of the Pieman-Mackintosh
River the Ordovician beds of the Jukes Breccia-Owen Con-
glomerate rest directly on the Rosebery Volcanics.

This is particularly noticeable in the Mt.
Murchison-Red Hill area, where a high angle unconformity
separating the volcanic assemblage from the Jukes Breccia-
Owen Conglomerate-succession is admirably exposed (Plate VI,
top sections).

The Rosebery Volcanics would thus post-date the
deposition of the Cambrian basal sequence, and pre-date
the conglomerate-greywacke suite of the Dundas Group.
While this suite was deposited, the Rosebery Volcanics,
already folded and uplifted, formed for the greater part
an emergent land supplying felspathic material to the
adjacent Dundas trough.   The age of the Volcanics is thus
regarded as Lower to Middle Cambrian.   (Campana, King and
McKenna, 1960).

5. THE DUNDAS TROUGH

The arenaceous-dolomitic beds described above are unconformably overlain by vari-coloured argillites, shales, cherts, slates, greywacke, greywacke conglomerates and possibly tuffaceous layers, which form the Dundas Group sensu stricto (Fig. 2).

The Dundas Group occupy what is named, for the purpose of this paper, the Dundas Trough. This Trough would have reached at least 25 miles in width at the latitude of Rosebery, extending to the south beyond Elliott Bay, on the 43° parallel where the Cambrian sediments are truncated by the sea. North of Rosebery, it would have reached the 41° parallel near Penguin, to continue in a south-east direction up to Deloraine and beyond.

The Dundas Trough has thus to be visualised as an arcuate and narrow eugeosynclinal trench developed along the Rosebery Volcanic Arc. Subject to prolonged subsidence phenomena, nourished at intervals by a powerful greywacke sedimentation associated with igneous basic activity, the Dundas Trough can be compared with the present marginal troughs of some island-arc areas. In geological times, similar bathymetric and sedimentary conditions would have controlled the deposition of the typically geosynclinal sequences of the Flysch, with which the infilling of the Dundas Trough show indeed remarkable affinities.

(A) The Sedimentary Successions

The more recent stratigraphic investigations in West Tasmania, and in particular the work of Taylor (1954), Elliston (1954), Bank (1957), have shed a great deal of light on the complex succession of the Dundas Trough, almost entirely confined to trackless and densely timbered areas. It has been our aim, in the course of field work using helicopter transport, to complete previous studies by investigating the more remote areas, to obtain uninterrupted sections, observe lateral and vertical variations, and attempt a stratigraphic-palaeogeographic synthesis of these very important terrains.

The term Dundas Group has been widely used by earlier investigators to designate various rock units of Cambrian age occurring in West Tasmania.   A historical review of its formations is found in Bank   work (1957). However, certain sequences previously included in the Dundas Group are considered by us as different units, for a distinct unconformity separates them from the Dundas succession of the type area or from the beds which, on palaeontological and stratigraphic ground, have to be correlated with the type section.   In particular we were le   to range   formations in an older sedimentary group, as shown above, and to range some others in the succession of the Rosebery Volcanic Arc, already described (Plates V and VI).

The Dundas sequence begins with marked argillaceous sediments passing upward into a greywacke suite and ending with gritty and conglomeratic deposits.

(a) The Argillites Sequence

The argillaceous facies of the Dundas sedimentation is typified by the succession studied by Taylor (1954) along the Pieman River and Crimson Creek.   This succession would reach 12,000 feet in thickness and comprises a thick suite of purple and greenish argillites, mudstones, black pyritic shales, cherts and tuffaceous layers, which overlie the arenaceous basal sequence described above.   The argillites are overlain in the Huskisson River basin by slates, conglomerates, minor volcanics and grits which he demonstrates by lithology and fossil evidence to be correlates of the Dundas Group of the type area.

The present authors have distinguished a comparable suite lying at the same stratigraphic level in many places between Zeehan and Rosebery.   A feature common to all the outcrops examined is that the argillite beds are distinctly less indurated and less deformed than the quartzites and slates of the early Cambrian Sequences.

Investigations in the area between Tunnel Hill
and Renison Bell would show that an angular unconformity
exists between the argillites and the early Cambrian beds.
In numerous exposures in this area, the contact is always
sharply defined, commonly faulted, but never conformable.
Outliers of the argillite beds have been mapped near Argent
Dam resting and apparently transgressing upon the early
Cambrian quartzites and slates.

Four miles northerly of Zeehan, in the vicinity of
the old Dunkley tram line, the black slate and quartzite
assemblage of the Montana and Western mining area is over-
lain by red and amber shales and tuffs which are correlated
with the argillite succession. The nature of the contact
is obscured by swamp land, but a marked contrast exists
between the well bedded, red coloured argillites and the
black and grey highly contorted sheared rocks of the early
Cambrian beds.

The argillite sequence of the Pieman-Huskisson
River area has proved so far unfossiliferous. It is con-
formably overlain by beds containing Upper Cambrian trilo-
bites (Glyptagnostus reticulatus Zone) and Opik (personal
communication, 1959) considered that it largely represents
a lateral facies of the fossiliferous beds of the Dundas
Group, beginning with the Ptychagnostus gibbus Zone of
Middle Cambrian age. The argillite sequence is therefore
considered as a formation of the Dundas Group, although we
believe that it antedates, in part at least, the Ptychag-
nostus Zone. On the whole it appears to reflect the
early stage of a geosynclinal infilling, much similar in
facies and vertical development to the Flysch series.

(b) The greywacke-conglomerate sequence

This sequence consists of slates, greywacke
(and sub-greywacke), felspathic grits, breccias, con-
glomerates, pseudo-tillite and possibly subordinate
tuffaceous beds.

The assemblage includes the formations described by Elliston (1954) at Dundas township, by Taylor (1954) in the Huskisson River, and a previously undescribed rock succession, which occurs along the lower reaches of the Que River. The distinctive lithology of the sequence as exposed in the Que River enables a close equation of this section with the Huskisson section. Additional observations have also been made at Dundas, and these, coupled with a slightly different interpretation of Elliston's rock types, have enabled us to correlate the three widely separated successions. The Zeehan area contains some rocks of the Cambrian Upper sequence, and the boundaries of this western occurrence have also been defined (Plate V).

Dundas Area

The greywacke-conglomeratic sequence of the Dundas Group near Dundas township has been re-studied by us in an attempt to determine the relations with the underlying and overlying formations and to elucidate the depositional environments.

The more conspicuous formation near the base of the Dundas Group is, in this area, the Razorback Conglomerate, which we have traced along its westerly strike to a point where it terminates approximately 3/4 mile west of the main Zeehan-Rosebery road on a cross fault which places it in contact with the Crimson Creek argillite sequence. This strikes in a northerly direction, and the difference between the regional strikes of the argillites and the Razorback Conglomerate may mark a local unconformity.

The top of the Dundas Group is, in this area, the Misery Conglomerate. As one approaches the crest of Mt. Misery the siliceous pebbles in the conglomerate become more abundant, and the argillaceous or greywacke matrix becomes more sandy. The rock type above the Mt. Misery conglomerate consists of a coarse and ill-sorted assemblage of quartzite pebbles and boulders, set in a sandy a quartz-

We therefore, believe that the top most beds of the Dundas
Group are transitional in this area into Owen Conglomerate,
described below as a continental deposit.

These features indicate in our view, that parts
at least of the Mt. Misery Conglomerate layers are fluviatile
in origin.   They would evince the latest infilling stage
of the Dundas Trough, when the marine Flysch-like sedimenta-
tion was gradually replaced by a continental Molassic de-
position - a veiw well substantiated by the extreme lenti-
cular character of the Mt. Misery Conglomerate, whose
thickness decreases from over 2,000 feet to some three
hundred feet within 2 miles.

The formations underlying the Mt. Misery Conglo-
merate are marine and consist mainly of greywacke conglomerates,
greywacke, mudstones, green, brown and purple shales or slates,
with shaly pebble beds at various levels and possibly tuff
layers.   Their lithological and pal ontological character-
istics have been described by various authors (Ward, 1909;
Thomas and Henderson, 1945; Elliston, 1954) so that it will
suffice to indicate here our conclusions on some controversial
questions.

Some conglomerates and pebble beds have been
considered of glacial origin, in particular by Elliston
(loc. cit.), who attempted to correlate them with the
Zeehan Tillite.   However, this formation has been proved
to be Permian in age (Campana and King, 1958) and the
conglomeratic layers of the Dundas succession have little
in common with typical glacial formations.   Pebble beds
such as those found in the Dundas Group are a feature of
the Flysch type successions, and have been variously des-
cribed as pseudo- illites, tilloids, pebbly mudstones, etc.
They occur at many levels in the lpine Flysch series, where
they have been studied by one of us.   Thus we have reached
the conclusion that no glacial members are present in the
pre-Permian terrains of the area.

Pyroclastic rocks, and particularly tuff layers
have been described at several levels of the Dundas Group.
In agreement with Banks (1957 p.172), we consider that many
of these layers should be regarded as greywacke or sub-
greywacke beds.

Felsitic or porphyritic lava pebbles, which are
petrologically identical to the effusive members of the
Rosebery Volcanic Arc, have been observed within the
Razorback Conglomerate, being particularly common just west
of the point where this formation crosses the Rosebery road.
These pebbles, and the abundance of felspathic detritus
within the greywacke assemblage, would show that the Dundas
Group formations post-date the emplacement of the Rosebery
Volcanics, as discussed below.

Que River-Huskisson River Area

A sedimentary sequence along the lower reaches
of the Que river is folded into a syncline (Que Syncline),
the axis of which strikes and plunges north east.   The
nose of the structure is a little north of Pinnacles Mine.

The lowest member of the east limb rests un-
conformably on the porphyritic rocks of the Rosebery
Volcanic Arc.   The unconformable nature of the contact
was determined in a railway cutting on the Emu Bay Railway
line approximately one and a half miles north of Bulgobac
siding.   Here the porphyritic rocks appear truncated by
an old erosion surface on which rests a bedded slaty
sequence which locally begins with layers of porphyritic
pebbles and meets the surface at a low angle.   Further
north, near the Que River crossing of the Emu Bay Railway,
the same surface is evinced by gritty sediments containing
sub-angular fragments of the older porphyry.

The type section of the bedded rocks is exposed
along the Que River from near its junction with Bulgobac
Creek, towards the Huskisson River.   The succession is
difficult to subdivide because of the paucity of distinctive
horizons and the sparse evidence of fossils.

However, the following sections were recognised by D. McKenna,
who carried out the investigations in this area.

East Limb of the Que Syncline

(1E) The basal bed is a black, well-bedded slate, thinly
laminated, and rests with low angle unconformity on the
older porphyries. This horizon is the only black slate
along the Que River. The thickness is 490'.

(2E) Thinly bedded, brittle, blue and green slates and
quartzites overlie the basal member. They are exposed
over a   of 680'.

(3E) Alternating blue slates, cherts and fine grained tuffs
or greywacke-type silts and grits. The greywacke members
are in part felspathic. The whole zone i 1670' wide.

(4E) Blue slates and shales, containing possible rare
tuff bands, 620' wide.

(5E) Three bands of siliceous conglomerate occur within
this zone. The pebbles are of white quartzite and average
2 inches in diameter, set in a siliceous matrix. The
individual bands are each of the order of 30' wide and are
separated by blue and green shales and quartzites. The
whole is contained within a zone 230' thick.

(6E) Variegated, generally massive green slates, green
quartzites and tuffaceous (?) impure quartzites.

(7E) Greywacke conglomerate or breccia, consisting of sub-
angular pebbles, up to 2 inches in size, of green and pink
slates, blue quartzite and occasional chert and tuff particles,
set in a green slaty matrix.

West Limb of the Que Syncline

(1W) The lowest exposed member of the group is in fault
contact with alternating black slates and quartzites of the
Cambrian basal sequence. It consists of a monotonous
sequence 1850' thick of brown to pink coloured thinly lami-
nated shales containing lenticular gritty tuff(?) bands.

One band of coarse greywacke breccia or conglomerate 120'
wide occurs midway along this section.   It is noteworthy
that in the Hatfield River, approximately ½ mile north
along strike of the shales, almost the full thickness
of the shaly unit is represented by a coarse greywacke
conglomerate consisting of boulders up to 10 inches across
of brown and green shale and tuff set in a matrix of
similar composition.   The pronounced change in rock type
along strike is considered to be due to intraformational
brecciation of the incompetent shales.

(2W) Green and brown coloured alternating shales, fine-
grained greywacke, containing occasional narrow inter-
calations of blue slate, aggregating 1125' in width.

(3W) Blue, green and brown coloured micaceous shales, 680'
wide.

(4W) Alternating blue quartzites and variegated brown, blue
and green micaceous shales, up to 490' in width.

(5W) Four bands of siliceous conglomerate interbedded with
blue and grey shales and quartzites.   This is the equivalent
horizon to 5E on the eastern limb and contains an additional
conglomerate band.   The width of the whole zone is 700'.
The conglomerate of this horizon is mainly composed of
siliceous pebbles and boulders set in a matrix of either
quartzite or sandstone, thus resembling the Owen Conglomerate.
The conglomeratic beds have been traced at intervals on the
eastern limb north-easterly along a prominent ridge between
the Hatfield River and the Emu Bay Railway.   It crops out
south of the 50 mile railway cutting where scour and fill
structures were observed at the base of one of the con-
glomerate bands.   A feature of the zone is the absence of
graded bedding.   The transition from shale to coarse
conglomerate is abrupt and the contact cleanly marked.

(6W and 7W) Similar to 6E and 7E.

The Que River succession is comparable to that
described by Taylor (loc. cit.) in the Mackisson River,
where it is conformably underlain by the Crimson Creek

argillites and overlain with apparent disconformity by the
Gordon Limestone.

The following are the more apparent similarities
in rock type between the Huskisson River section and the
sequence forming the east limb of the Que Syncline.

A distinctive band of black slate is the basal
member of each.

Taylor has noted   in the Huskisson River
section a siliceous conglomerate which closely
resembles the Owen Conglomerate.   This is also
an obvious feature of formations 5E and 5W of
the Que Syncline.

Fossiliferous black shales lie below and above
the siliceous conglomerate of the Huskisson
River.   At the 50 mile cutting (Emu Bay Railway)
the conglomerate bands are separated by sand-
stones and black shales, and at the Que River
type section, by blue and green shales.
The rock assemblage between the basal black
slate of the Huskisson River sequence and up
to and including Taylor's formation No. 13,
is lithologically much similar to the beds
between and including 2E and 5E of the Que
River section.

No fossils were found by us in the Que River
sections, but the presence of Hurdia davidi, described
as probably Middle Cambrian, has been reported (Chapman,
1926).   This and the lithological evidences presented
above leave little doubt that the Que River and the
Huskisson River beds are coeval.   The latter have been
proved to be Middle Cambrian to Upper Cambrian in age,
and have been correlated with the Dundas Group of the
type area on palaeontological evidences (Banks, 1957).

Zeehan Area

Elliston (1954, p.175-6) points out that fossils found in the summit cutting of the Comstock tram line are equivalent to that of the Hodge Slate at Dundas. He has also noted the similarity in lithology between the Swansea grits and conglomerates and the Razorback formation. In addition, greywacke breccias outcrop on the T.L.E. road near Swansea Mine.

It is therefore considered that these sediments belong to the Dundas Group, and their distribution is shown in Plate V. They partially surround inliers of the Cambrian basal sequence except where truncated by faulting. Typical Dundas Group beds persist as far south as Mt. Zeehan where they are in fault contact with Owen Conglomerate.

Dundas type shales and tuffs (?) occur also near the Zeehan golf course and southwards on the Austral Flat.

The glacial beds noted by Elliston near Swansea Mine are identical with those occurring near the Montana Mine, and are therefore considered as Permian in age.

(B) Dundas Group as a syn-orogenic suite
of the Flysch type.

From the foregoing description it is seen that the Cambrian upper sequence furnishes a clear example of geosynclinal sedimentation, in which argillite-euxinic deposits were followed by a greywacke-conglomeratic sequence ending with grits and conglomerate of possible deltaic or terrestrial origin (Mt. Misery Conglomerate).

This succession can be compared with well known geosynclinal series of the world geological column, and in particular with the typical series of the Alpine Flysch-Molasse sedimentary cycle.

Like the Flysch, the bulk of the Cambrian upper sequence is composed of argillaceous and greywacke deposits showing violent variations in thickness, poor sorting, paucity of cross-bedding, textural and mineralogical

immaturity, inter-fingering of lithological units, rapid
gradations from coarse to very fine grained layers.

Considering on the other hand the vertical
succession of the lithofacies, it is seen that the sequence
reflects a cycle of sedimentation which closely compares
with the geosynclinal Flysch cycle proposed by Bertrand
(1897), generalised by Krinine (1941, 1942), critically
discussed by Tercier (1939) and accepted by Pettijohn (1957).
The early phase of the cycle, normally marked by an increase
in coarseness from the base to the top, would be represented
by the Crimson Creek Argillites and interbedded cherts and
black pyritic shales, probably deposited in localised basins,
surrounded by low relief and with a moderate participation
of volcanic ejectamenta.   The following stage, characteri-
sed by the greywacke-conglomerate suite, would reflect
more intense tectonism accompanied by cyclic rejuvenation
of the relief, as inferred by Bank (1957).   Finally, at
the end of the Cambrian times, the geosynclinal sedimentary
cycle ended with deposition of the Mt. Misery Conglomerates,
marking the incipient stage of Molasse sedimentation.   This
stage continued in the following Ordovician times under
quite different tectonic conditions, for an important system
of grabens modified the normal geosynclinal evolution of
the area and brought about the continental red-facies
sedimentation to be described in a later section.

(c) The Dundas Trough as a basin of Archipelagos

The similarities of facies between the Dundas
Trough infilling and the geosynclinal sequences of the
Flysch type, led us to consider the possible geographic
and bathymetric configuration of the ancient basin of
deposition.

In this respect, the series of the pre-Alpine
Flysch have furnished in the last two decades much
illuminating data.   They have revealed, together with
great differences in age, a marked discontinuity in time
and space of the Flysch sedimentation.   In fact the Flysch

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terrains belong to various tectonic units - the Prealpes nappes - deposited in distinct and widely separated troughs, within the wide area of the Alpine Geosyncline. This Geosyncline was in its early folding stages when the various Flysch series were deposited in Middle Cretaceous to lower Tertiary times; and must have been comparable, with its emerging festoons and intervening local trough, to the present Indonesian Archipelago.   It was this environment that appears to have controlled the Flysch deposition, as lucidly shown by Tercier (1939). For this author the Flysch has to be regarded as a formation of marine basins of an average depth, narrow or fairly wide, of the type of the archipelago basins. Tercier postulates, along the immediate borders of the Flysch basin, the presence of fairly steep and discontinuous ridges with narrow littoral platforms, rapidly leading to important marine depths.

This palaeotopographic frame   continuously rejuvenated by contemporaneous tectonism, adequately accounts for the clastic immature sedimentation of the Flysch, the almost general absence of carbonate rocks and orthoquartzites of shelf areas, the interdigitations and rapid gradations from fine to coarse sediments, the local and yet very thick deposition characteristics which are all found in the deposits of the Dundas Group and which suggest a comparable environment.

The individuality of this trough as an archipelago furrow is accentuated by the presence of the Rosebery Volcanic Arc, developed at an earlier stage between the Trough and the Tyennan Craton.

(III) THE ORDOVICIAN ELEMENTS

A preliminary account of the West Coast Range conceived as an uplifted early Palaeozoic graben (Owen Graben) has already been given (Campana et al, 1958).

We shall analyse here the sedimentological and structural
data on which this conception is based and account also
for the presence of conglomeratic layers identical in
facies to what we have regarded as a terrestrial graben
infilling (Owen Conglomerate) but occurring in other
localities at various distances from the West Coast Range.

1.   THE OWEN GRABEN (WEST COAST RANGE)

The West Coast Range, which forms the most con-
spicuous orographic element of the area is a narrow,
rectilinear chain stretching from Mt. Darwin to Mt. Farrell.
A north-south alignment of rocky peaks, comparable in
elevation and geological characteristics, now separated
by deep gorges or narrow valleys, testify the striking
geological individuality of the Range; and the contrast
with the lower timbered depressions which flanked them to
the west emphasises this individuality even more.   Mt.
Sorrell (3756'), Mt. Jukes (3800'), Mt. Huxley (3200'),
Mt. Owen (3600'), Mt. Lyell (2750'), Mt. Sedgwick (4000'),
Mt. Tyndall (3850'), Mt. Murchison (4400') and Mt. Farrell
(2100') form the summits of the Range over a length of
about 36 miles.   All these peaks have been carved in
conglomeratic formations, i.e. in the Owen Conglomerate,
generally underlain by the Jukes Breccia, which rests on
the formations of the Rosebery Volcanic Arc described above.

The Owen Conglomerate shows its maximum deve-
lopment in the West Coast Range, to which it is largely,
but not entirely, confined.   The Jukes Breccia is strictly
confined to this Range, at least in the area studied by us.

The conglomerate formations, which have been
mapped between Mt. Sorell and Mt. Lyell by Solomon (Wade
and Solomon, 1958), and between Mt. Lyell and Mt. Farrell
by and associated geologists of the Rio Tinto Company, are
of particular significance in relation to the tectonic
history of the Tasmanian West Coast.   Their stratigraphic
characteristics, distribution, mutual relations and de-
positional environment have therefore to be described in
fine detail.

(A)   The Sedimentary Succession

( )   The Jukes Breccia

In spite of great variations of lithological
details, the Jukes Breccia shows a remarkable uniformity
of facies all over the Range, from Mt. Sorell to Mt.
Murchison.   It was first described (and stratigraphically
defined) by Hills (1915) as a "brecciated conglomerate" which
"forms the base of the whole West Coast Range conglomerate
series in this (Jukes-Darwin) district."   It "consists of
varying thickness of beds composed of angular, sub-angular
to partially-rounded fragments of those members of the
porphyroid series, including fragments of the Darwin
Granite.   These fragments are cemented together by a
paste of the finer particles of the same rocks.   The size
of the constituent fragments varies from masses approximately
4 feet in diameter down to the finest material forming the
cement paste.   The arrangements of the fragments is generally
tumultuous, but occasionally a distinct stratification is
present.   Although the varying character of the beds is
thus instrumental in developing a rudely-stratified arrange-
ment, the disposition of the fragments in the beds themselves
is always devoid of any stratiform characters.   They are
seen to be resting unconformably on the upturned edges of
the porphyroids and show a distinctly stratified arrangement
en masse."

The Jukes Breccia formation can hardly be more
lucidly described.   In the northern segment of the Range
at Mt. Lyell, Mt. Sedgwick, Lake Dora, Red Hill, Mt.
Murchison and elsewhere, its fundamental traits are the
same.   It invariably consists of unsorted, poorly washed
and crudely stratified material - porphyritic pebbles and
boulders, with quartz, quartzites and hematite fragments,
loosely dispersed in a micaceous felspathic matrix of a
dull grey or dark colour (Plate III).   It may vary in
thickness from a few feet (Lake Julia) to more than 1000
feet (Mt. Lyell-King River area).   A specimen of the Jukes

Breccia matrix collected in this area is a dark grey, evenly
granular greywacke with an average grain size of about 1 mm.
The rock is virtually massive although a weak schistosity is
visible in thin section.   About 20 per cent of the rock
consists of clear, unstressed, angular quartz grains, many
of which have curved embayments.   In addition, some 10
per cent of the rock is formed by granular quartz aggregates.
Thus, the quartzose rock components appear to have derived
partly from an igneous source and partly from a metamorphic
source.   Extensively kaolinised felspar and grains of
devitrified glassy substance form 50 per cent of the rock.
These grains are irregularly shaped or euhedral.   The
bulk of the felspar is orthoclase, the remainder is acid
plagioclase.   Chlorite, sericite, magnetite and hematite
form the remainder of the rock.   These are located inter-
stitially amongst quartz, devitrified glass and felspar
grains, and it is the cleavages of the micaceous minerals
which give the rock its weak schistosity.

In this matrix are embedded fragments of por-
phyries and keratophyres, ranging in size from 1 inch to
3 feet and showing various degrees of roundness - from
small angular pebbles to well worn cobbles and boulders
(Plate III).

These characteristics persist later   and
vertically throughout the area investigated, although the
breccia fragments become more closely packed towards the
top of the formation.

The Jukes Breccia is thus a typical greywacke
breccia-conglomerate, unfossiliferous all through, and
inferred as Lower Ordovician in age from its relations
with the overlying formations (Plate III (c), Fig 5).

The lower limit of the Jukes Breccia is seldom
exposed and not always clearly defined.   However, the
angular unconformity between this formation and the under-
lying Cambrian volcanic rocks has been recognised in the
Red Hill area by Carey and Banks (1954) and confirmed by
our regional mapping work (Plate VI top section).

The angle of the unconformity reaches 90°, the Cambrian
volcanics and slates dipping 70-80° westerly and the Jukes
Breccia - Owen Conglomerate layers dipping 20-35° to the
east. This is clearly observable ½ mile east-north-east of
the northern shore of Lake Westwood, at the base of the
erosional rim of the Owen Conglomerate-Jukes Breccia, which
form there a broad local anticline.

In the Lake Dora area, R.B. Fraser records in
an unpublished Company report (1958) that the basal portions
of the Jukes Breccia (Dora Conglomerate) "are interfingered
with porphyry flows and derived sedimentary material and
pyroclastics. Ash beds, coarse pyroclastics and possibly
agglomerates exist in minor amounts within the main Dora
Conglomerate." He also observed that "throughout the main
volcanic assemblage there are frequent lenses of conglomerate
(indistinguishable in type from the Dora Conglomerate) and
finer sediments derived from the volcanics. The Dora
conglomerate appears to be markedly diachronous particularly
when considered with respect to the volcanic facies. The
contacts between the volcanics and the Dora conglomerate
are in the strictly local sense, unconformable, but postu-
lation of a major stratigraphic break between the volcanic
facies, the Dora conglomerate and the overlying Owen
Conglomerate seems quite unjustified in the area mapped."

Carey and Banks (1954) have also made similar
observations in this area and state that "a mile south of
Walfords Peak, finely-bedded deep red sandstones and
siliceous conglomerates" (Owen Conglomerate) "appear to
pass transitionally downwards into greywacke conglomerate
and breccia" (Jukes Breccia) "with an interbedded flow of
altered biotite quartz keratophyre."

It is thus seen that the lower limit of the
Jukes Breccia is in places lithologically indefinite, as
the formation appears to merge into the volcanics. This
is in contradiction with unquestionable angular relation-
ship, mentioned above and especially with the fact that a

long span of time (and an orogenic phase) separate the
Lower to Middle Cambrian volcanics from the Ordovician
Jukes Breccia-Owen Conglomerate beds.

We shall attempt below to account for this
fact in describing the depositional environment and the
subsequent history of the Jukes Breccia and the Owen
Conglomerate.

The Upper Limit of the Jukes Breccia, i.e. its
contact with the Owen Conglomerate, is admirably exposed
in several localities - at Mt. Lyell, Mt. Sedgwick, Lake
Dora, west of Lake Julia, westerly of Lake Westwood, on
the south and north slopes of Mt. Murchison, and elsewhere.

At Mt. Lyell, Lake Julia and Lake Dora the Jukes
Breccia passes rapidly but gradationally into the Owen
Conglomerate.   The dark grey porphyritic pebbles and
boulders of the Jukes Breccia give way to light-coloured
siliceous cobbles and boulders, which become predominant
within a vertical interval of about 100 feet and are almost
the only ones to be represented at higher levels.   In these
localities the relations between the Jukes Breccia and the
Owen Conglomerate are thus conformable, and no break of
sedimentation or change of depositional environment occurred
at this level.   The replacement of the felspathic fragments
of the Jukes Breccia by the siliceous material of the Owen
Conglomerate would merely reflect a change in the source
of supply.   This is no doubt related to the uplift of the
Precambrian quartzites easterly of the basin of deposition,
concomitant with the sinking of the porphyritic formations
beneath the level of erosion (Table VI and Fig. 4).

However, in the Mt. Murchison area a strati-
graphic break between the Jukes Breccia and the Owen
Conglomerate is clearly shown at two places (Fig. 5).
There the top layers of greywacke conglomerates (Jukes
Breccia horizon) are truncated by an unmistakable erosion
surface.   This surface is irregular, uneven with alternating
ridges and grooves reaching ten feet in depth.   The grooves

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are infilled with typical Owen Conglomerate material, con-
sisting of well rounded siliceous pebbles and sand. Upon
these infillings rest other layers of Owen Conglomerate,
which cover grooves and ridges alike without any break of
continuity. It is manifest that this surface reflects an
erosion interval during which water courses have carved
their channels in the Jukes Breccia strata, which were
apparently unconsolidated at that time. This interval
was followed by the deposition of the Owen Conglomerate
over the eroded but unfolded strata of the Jukes Breccia,
no angular relation being observable between the two
formations. The break is thus a local continental un-
conformity, i.e. a buried land surface. We shall discuss
below the palaeogeographic and structural implications of
this surface.

Origin of the Jukes Breccia. Unfossiliferous,
unwashed, ungraded, massive or very poorly stratified,
extremely variable in thickness and entirely confined to
the narrow elongated trough of the Owen Graben, the Jukes
Breccia is regarded by us as terrestrial in origin. It
chiefly derived from the underlying porphyritic and pyro-
clastic rocks and would represent accumulations of rubble,
talus and alluvial fan material taking place along the
faulted scarps of the graben, mainly along the eastern
edge. The mode of occurrence of the Jukes Breccia in the
Lake Dora area furnishes fine evidence of these deposit-
ional conditions, as shown in Fig. 4. This reconstructed
depositional section accounts for the fact that the Jukes
Breccia, which is conformably overlain by the Owen Conglo-
merate and reaches over 1000 ft. in thickness between Lake
Dora and Lake Spicer, thin out completely to the east, with-
in a distance of less than one mile, the Owen Conglomerate
coming to directly overlap the Precambrian quartzite. The
Cambrian volcanics, which formed the eastern shoulder of
the graben before the deposition of the Jukes Breccia,
have been stripped from their Precambrian basement and re-

deposited as rubble and scree in the Graben to form the
Jukes Breccia.

The local existence of a continental unconformity
is a further evidence of this terrestrial environment of
deposition which, as shown below, persisted in post-Jukes
Breccia time to control the sedimentation of the Owen
Conglomerate.

It is notable that the terrestrial origin of
the Jukes Breccia has been postulated by Hills (1914, p.47).
The overlying normal conglomerates (Owen Conglomerate) con-
sidered in this early work as a littoral deposit, but in a
later publication (Hills, 1915), he described these con-
glomerates as "continental hydroclastics", and concludes
"that the mode of deposition of the whole conglomerate
series is really a continuation of the same conditions which
characterised the formation of the basal brecciated conglo-
merates". These views have not been retained by later
investigators who considered the conglomerates as marine.

However, a question remains to be clarified -
the apparent lithological gradation from the Rosebery
Volcanics into the Jukes Breccia, which are observable at
Lake Dora.

Since a violent angular unconformity is evinced
in other portions of the Range between the Rosebery Vol-
canics and the conglomerate layers (Plate VI, top figures)
and since we have shown that the Volcanics predate Middle
Cambrian beds, the observed lithological passage cannot
reflect a stratigraphic continuity between the two forma-
tions. Bradley (1957) accounts for this passage by post-
ulating that the "felspathic greywacke conglomerate was
permeated by felspathising solutions. Felspar porphyries
are considered to have originated by the felspathising of
spilitic lavas, lava breccias and related greywacke during
a period of (post-Ordovician) progressive metamorphism."

This view is unacceptable, for scattered pebbles and
boulders of porphyries, keratophyres and pyroclastics
are to be found in the Middle-Upper Cambrian sediments
of the Dundas Group, as well as in the Ordovician Jukes
Breccia and in the lower beds of the Owen Conglomerate.
Moreover these pebbles and boulders are stressed and
schistose, while the sediments in which they are embedded
are generally unmetamorphosed.

It follows that the metamorphism of the Rosebery
Volcanics predates the deposition of the Ordovician Jukes
Breccia-Owen Conglomerate succession, in accordance with
the Middle Cambrian   ogeny described above.

In our view two factors would account for the
apparent gradations from the Jukes Breccia to the under-
lying volcanic rocks.   Firstly, the volcanic assemblage
also includes some volcanic breccias lithologically much
similar to the Jukes Breccia.   Where these rocks are
intimately associated they may become indistinguishable in
the field, especially because their unbedded and unsorted
nature would render obscure the angular relations between
them.

In addition, the basal Jukes Breccia layers are
as a rule derived from the disintegration and reworking of
the underlying porphyries, pyroclastics and volcanic breccias.
Diagenetically reconstructed as coarse and unsorted clastic,
these reworked products would show in places lithological
similarities with the underlying formations.   Thus the
boundaries between the original and the reconstructed rocks
cannot be but irregular and often indistinct, the net re-
sult being an apparent lithological gradation from older
to younger rocks.   Similar phenomena of lithological
welding previously regarded as evidences of granitization,
occur between arkosic till and granite in the northern
Flinders Ranges and in the Olary Province of South Australia
(Campana, 1955; Campana and King, 1958 (a)).

(b) The Owen Conglomerate

General Characteristics

The felspathic greywacke-conglomerates and breccias of the Jukes Breccia horizon are invariably overlain by an alternation of conglomerates and sandstones, named West Coast Range Conglomerate in the earlier geological literature, and Owen Conglomerate in the more recent works.

This formation has its greatest development in the West Coast Range, and particularly in the northern half of the chain between Mt. Lyell and Mt. Murchison, where it reaches more than 2500 feet in thickness.

In this part of the chain at least, the members of the Owen Conglomerate formation retain distinctive lithological characteristics. The conglomeratic beds, which are coarser and thicker in the lower part of the formation, chiefly consist of closely packed pebbles, cobbles and boulders of quartzites, quartz, with cherty debris at some levels, and porphyritic fragments in the lowest strata. These basal conglomerates occur in massive layers, which reach many hundreds of feet in thickness without showing bedding features, except for occasional sandy partings. Their colour varies from grey to deep purples, with intermediate yellow, brown, pinkish and reddish tinges. Grading is largely absent, many of these beds showing a chaotic assemblage of angular to well worn fragments which range from less than one inch to 15 inches across (Plate IV).

The cobbles show in many instances a marked imbricate arrangement, their long axis being preferentially oriented and steeply inclined as compared to the initial dip of the bedding plane (Plate IV (c) and (d)).

The basal strata are succeeded by an alternation of pink sandstones and vari-coloured conglomerates or breccia-conglomerates. These differ from the basal conglomerates in being generally fine . Their pebbles do not exceed 2-3 inches in size and include angular fragments of

cherts and siliceous slates intermingled with more rounded quartzitic pebbles.

Gradations to sandy layers with or without interspersed pebbles are numerous, although sharp contacts between sandstones and conglomerates are observable in many parts of the succession, which ends with a distinctive sandy sedimentation in which reddish sandstones, grits and fine conglomeratic layers gradually give way to light-coloured sandstones.

This general order of succession persists throughout the area studied by us and has been also described south of Mt. Lyell by Hills (1913), Alexander (1953) and Wade and Solomon (1958). However, variations occur along and across the regional strike, so that accurate correlations over long distances are not everywhere possible. A general correlation is presented in Fig. 6.

The lower limit . It has been shown above that the Owen Conglomerate of the West Coast Range is, as a rule, underlain by the Jukes Breccia, the contact being either conformable as at Mt. Lyell and Lake Dora (Fig. 6) or marking a continental unconformity (Fig. 5, Plate III (c)). However, along the eastern edge of the Range, in the Lake Spicer-Lake Selina area, the conglomerate rests either on the Cambrian porphyries or on the Precambrian basement. Likewise, in areas bordering the West Coast Range to the north, much thinner and often isolated layers of conglomerate, similar in facies to the Owen Conglomerate, rest on pre-Ordovician rocks of various ages. This also applies to conglomerates of the Zeehan area, indistinguishable in facies from the Owen Conglomerates of the West Coast Range.

The upper limit. In the West Coast Range the upper portion of the Owen Conglomerate and succeeding formations have generally been stripped by erosion. West of Lake Spicer and also at the eastern end of Lake Margaret, outliers of Gordon Limestone, of Upper Ordovician age rest

on lower members of the Owen Conglomerate, thus proving
that the Upper members were already locally eroded before
the deposition of this Limestone.   In the portion of the
West Coast Range under review, the upper limit of the Owen
Conglomerate remain   therefore undefined.

(B) The depositional trough, source of supply and origin.

            The origin and the depositional conditions of the
Jukes Breccia have been discussed above.   As for the Owen
Conglomerate it is noticeable that two rock types are pre-
dominant at any level - a flinty, massive silicified rock,
light coloured when fresh, faintly pinkish on weathered
surfaces, generally represented by well-worn pebbles and
boulders;   and a schistose grey quartzite, represented by
more angular fragments in which bedding features are
occasionally preserved.   Quartz pebbles are also abundant
at certain levels.   The source of these rocks is the Pre-
cambrian block which flanks the Owen Graben to the east,
and in particular the Sticht Range area, emergent in
Lower Ordovician time as high chains of mountains dissected
by powerful erosion.   These chains would have shed their
debris in all directions, as evinced by the presence of
Ordovician siliceous conglomerates in various areas around
the Precambrian terrain;   but the rapidly subsiding zone
of the Owen Graben and the related rejuvenation of relief
at its margins were no doubt responsible for the great
thickness of the Owen Conglomerate in this zone.

            It is believed that most of the material was
poured into the sinking graben by short steep streams and
torrents, which built up alluvial fan deposits in the pied-
mont zone, reworked in part by longitudinal rivers along
the rift valley.   The gradual planation of the relief is
reflected by an upwards decrease in size and an increase
in the roundness of the Conglomerate fragments.   The
last stage of planation to be observed is an uppermost
sandy formation known as the Tubicolar Sandstone.

It is estimated that over 90% of the material
has been supplied by the Precambrian quartzitic formations
of the Sticht Range. The remainder derived from the Dundas
Group, comprises layers of breccia, largely composed of
purple chert and slate fragments, which are well developed
in the Lake Selina-Mt. Murchison area.

The predominance of quartzite and quartz frag-
ments from the Precambrian area is partly due to their
resistance to wearing and decomposition. In contrast,
the Cambrian sediments, being easily decomposed by
weathering and destroyed in transportation, are compara-
tively rare as fragments in the Ordovician Conglomeratic
suite just as they are rare in the Quaternary glacial and
alluvial beds. However, the main reason for the predominance
of material from the eastern Precambrian block is the per-
sistence of this block as a highland shield area of con-
tinuously rejuvenated relief throughout the whole Cambro-
Ordovician time, as testified by the absence of Cambrian
sedimentation and the presence of very coarse Ordovician
scree breccias and fanglomerates along its western margin.

A great proportion of the Owen Conglomerate beds
are purple, reddish, pinkish or brown in colour. These
tinges persist in depth, as shown by numerous deep drill
holes at Mt. Lyell (personal communication by M.L. Wade).
Brown, yellow or even pale tinges in weathered outcrops,
often give way to reddish tinges as soon as the unaltered
rock is reached. The reddish tinges are thus primary in
origin, and the formation has therefore to be regarded as a
typical red beds suite deposited under sub-aerial conditions.
It is comparable in all respects with the well known Triassic
Newer Series and Precambrian Keweenawan deposits, accepted as
terrestrial piedmont formations (Pettijohn, 1957).

The formation is virtually unfossiliferous, although
tracks of problematical organisms occur, in some layers
of the upper portion of the succession. Cross-bedding
is a general feature, and cut-and-fill structures,
slumping (Plate IV (b)) intra-formational discon-

formities have been observed at various levels and illus-
trated previously (Campana et al, 1958).

These lines of evidence leave little doubt that
the Ordovician Conglomerates of the West Coast Range are
essentially terrestrial formations. They would represent
fluviatile sediments - chiefly fanglomerates, gravel layers
and sandy deposits of piedmont and alluvial plains - in-
filling a land-locked rectilinear graben which reached at
least 40 miles in length but rarely exceeded 4 miles in
width, and which has been named Owen Graben in a previous
publication (Campana et a , 1958).

(2) OWEN CONGLOMERATE OCCURRENCES IN OTHER AREAS:
     THE ZEEHAN GRABEN

North and west of the West Coast Range, Ordovician
conglomerates, similar in facies to the Owen Conglomerate,
are found in some localities, usually as widely separated
outliers of what must have been originally an extensive, if
not continuous, blanket. These conglomeratic layers are
generally thin, from a few feet to a few hundreds of feet
at most, and reflect no doubt sedimentary environments
different from those prevailing in the West Coast Range.
Some of the outliers would represent, in our opinion,
terrestrial gravel veneers and tongues deposited on low-
lying but stable land surfaces surrounding the Precambrian
chains. Others may represent thin beach conglomerates
marking the transgression of the Upper Ordovician sea, for
they are conformably overlain by the Gordon Limestone.
This appears to be exemplified by a few feet of pebbly
conglomerate found at the base of the Gordon Limestone,
in the White Hawk Creek area, beyond the northern end of
the Owen Graben, where the coarse and thick layers of the
Jukes Breccia-Owen Conglomerate formations thin out abruptly.
This thin pebbly conglomerate rests on a Cambrian granitic
body and is conformably overlain by the Gordon Limestone,

It marks the shelf conditions prevailing in Ordovician
time north of the White Hawk Creek, in striking contrast
with the unstable sedimentary environment of the Owen Graben
to the south (Plate V).

However, at Mt. Zeehan, 14 miles west of the
West Coast Range, the Owen Conglomerate is again to be
found in stratigraphic and structural conditions which
closely compared with those of the Owen Graben.

(A) The Owen Conglomerate Succession

The more complete and thickest development of
the Owen Conglomerate formation of these areas is found
at Mt. Zeehan, where the succession is as follows.

The basal layers consist of coarse, poorly
sorted conglomerates, with closely packed pebbles and
boulders up to 12 inches across. Their colour is generally
pink to purple, and their thickness is of the order of 1800
feet. The rock fragments are chiefly quartzites and
quartz, no doubt derived from the Precambrian terrains.

The succeeding beds consist of about 400 feet
of cross-bedded pinkish pebbly grits and fine breccia-
conglomerate interbedded with pink and grey sandstones.
These are overlain by 200 feet of thick-bedded grey sand-
stones showing tubic lar forms at right angles to the
bedding planes and followed by the Gordon Limestone
formation.

The most striking characteristic of this suc-
cession is its very restricted distribution. In spite
of its great thickness it occupies an area of less than
3 square miles around Mt. Zeehan, where it forms over a
short distance the western limb of the Zeehan syncline
(Plate V and Fig. 7). Northwards, it thins out abruptly,
and is not represented in the stratigraphic succession of
Zeehan, 2 miles to the north, where the Gordon Limestone
rests on various pre-Ordovician formations.

Three miles east of Mt. Zeehan, in the Mariposa-
Mt. Misery area, the Owen Conglomerate occurs again dis-
continuously along the eastern limb of the regional syncline,
but its total thickness is much reduced and variable.
The basal conglomeratic part, up to 200 feet in thickness,
consists of coarse pebbles and boulder layers (Plate IV (a)).
The remaining portion up to 500 feet thick, consists of
light-coloured quartzose sandstones, with occasional pebbly
bands.

In spite of the abrupt facies and thickness
variations of the Owen Conglomerate, the Gordon Limestone
persists throughout the Zeehan synclinal structure, over-
lying the Conglomerate without angular unconformity, or
overlapping older formations where the Conglomerate is
missing (Plate V and Fig 7).   This shows that the thick-
ness variations of the Owen Conglomerate are essentially
original features, reflecting localised subsidence and .
deposition prior to the Gordon Limestone transgression.

The various stratigraphic sections of this
trough are described and correlated in 7 which also serves
to illustrate that the Owen Conglomerate of the Zeehan-
Mt. Professor area conformably succeeds the Upper Cambrian
beds of the Dundas Group (Mt. Misery Conglomerate), without
Jukes Breccia layers at its base.   The Conglomerate is in
turn overlain by the transgressive Gordon Limestone of
Upper Ordovician age, without angular unconformity, except
at Mt. Professor where the transgression appears to have
taken place on a faulted and eroded conglomeratic block.

(B) Depositional trough and source of supply.

Considering the facies of the Owen Conglomerate,
its great and abrupt variation in thickness, the discon-
tinuity of its occurrences and the fact that the overlying
Gordon Limestone persists throughout the area as a continuous
and uniform unit, it becomes evident that the depositional
environment of these two formations were vastly different.

It follows that the Owen Conglomerate has no more to be
regarded as the transgressive basal member of the Ordovician-
Silurian marine sequences (June and Elden Groups).   Its
coarse and middle beds testify to a period of erosion and
restricted continental deposition, taking place as terrestrial
infillings of local grabens subsequently buried by marine
transgressive layers in Upper Ordovician time.   The up-
ward decrease in coarseness and the more widespread
occurrences of sandy layers would reflect a gradual plan-
ation of the relief and a widening of the area of aggradation
beyond the margin of the downfaulted troughs.

It is not possible, at this stage, to accurately
delineate the original extension of these troughs.   Broadly
speaking, they would have extended southerly of Zeehan in a
direction roughly parallel to the axis of the Devonian
Zeehan Syncline, but their marginal faults have been largely
covered by post-Ordovician sediments and obscured by later
movements.   We shall, therefore, collectively refer to
these Lower Ordovician troughs as the Zeehan Graben, the
Mt. Zeehan succession being best example of localised in-
fillings.

The pebbles and boulders of the conglomeratic
beds of Mt. Zeehan, like those of the West Coast Range,
are subangular to well rounded fragments of quartzitic
rocks, dense or cleaved, light-coloured to reddish on
weathered surfaces, closely packed and cemented by a
siliceous matrix.   The material, although well washed,
is poorly sorted and largely unstratified.   At first view,
this material seems to have derived from the same source
as the Owen Conglomerate of the West Coast Range, namely
the Precambrian block of the Sticht Range.   However, as
the Zeehan Graben appears to have been separated from the
Owen Graben by an area of little or no lower Ordovician

deposition [1], it has to be assumed that the material chiefly derived from the Precambrian quartzites of the Rocky Cape Geanticline, which flanks the Zeehan Graben to the north.

(3) **Lower Ordovician conglomeratic beds as Post-Orogenic Deposits of the Molasse type.**

In a preceding paragraph is has been shown that the Dundas Group can be compared with the geosynclinal series of the Alpine Flysch. Likewise the succeeding deposits, i.e. the Molasse beds of the peri-Alpine basins and the clastic infillings of the West Tasmania graben zones, show facies similarities which suggest a comparable phase of deposition at the end of the geosynclinal sedimentary cycle.

In the Alpine Molasse as well as in the Mt. Misery-Owen Conglomerate beds, thick conglomerates and sandstones are the dominant rock types. In both cases the conglomerates are the oldest members of the clastic successions and represent fluviatile deposits accumulated at the margin of rejuvenated chains following on a synorogenic greywacke sedimentation.

(1) The absence of Owen Conglomerate in this area is undoubtedly due to a stratigraphic hiatus as shown by the complete thinning out of the Owen Conglomerate north and east of Zeehan (Plate V and Fig. 7).

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PART II

THE STRUCTURAL HISTORY: EARLY PALAEOZOIC AND LATER PERIODS OF DIASTROPHISM

The more conspicuous effects and the age of the various orogenic and epeirogenic movements of the area under consideration are illustrated by plates V and VI. The following comments summarize our views on the characteristics of these movements and on their possible correlation with those recorded in the Australian land mass.

(1) THE CAMBRIAN DIASTROPHISM

Various authors have dealt lately with the Cambrian tectonic movements of West Tasmania, generally described as the Tyennan movements. Bream (1950 considered them as having occurred between Middle and Upper Cambrian times. For Carey (1953) these movements are probably coeval with the deposition of the Dundas Group. For Carey and Banks (1954) the Tyennan orogeny would include various movements ranging from pre-Upper Middle Cambrian to pre-Lower Ordovician in age. For Opik (1957) the main Tyennan movement must be dated as Upper Cambrian to lowermost Ordovician.

The age of the Upper Cambrian movements has been previously deduced by considering the Dundas Group (sensu lat) as unconformably overlain by the Lower Ordovician Conglomerates. However, we have shown above that, in the area studied by us, these conglomerates either overlie the Dundas Group of the type area without angular discordance, as at Mt. Misery (fig. 7) or they overlie with violent angular unconformity the Rosebery Volcanics, which were already uplifted and eroded at the time of deposition of the Dundas type succession (Plate VI). From these and other lines of evidences, we are inclined to consider the main movements of the Tyennan orogeny as pre-Upper Middle Cambrian in age. They are recorded, in our views, by the unconformity between the Dundas beds and

the Rosebery Volcanics, or by the unconformity between
these Volcanics and the Lower Ordovician Conglomerates in
areas where the Dundas sedimentation did not take place,
as at the Red Hill and Lake Dora (fig. 4). Thus the
Jukesian Unconformity of Carey and Banks (1954) would
no more be "the expression of an orogenic movement of
post-Lower Upper Cambrian but pre-Lower Ordovician age"
but the expression of movements and erosion in pre-
Upper Middle Cambrian time.

Except in some area affected by Ordovician
faulting, the Lower Ordovician Owen Conglomerate is
succeeded by the transgressive Gordon Limestone without
angular discordance. As this Limestone shows in turn
concordant relations with the overlying Silurian-Lower
Devonian beds it is concluded that no important folding
movements occur in the area of our studies between Middle
Cambrian and Middle Devonian periods.

In late Cambrian time tectonic movements in
this area were mild and contemporaneous with deposition,
as shown by the synorogenic characteristics of the Dundas
suite and by the presence of several sedimentary cycles
within this suite (Banks, 1957). At the dawn of the
Ordovician period these movements ended not with the
folding of the belt but with an epeirogenic uplift of
the sedimentary area and with gradual faulting, particularly
along the Rosebery Volcanic Arc, which formed on older zone
of weakness at the margin of the geosynclinal trough.

The pre-Middle Cambrian age of this deep-seated
zone of weakness, the fault system which developed along
it and its mobility in later times is evinced by the
rectilinear distribution of the Rosebery Volcanics and
of the lower Ordovician terrestrial conglomerates which
are found in this zone. Its meridional trend strikingly
contrasts with faulting of the Devonian orogeny which are
north-easterly, north-westerly or sometimes easterly
directed, more local in character and unrelated to any

contemporaneous volcanism or sedimentation.

The effects of the various diastrophic periods being generally superimposed, it is not always an easy matter to distinguish the earlier from the later movements. However, in places differences in orientation are so striking as to render possible the reconstruction of palaeotectonic settings even where early elements have been disrupted by later movements. Thus in the Rosebery-Mt. Read-Red Hill area (Plate V) it is seen that the Cambrian elements have been affected by.

1.   Pre-Upper Middle Cambrian folding and faulting.

2.   Lower Ordovician epeirogenic movements, giving
         rise and delimiting graben basins (Owen Graben).

3.   Middle Devonian folding, evinced by the north-
         west trending schistosity of the Rosebery Volcanics
         and by fold ax   of similar trend in Ordovician-
         Silurian formations.

4.   Upper (?) Devonian thrusts, shown by a large
         lateral displacement of the Mt. Read block.

5.   Post-Permian faulting.

Likewise, these various diastrophic periods have been recognised in the Lake Dora-Sticht Range area (fig. 4).

Correlations.   A critical review of the Cambrian diastrophic movements in Tasmania generally is beyond the scope of this work.   Some remarks on this subject and on the possible correlations with movements of this period in Victoria and South Australia appear, however, relevant.

In South West Tasmania, at Adamsfield, Carey and Banks (1954) have recognised a marked unconformity and an erosion period between the emplacement of Cambrian serpentines and trilobite-bearing sediments coeval with the late Cambrian Dundas beds.   According to Carey and Banks (loc. cit) the trilobite-bearing beds "are followed con-formably by the Owen Conglomerate, and then again con-formably by the Gordon Limestone and the Eldon Group",

so that the Tyennan movements of this area antedate en-
tirely the local fossiliferous sequence of the Dundas Group.

In North West Tasmania, in the Middlesex area,
a high angle unconformity has been mapped by Jennings (1956)
between Lower Ordovician Conglomerate and a sequence of
sheared porphyries, quartz schists, graywacke conglomerates
and pyroclastic rocks, which closely compares with the
Rosebery Volcanics. The age of the pre-Ordovician
movements is not precisely known, for the volcanic sequence
is unfossiliferous. However the composition of this
sequence, its metamorphism, its high angle unconformity
with the overlying conglomerates, and its position at the
edge of the Tyennan craton seem to indicate that the
early Palaeozoic movements of the Middlesex area were
coeval with those of the West Coast Range and Adamsfield.

In Victoria the thick spilite-keratophyre-
pyroclastic suite of the Heathcote Greenstones, of a
Lower (?) to Middle Cambrian age, is overlain by the
Knowsley East formation, the trilobite faunas of which
are correlated with the Ptychagnostus gibbus zone (Thomas
and Singleton, 1957). Stratigraphically, these conditions
are therefore comparable with those of the West Coast Range -
Zeehan area, where the Rosebery Volcanics are succeeded by
the Dundas sediments beginning with the Gibbus zone. How-
ever in Victoria the relations between the two sequences
are described as conformable, the Knowsley East formation
being in turn conformably overlain by Upper Cambrian beds.
Thus no diastrophic movements are recorded in Victoria
within the Cambrian succession.

It is however, noticeable that pre-Devonian
volcanism is confined in this State to Lower and Middle
Cambrian times, and that in the Mt. William-Heathcote-
Colbinabbin area it occurred along a narrow meridional
belt which reaches 70 miles in length but does not exceed
2½ miles in width (Thomas and Singleton, loc cit.). In
our view, this belt would reflect a deep-seated early
Cambrian faulting which like the faulting of the West

Coast Range in this period, was meridionally directed and occurred at about the same longitude. A correlation between these faulting periods is therefore suggested.

In South Australia two orogenic periods are recorded within the Lower to Middle Cambrian formations of the Adelaide Geosyncline. The earlier movements predate the Kanmantoo Group and the Kedlichia beds of Kem Bay, and is dated by Daily (1957) as Lower Cambrian. The second and more widespread orogeny is considered by the same author as middle Middle Cambrian. This orogeny could well be coeval with the pre-Dundas folding movements of West Tasmania, as recorded in the West Coast Range and at Adamsfield.

(II) THE TYENNIAN EPEIROGENIC MOVEMENTS

The recognition of the Lower Ordovician conglomerates of the Zeehan-West Coast Range areas as terrestrial graben infillings, together with the fact that no angular relations are observable between these conglomerates and the underlying Upper Cambrian beds, show that the Ordovician movements of West Tasmania were essentially epeirogenic in character and probably due to tensional stresses. As pointed out above, these movements would have occurred in the main along the pre-existing lines of weakness of the Cambrian lineaments, in particular along the Western edge of the Tyennan craton, where the Rosebery Volcanic Arc developed in earlier times. Indeed the Owen Graben would have derived from the collapse of portion of this Arc, as evinced by the similar distribution of the Owen Conglomerate and the Rosebery Volcanics south of the Henty Fault (Plates V, VI).

The Henty Fault and the related Jupiter Fault to the north intersected the Cambrian lineaments and delimited a block (Mt. Read Block), which appears to have remained stable while subsidence was bringing about the Owen Graben to the south & to the east. It is therefore suggested that these faults developed essential satellite

faults of the Owen Graben. However the important trans-
current movements of the Mt. Read Block are thought to
be related to the Devonian orogeny, which further reacti-
vated the earlier lineaments of the Owen Graben (Plate VI).

Isostatic adjustments in the form of upheaval at
the edge of the subsiding basins took place in various areas.
The more pronounced was the uplift of the Sticht area, which
gradually rose as prominent cordilleras east of the sinking
strips. These adjustments are also suggested by gravi-
metric data recorded by geophysicists of the Rio Tinto
Company, who found abrupt mass deficiencies in entering
the Owen Graben across its eastern and western edges.

The greatest cumulative effect of uplifts and
subsidences is, in the West Coast Range, a vertical dis-
placement of the order of 4000 feet, as indicated by
the aggregate thickness of the Owen Conglomerate-Jukes
Breccia formations.

Correlations. The Ordovician faulting period
outlined in this and in a previous work (Campana et. al.,
1958), has not been reported elsewhere in Tasmania.
The Owen Conglomerate was, so far, considered as marine
shore deposits marking a sea transgression, and the
faulting at its edges was chiefly related to the Devonian
orogeny. Bradley (1954) and Wade and Solomon (1958)
inferred vertical movements contemporaneous with sedi-
mentation. Our interpretation of a continental graben
environment has been critically discussed by Hall and
Cottle (1959), Scott (1959) and Solomon (1959), but no
invalidating evidences have been advanced.

We have previously inferred that the Adamsfield
strip occupied by the early Paleozoic formations could also
represent a graben-like basin of Cambro-Ordovician age
(Campana et. al., 1958). This inference was chiefly based
on rock distribution and facies. The presence of Upper
Cambrian beds conformably overlain by the Owen Conglomerate
which has been recognised since our publication, would show

that no folding occurred at the end of the Cambrian sedi-
mentation, as pointed out above. On the other hand
striking changes in the sedimentary conditions must have
taken place at this time, for the trilobite-bearing shales
of the Cambrian succession are followed, according to
ye (1929) by a clastic sequence, with coarse conglomerates
at its base reaching hundreds of feet in thickness. This
conglomeratic sequence is considered coeval with the Owen
Conglomerate and Carey (1953) showed that it occupies a
belt extending meridionally for 45 miles and never exceed-
ing 5 miles in width. The facies and distribution of this
sequence, together with its conformable relations with the
Cambrian beds, little doubt that marked high-angle
faulting occurred in Lower Ordovician time in this area.
This faulting is regarded by us as coeval with and parallel
to that of the Owen Graben, some 30 miles to the west.

In other areas of West and North West Tasmania
the depositional conditions of the Lower Ordovician
Conglomerates are still obscure, so that the movements
which have controlled their sedimentation remain unde-
termined. However, local pene-contemporaneous faulting
must have occurred, for these conglomerates are generally
very lenticular and sporadically distributed. In contrast,
the overlying Tubicolar Sandstone and especially the Gordon
Limestone reflect, no doubt, the onset of stable and wide-
spread marine conditions which persisted throughout the
Silurian and Lower Devonian periods and brought about the
deposition of the Eldon Group (Plate VI).

(III) THE DEVONIAN OROGENY

(a) Folding characteristics

The Middle Devonian orogeny, which affects
Tasmanian and large areas of the Australian land mass, is
marked in the area under review by synclinal outliers of
Upper Ordovician, Silurian and Lower Devonian sediments
ranging from the Gordon Limestone to the Bell Shale
horizons.

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The axial trends of these folds is generally
north-north west, thus forming an angle of about 30° with
the Cambro-Ordovician lineaments described above. This
regular harmonic folding is particularly marked in the
Mt. Professor, Zeehan and Huskisson synclinoria, a fact
which is possibly in relation with the clastic nature of
the underlying strata. In contrast the Devonian folds
to be found within the Rosebery Volcanic Arc shows in
places trend differences and disharmonies which we are
inclined to relate to a more rigid substratum and to the
influence of earlier structural framings. A noticeable
feature in this respect is the superposition in Cambrian
rocks of Devonian lineation with a north-north west direction
to bedding with a north or north easterly strike (Plate V).
Equally significant for the distinction of the Cambrian,
Ordovician and Devonian movements are the difference be-
tween the original orientation of the depositional troughs
and the direction of their fold axes.

(b) Faulting system: Wrench and Cross-faulting

The distinctive cognate directions of the
Devonian faults which affect the area, have been mentioned
in the foregoing discussion of the earlier movements, and
are clearly illustrated by Plate V. It will suffice here
to draw attention to the occurrence of important wrench-
faults and cross-faults related to the Devonian orogeny.
The wrench-faults have a marked horizontal slip and are
clearly due to compressive processes. They vividly
contrast with the Cambro-Ordovician faults which we believe
to represent normal tensional rifts, with little horizontal
components.

The most striking examples of Devonian Wrench-
faulting are the Jupiter Fault, and Henty Fault of the
Rosebery-Hercules area (Plate V), which have to be des-
cribed with some details because of their economic signi-
ficance. Rosebery and Hercules Mines, distance four miles

from one another, lie within an identical wall rock
environment comprising easterly-dipping hanging wall
slates, host-rock tuffs and footwall pyroclastics (Hall,
et al, 1953).

Intense shearing is common to the footwall rocks
of both mines and the ore is stated to be "markedly similar
and uniform in texture and composition." It is therefore
reasonable to assume that the ore-bodies occur at the same
stratigraphic level and, originally, along the same con-
tinuous structure. The strike of the host rocks and
lode formations of the two mines are roughly parallel,
but by projection there is a lateral off set of about
two miles between the lines of lodes.

From these lines of evidence the presence of
major post-ore wrench-faults has been inferred. This
inference is supported by other stratigraphic and structural
data from the area. The displacement along the Jupiter
Fault is admirably shown between the Salisbury workings
and Moores Pimple by the off-set of the Fuchsite Conglomerate
and Stitt Quartzite marker beds. The Conglomerate, for
example, is cut off by the fault between the Rosebery
Cemetery and Jupiter Mine, and displaced south-westerly
to reappear about half a mile north-east of Moores Pimple.
The horizontal movement involved is of the order of two
miles, the Mt. Read Block being displaced south-west.

The strike of the Jupiter Fault is 25° true north,
and by projection it would extend N-N.E. through Rosebery
township. Its actual trace is marked by the abrupt
termination of the bedded footwall pyroclastics against
the massive volcanics of Koonya Hill, well shown in
particular by the Barker Road Slates which abut against
the volcanics between the rifle range clubhouse and the
main road. In the Rosebery township area, this Fault
would be marked by the southern limit of the Rosebery host-
rocks, as mapped by the E.Z. Company geologists, near the
Catholic Church.

Conspicuous cross-faultings with horizontal displacements reaching locally a mile or so occur at Mt. Lyell, where they have been described by various authors and more recently by Wade and Solomon (1958). The faulted zone is described as extending for many miles in E-W or N-N.W. directions, and the intersections of these cross-structures with the north-trending lineaments of earlier times are considered important loci for mineralization (Gregory, 1905; Ball and Cottle, 1959). The large trans-current movements of the Rosebery area would post-date the ore deposition, but the deep-seated faulting process was no doubt initiated in earlier times, as already pointed out, and could therefore have played an important role in the localisation of ore deposits. However, in the writer's view, the control of mineralization was chiefly provided by the reactivated Cambro-Ordovician rifts, and in particular by the Owen Rift.

(IV) THE POST-DEVONIAN FAULTING MOVEMENTS

The Devonian orogeny brought about terrestrial conditions all over the area, which remained emergent from Upper Devonian to Permian times. The Tabberabberan chains of mountains were planed down in the course of the Carboniferous period, so that the deposition of the Permo-Triassic succession took place on a subsiding surface which was almost reduced to a peneplain. These Permo-Triassic beds have been dismembered and variously uplifted by Jurassic and Tertiary movements, but wherever their bases can be identified, it shows an even depositional surface over long distances (Figs. 8, 9). In the area under consideration this surface is almost horizontal or only slightly tilted, thus proving the epeirogenic nature of the Permian sinking and the post-Permian upheavals.

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The order of magnitude of the Permian sub-
sidence cannot be estimated in this area because the basal
portion only of the Permo-Triassic succession is preserved.
The maximum uplift over the present sea level is shown by
remnant of the Permian depositional surface found between
2500' and 3300' at Mt. Sedgwick, Mt. Dundas, Mt. Read and
at Perrins Bluff, east of the Sticht Range.   These remnants,
now isolated by erosion, appear to have been part of an up-
lifted but continuous surface, for no step fault can be
recognised between them.   They would belong to a block-
faulted unit for which the name Dundas Block is proposed.
This shows an uplift of about 2000' in respect to another
block - the Zeehan Block - which is marked by the deposit-
ional surface of the Zeehan Tillite in the Montana Mine
area, at about 700' above sea level.   The intervening scarp
is formed by the steep eastern slopes of Mt. Dundas, at the
foot of which one would expect to find a major post-Permian
fault, forming a straight and long break between the Mt.
Dundas and the Zeehan blocks.   However we were unable to
identify this post-Permian break, and it is therefore con-
cluded that the Permian movements took place chiefly along
older lines of weakness, giving rise to local steps of
variable elevation and orientation.   As these steps have
been deeply eroded by the present cycle of denudation, the
dismembered Permian levels are difficult to recognise, and
therefore the relative displacements can be estimated in a
few areas only.

The forthcoming contour maps, coupled with
accurate field observations, may allow a more accurate study
of these movements and of the Permian surface of deposition.
In this manner we were able to infer that the pre-Permian
rocks of the West Coast Range that outcrop at present above
3200' elevation, must have formed monadnocks that reached as
much as 1000' elevation above the Permian peneplain (Plate VI).

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This is shown by the conditions in the Mt. Dundas-Mt. Sedgwick-Perrins Bluff area, where the elevation of Permian depositional surface does not exceed 3200'. These data also show that the present relief of the West Coast Range between Mt. Sedgwick and Mt. Murchison is due to differential demudation, which has isolated the resistant slabs of the Owen Conglomerate from the more easily eroded Cambrian rocks that surround the conglomeratic peaks.

ECONOMIC GEOLOGY: AGE AND CONTROL OF MINERALIZATION,
RESULTS OF THE EXPLORATION PROGRAMME AND RECOMMENDATIONS.

(1)   AGE AND STRATIGRAPHIC DISTRIBUTION OF MINERALIZATION.

In commencing the present programme of mineral ex-
ploration in West Tasmania, it was already well known that
most of the base metal deposits found in West Tasmania occur
within the Cambrian sequences (Carey 1953), and that metal-
liferous deposits of lesser importance also occur in Ordovi-
cian and Silurian rocks.   The age of the widespread
mineralization, with the exception of nickeliferous and
platinoid ores associated with basic igneous rocks of Cambrian
age, was considered to be Devonian and genetically related
to the Tabberabberan orogeny and diastrophism (Twelvetrees,
1908; Carey, 1953).

The study of sedimentation, tectonics and igneous
activity within the Early Palaeozoic terrains (Parts I and
II) was undertaken as the basis for a more critical analysis
of ore control within these sequences, which occupy the
greater part of the densely forested and uninhabited regions
within the R.T.A.E. exploration licence area.   As a result,
it was established that the most important ore-producing
deposits are replacement type bodies confined to the Early
to Middle Cambrian (pre-Dundas) sequences as shown in Table
II.   Likewise, the most productive of the fissure lode
systems are found to occur within the Early Cambrian rocks.

Earlier brief reference has been made to an important
mineralization in West Tasmania of Cambrian age (Campana et.
al. 1958) which has now to be considered in greater detail.

A.   Cambrian (Tyennan) Metallogenic Epoch.

Table II and Plate V show that the large copper-
lead-zinc ore-bodies of the Mt. Lyell and Rosebery-Hercules
groups occur in intimate association with Early to Middle

<u>Cambrian igneous rocks of the Rosebery Volcanic Arc.</u>   These
comprise prophyries and pyroclastics (Rosebery Volcanics)
which grade to granite porphyries in the Murchison River
gorge, and to porphyritic granite at Mt. Darwin.   Dis-
seminated copper and iron sulphides also occur within the
massive porphyries in many areas, for example Red Hill,
Lake Dora and Lake Selina.   This close association of
the copper-lead-zinc deposits and the porphyries was earlier
recognised by Carey (1945) and by Twelvetrees (1908 p.166)
who questioned "whether some ore-deposition (copper) is
not connected with the porphyroid or granite eruption of
Cambrian age."

The Mt. Darwin-Mt. Lyell-Red Hill mineralized
porphyry belt is flanked to the east by Owen Conglomerate of
Lower Ordovician age, which forms in places a well defined
wall rock of the major ore-bodies.   In spite of this dis-
position, no indisputable evidence of epigenetic sulphide
mineralization is found in it throughout the West Coast
Range.   The same applies to the Jukes Breccia which under-
lies the Owen Conglomerate.   Although the Jukes Breccia is
comparable in petrological composition to the underlying
volcanics and can be considered equally favourable for
sulphide replacement it has proven unmineralized throughout.

It was suggested in a previous contribution (Campana
et. al. 1958) and confirmed by subsequent investigations
(Plate V) that the copper-lead-zinc deposits of Rosebery and
Hercules and the large pyritic body of Chester, lie on the
same regional structure and within the same volcanic suite as
the copper mines (Campana et al, 1958).   They also have in
common a restricted range of metalliferous constituents,
essentially chalcopyrite, pyrite, galena and sphalerite, in
varying proportions, while the presence of barytes in the
gangue and noteworthy amounts of gold in the sulphides are
mineralogical characteristics which, in West Tasmania, are

unusual other than at Rosebery and Hercules Mines.   Barytes
is also a common gangue mineral at Chester.

The dismembering of the Hercules-Rosebery minerali-
sed level by Devonian faulting (Jupiter Fault, Plate V) is
further evidence that these deposits ante-date the Devonian
faults which at Chamberlain, Salisbury and Mt. Black Mines
are significantly characterised by a mineral assemblage that
is absent in the local replacement deposits.   It includes tourmaline
fluorite and wolfram (Waller, 1902) which it will be shown below
are characteristic of the Devonian mineralization.

These lines of evidence leave little doubt, in our
opinion, that the large pyritic copper and copper-lead-zinc
replacement type deposits flanking the West Coast Range are
genetically related to the emplacement of the Rosebery
Volcanics.

This association of the metalliferous mineralization
with porphyries and pyroclastic rocks, closely compares with
the conditions of well known deposits of copper, lead, zinc,
silver and gold exploited in many parts of the world and
forming the important group of mesothermal deposits of Lindgren
(1933).   In particular, the copper ore-bodies of Mt. Lyell
and those of Rio Tinto in Spain show so many similarities of
paragenesis and mode of occurrence that their common genetic
                  can
traits/hardly be questioned.   Indeed, according to Lindgren
(p.618), "the deposits of Rammelsberg, of Mt. Lyell, of Rio
Tinto, Spain, of Shasta County, California, may serve as
examples" of "class 2" (Pyritic replacement deposits) "con-
nected with the eruption of igneous rocks, but (in which) the
high-temperature minerals are absent".

At Mt. Lyell (p.622) "the ore consists mainly of
fine-grained pyrite with some gangue of quartz and barite.
It also contains (up to) 5 to 6 per cent of copper in the
form of chalcopyrite, more rarely bornite and enargite.

Pyrite is the oldest mineral, it was followed by chalcopyrite, bornite, enargite and tetrahedrite. The ore-bodies replace sericite schists, which are dynamo-metamorphic of perhaps (now definitely established) Palaeozoic acid porphyries".

At Rio Tinto, Spain (p.624) "the ore consists chiefly of almost massive pyrite. The succession is pyrite, chalcopyrite, sphalerite, galena. Tetrahedrite and enargite are present". Several varities of porphyries, including rhyolite porphyry and keratophyre are to be found in close association with the ore-bodies and "in places the porphyry is affected by shearing and schistosity. In the latest contribution by Finlayson and Bateman it appears firmly established that the deposits were formed by hydrothermal replacement of crushed and sheared zones." This view is entirely confirmed by the later work of D. Williams, for whom "the intense sericitisation and chloritization of the wall-rocks, the absence of typically high-temperature minerals, the presence of free silica and primary sulphates, and the existence of sulphides characteristically associated with aqueous solutions all imply that hydrothermal action must have played an important role in the formation of the ore-bodies. It is considered that <u>the sulphides were deposited from solutions genetically related to the porphyries and were derived from the same primary magma</u>".

More recently the genesis of mineral deposits related to the spilitic-keratophyre rock suite has been reconsidered by Amstutz, Professor at the University of Missouri School of Mines (Amstutz, 1958, 1959). This author considers that "spilites and keratophyres are primarily magmatic rocks. Later hydrothermal stage of spilites also lead to the accumulation of metallic elements such as silver, copper, gold and probably also nickel and cobalt. Commonly a portion of the volatile fraction of spilitic magmas escapes also in adjacent rocks and produces

replacement deposits.   Spilitic ore deposits are basically
syngenetic (that is coeval with the spilite and keratophyre
emplacement), just as are many propylitic alterations."

It is thus seen that field evidence as well as
authoritative studies and conclusions on the subject leave
little doubt on the genetic relationship between porphyries,
spilites or keratophyres and the mineral deposits associated
with them.   Thus the replacement deposits of Mt. Lyell-
Rosebery area are considered by us as genetically related
to a metallogenic phase broadly coeval with the emplacement
of the Rosebery Volcanics, of a pre-Upper Cambrian age.
The minor nickeliferous sulphide deposits (Williams, 1958)
and alluvial concentrations of osmiridium (Elliston, 1953)
and chromite, which are clearly derived from associated basic
and ultrabasic igneous rocks of pre-Ordovician age, are of
common occurrence in West Tasmania and may also be genetically
related to basic derivatives of the pre-Upper Cambrian igneous
activity and metallogenic epoch.

The case for associating the major copper-lead-zinc
deposits of West Tasmania with the Devonian metallogenic
epoch, as previously generally accepted (Hills, 1915; Carey
1953) was largely based on general considerations.   However
these deposits are clearly of high temperature (mesothermal)
origin and yet the nearest outcrops of Devonian granite are
many miles distant from Rosebery and Mt. Lyell.

It will be shown below that, elsewhere in West
Tasmania, high temperature replacement bodies of Devonian
age are found only in close proximity to the granite or
its apophyses, and are frequently stanniferous, while the
lead-zinc and subordinate copper mineralization of like age
is almost exclusively found as epithermal fissure lode
systems with distinctive mineralogical characteristics.

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The essentially unstressed condition of the ore in contrast to the intensely deformed footwall rocks of Mt. Lyell, Rosebery and Hercules Mines has been advanced as evidence that the ore is Devonian in age (Solomon, 1959). However, it was pointed out in Part II of this work that the schistose zones within the volcanics are primarily the result of Early Cambrian (Meridional) rather than Devonian (N.N.W. — S.S.E.) faulting, as testified further by the presence of stressed volcanic rocks in the Ordovician conglomerates.   The inference is that the Cambrian schists associated with the ore deposits reflect a major structural weakness which controlled the mineralization rather than a post-ore (Devonian) deformation.

The fact that the Owen Conglomerate has been locally schisted in Devonian time does not invalidate this interpretation, since the Cambrian faults have been rejuvenated in Ordovician and in Devonian times, as shown above.   On the other hand it is quite possible that the Cambrian orebodies have been, to some extent, mobilized during the Devonian orogeny, so that any previous textural stress would have been obliterated.

Finally another fundamental datum has to be considered in relation to our future exploration work, i.e. the vertical range of the hydrothermal replacement mineralization.   It is known that many mesothermal deposits of the West Coast Range "have a vertical range of 5,000 feet or even more.   Many of them continue to the greatest depth reached in mining" (Lindgren, p.531).   At Mt. Lyell the proved range of mineralization is already in excess of 1500 feet, and the ore persists beyond the explored depth with unchanged general characteristics.   At Rosebery the ore lodes persist in tested range of more than 2000 feet and nothing suggests an early end in depth.   It follows that

these large replacement deposits are not necessarily exposed
at the surface, which is just a fortuitous plane of erosion,
and in fact the presence of concealed ore-bodies was estab-
lished at Mt. Lyell, Comstock and Hercules.   Indeed, judging
from the extensive and persistent vertical range of minerali-
zation in the West Coast Range, it can be safely inferred
that erosion has just reached the top part of the level of
mineralization which may well exceed 4000-5000 feet.   The
probability that other concealed deposits occur within this
range is indeed strong, and should provide a great stimulus
for carrying out, in G. Hall's words "drilling and still
deep drilling".

B.   Devonian (Tabberabberan) Metallogenic Epoch

The metallogenesis which accompanied the Devonian
orogeny and diastrophism is represented throughout the
Palaeozoic rocks of West Tasmania by a wide range of ore
deposits ranging in type from pegmatitic and pneumatolytic
concentra tions to replacement bodies and epithermal fissure
lodes and which are zonally arranged about the parent granites.

The Zeehan area provides a clear example of this
zonal distribution of the metalliferous mineral deposits in
relation to the granite massif of Mt. Heemskirk, both in
mineralogical assemblage (Waller, 1904; Twelvetrees and
Ward, 1910) and in the various forms assumed by the minerali-
sation.   Within the granite and its apophyses are the primary
hypogene veins and segregations containing cassiterite and
wolfram associated with quartz, tourmaline and monazite
as found at Mt. Heemskirk (Waterhouse, 1915, 1916).   At
the borders of the granite and within the limits of the
metamorphic aureole, the vein deposits and fissure lodes
are characterised by a wide variety of metallic sulphides
including pyrite, chalcopyrite, pyrrhotite and tetrahedrite
in association with cassiterite, tourmaline and fluorite

(Maynes and Globe Mines), while segregations of pyritic
magnetite are locally found where the granite is in contact
with older basic igneous rocks (Tenth Legion).

Beyond the contact aureole of the Heemskirk granite,
the related mineralization is of the hydrothermal type and
is represented almost exclusively by fissure lode deposits.
West of Zeehan, and nearer the granite, the lodes are com-
monly of complex composition, including abundant pyrite
with sphalerite and antimonial ores in association with sub-
ordinate galena (Comstock, Swansea, Sylvester, Silver Stream,
Spray)and in places nearby porphyry dykes are accompanied
by cassiterite and stannite (Oonah, Clarke's Lode, Taylor's
Lode, Bradshaw's Lode). These are bordered to the east
by the epithermal argentiferous galena lodes of Zeehan
(Montana, Western Argent, Silver King, Silver Bell) in which
there is a paucity of other sulphides and commonly an
abundance of siderite in the gangue.

Likewise, in other areas, the type of mineralization
would vary at progressively increased distances from the parent
granitic rocks. Pegmatitic and pneumatolytic cassiterite-
bearing veins are found in the granites of Meredith Range,
Mt. Ramsay and Granite Tor (Ward, 1908). The large
pyrrhotite-cassiterite ore-bodies and associated vein de-
posits of Mt. Bischoff and Renison Bell occur in intimate
association with intrusive bodies of porphyry, and greisen,
carrying cassiterite and tourmaline, together with other
accessory minerals which are characteristic of the Devonian
granitic rocks (e.g. fluorite, monazite, topaz, bismuthinite
and wolframite of Mt. Bischoff).

Fissure lodes to be related to the Devonian min-
eralization are of widespread occurrence throughout the
Early Palaeozoic rocks. These would include the stanni-
ferous quartz-tourmaline lodes of Pine Hill and Exe River,

the stanniferous quartzo-pyritic lodes of the Athenic-
Olympic and Razorback-Grand Prize groups, and the complex
pyritic and antimonial ore types of North-East Dundas (Curtin
Davis and Ring Valley).   Silver-lead and sphalerite fissure
deposits comparable with those of Zeehan occur in the Mt.
Farrell-Sterling Valley, Success and Owen Meredith and Comet
groups of mines.   The presence of bismuthinite with the
antimonial lead ores of Curtin Davis and abundant fluorite
in some places (Thomas' Blocks, Mt. Farrell) with the galena
are evidence of their granitic parentage.

(II)   STRUCTURAL AND STRATIGRAPHIC CONTROLS

For the purpose of evaluating the mineral potenti-
alities of the region, the various sulphide deposits can be
conveniently ranged into two main groups.   These are the
replacement deposits which comprise the main producing mines
worked at present, and the fissure lodes which have been ex-
ploited in many parts of the West Coast but are now generally
abandoned.

A.   Replacement Deposits

The large replacement ore deposits of Mt. Lyell,
Hercules, Rosebery and Chester occur at intervals along a
major Cambrian fault lineament which has been previously
named the Owen Rift Fault (Campana et al, 1958).   This
deep seated structure is marked by zones of intense shearing
which are a characteristic of the footwall rocks at each of
the mines.   It is generally accepted that part of the
structure known at Mt. Lyell as the Great Lyell Shear, ex-
tends northerly along the margin of the West Coast Range
to Gooseneck.   Between Gooseneck and Rosebery, the Owen
Rift Fault is off-set to the west by the Henty and Jupiter
wrench faults (Plate V), beyond which it continues northerly
along strike with Gooseneck and Mt. Lyell.

The Owen Rift Fault is considered to have provided access for mineralized solutions which led to the development of replacement ore deposits under locally favourable stratigraphic and structural conditions. At the Rosebery and Hercules Mines, the ore-bodies occur within a particular bed, described as the host rock tuff by Hall et al (1953), while the ore shoots are structurally disposed along the strike and dip of the fracture cleavage.

In recent works by Wade (1958) and Hall and Cottle (1959), it was suggested that cross-structures have played an important role in localising the Mt. Lyell ore-bodies. Reference was made above to the presence of large scale trans-current faulting which occurs in the vicinity of the mines at Rosebery and Hercules. The movements along one of these, the Jupiter Fault, disrupted and displaced the mineralized zone of Rosebery-Hercules, and would be of Devonian age. However, it will also be observed that another of these the Henty Fault, corresponds with a line of deep-seated movement which delimited part of the Owen Graben in Lower Ordovician time. Thus we would postulate that the Jupiter and Henty wrench faults mark older branch structures of the Owen Rift Fault and may have influenced ore deposition prior to re-activation during the Devonian orogeny. The same may also apply to the system of cross-faulting which off-sets the mineralized bodies of Mt. Lyell.

We are thus also inclined to consider cross-faulting as a relevant factor in the localisation of the Cambrian ore deposits.

The conclusion is that the copper-lead-zinc replacement deposits of the Cambrian metallogenic epoch are fundamentally controlled by deep-seated Tyennan fault structures and hence would be confined to Early Cambrian or older rocks. The Early Cambrian sequences, especially the tuffs and bedded dolomitic members, have proven to be the most favourable for sulphide replacements.

The large stanniferous sulphide bodies at Mt.
Bischoff and Renison Bell are likewise replacement deposits
in a dolomitic bedded sequence of Early Cambrian age.   A
possible relation of the Mt. Bischoff deposits with the
Cambrian rift faulting was suggested in an earlier work.
However, as only one of the two like deposits would lie on
the projected rift structure, and as the mineralogical com-
position of these ore-bodies are more characteristic of the
Devonian mineralization, it is considered unlikely that the
tin-bearing deposits are related genetically to the porphyry
copper-lead-zinc ore-bodies, but would be primarily con-
trolled by the favourable carbonate rocks within the aureole
of the Devonian granite.

Replacement phenomena and wall rock alterations are
absent or only of minor importance in other metalliferous de-
posits which are referred to the Devonian metallogenic epoch.
Thus in the Ordovician Gordon Limestone (Oceana, Mariposa,
Despatch Mines of Zeehan) which would be especially liable
to replacement, the principal ore shoots are confined to
faulted and brecciated zones, with only sparsely disseminated
mineralization extending into the wall rocks.

B.   Fissure Lodes

These include the majority of the ore deposits
found and exploited during the early history of West Tasmania,
which were readily detectable by superficial prospecting.
Many of these deposits were mined at a profit, particularly
those of the Zeehan district which contained relatively
clean shoots of richly argentiferous galena.   The mining
operations at Zeehan and elsewhere disclosed that the pay-
able fissure lodes were invariably limited in dimensions,
both laterally and in depth, and most of the mines ceased
operations by the year 1910.   An exception is the Mt.
Farrell group of mines, which have been worked on a small
scale since 1899, although the original North Farrell Mine
was closed in 1933 at a depth of 878 feet.

In view of the consistently poor record of per-
sistence of the ore shoots within the fissure lodes, only
the more outstanding deposits of this type (Zeehan, Mt.
Farrell, Comet) have been examined in detail in the course
of the exploration programme.

Most of the fissure lode deposits occur within
the early Cambrian sequences (Table II) but others of
similar structural disposition and mineralogical composition
are found in rocks ranging up to Lower Devonian in age.   The
trend of the lode deposits is dominantly meridional and would
mark both Cambrian (N-S to N.E.) and Devonian (N.W. to N-S)
structural elements.

The structural pattern and stratigraphic setting
of the lodes in the most productive northern portion of the
Zeehan mining field has been investigated.   The main lodes
in this area occur within the early Cambrian sequences and
vary in strike from north-westerly to north-easterly.   The
lode fissures are truncated by at least two post-ore thrust
faults, which Waller (1904) tentatively suggested may have
pre-dated and channelled the ore solutions.

The movement on the Oonah thrust fault brings the
pyritic and stanniferous galena lodes of Oonah Mine and
Queen Hill into sharp contact with the sideritic galena
lodes of the Montana and Western properties.   At a depth
of 1000 feet in the Western Mine, however, the composition
of the lodes was observed to be more pyritic (with chalco-
pyrite) and more akin to the lodes of the Oonah-Queen groups.

The Montana fault (Main Slide of Waller, 1904)
marks the eastern limit of the rich sideritic galena lodes
and also truncatesthe extensive intrusions of melaphyre
which are believed to have had an influence on localising some
of the richer ore shoots (Thomal, 1895).   Thus it is believed
that the post-ore thrust-faulting involved appreciable movements,
which are also reflected by the cross-faulting of the Ordovician-

Devonian sequences of the Zeehan Syncline and similarly affected the Permian Tillite near Zeehan (Campana and King, 1958).

The lodes within the Middle to Upper Cambrian sequence (Dundas Group), while particularly rich in the Argent Flat, are less persistent and less well defined than those within the more competent early Cambrian rocks. The same applies to deposits in the Ordovician-Devonian fossiliferous sediments, although stratigraphic controls appear to have had a greater influence on localising ore in these beds.   Fissures within the Ordovician Gordon Limestone are invariably mineralized and in places were productive (Oceana, Mariposa, Despatch).   Other productive mines including the Silver Bell and Silver King are within calcareous shale horizons of Silurian age.   Likewise, the rich lodes of the Florence Mine, previously considered to be in Gordon Limestone (Ed., 1953), is also in the Silurian calcareous beds.

(III)   SUMMARY OF EXPLORATION RESULTS AND RECOMMENDATIONS

The exploratory work in West Tasmania has been directed, from the very beginning in accordance with the Company's general policy, towards recognizing the potentialities of our property for medium to large scale operations.   It was recognized that only replacement deposits of the type described above were likely to yield an adequate tonnage, so that the fields characterized by the high-grade but narrow and generally shallow fissure in-filling deposits were not investigated in detail except for the Zeehan field.

In spite of the remoteness of the area investigated and the difficulties of access, all the favourable ground between the southern boundary of our property and the basaltic plateau of Waratah has been studied and largely mapped at the scale 4 inches to 1 mile by keen and experienced

geologists. The water courses of this area have been
systematically explored, and accurate records of rock and
mineral exposures have been compiled. No exposed ore-
bodies were discovered, and the probabilities of outcrop-
ping ore-bodies, having been missed by our parties, is in-
deed very small. But the structural and stratigraphic
environment favourable for repetition of hidden deposits
of the Mt. Lyell or Rosebery type has been undoubtedly
delineated on the basis of geological data and inferences
which appear to us undisputable. By progressive elimina-
tion the favourable ground has been reduced to 15-20 square
miles, and has been recommended for geochemical and geo-
physical ground survey.

The ground explored so far by ground geophysical
and geochemical methods is represented in the accompanying
map (Plate V), which shows the discovered anomalies in
relation to the fundamental structural, stratigraphic and
mineralization traits of the area. The geophysical
anomalies have been described by E. McCarthy, Senior Geo-
physicist, and by J. Boniwell, Geophysicist, in a series
of progress reports. The corroborating geochemical data
have been regularly reported by our Geochemist, E. Muceniekas,
who carried out the related field work.

The more significant results are tabulated below
(Table III).

It is thus recommended that the following geo-
physical-geochemical anomalies be adequately tested by
diamond drilling and/or by trenching and pitting:-

1. West Sedgwick by diamond drilling.
2. Howard (anomaly at the contact Cambrian Volcanics –
Owen Conglomerate) by diamond drilling.
3. White Spur, western anomaly by diamond drilling.
4. Sterling Valley by diamond drilling.

5.   North and South of the Pinnacles Mines by trenching.

6.   Chester Mines by diamond drilling, if the geophysical
     work carried out at present confirms earlier gravi-
     metric results.

These testing operations are primarily directed
at discovering economic mineralization.   They would also
give us invaluable indications on the validity of the con-
clusions reached by surface exploration, in particular
by geophysical and geochemical methods.

B. Campana,
Senior Regional Geologist.

D. King,
Geologist.

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   Met., pp. 249-262.

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   Tasmania, Pap. Roy. Soc. Tas., 88: 161-83.

TABLE II

STRATIGRAPHIC SETTING AND AGE OF SULPHIDE DEPOSITS

WEST TASMANIA.

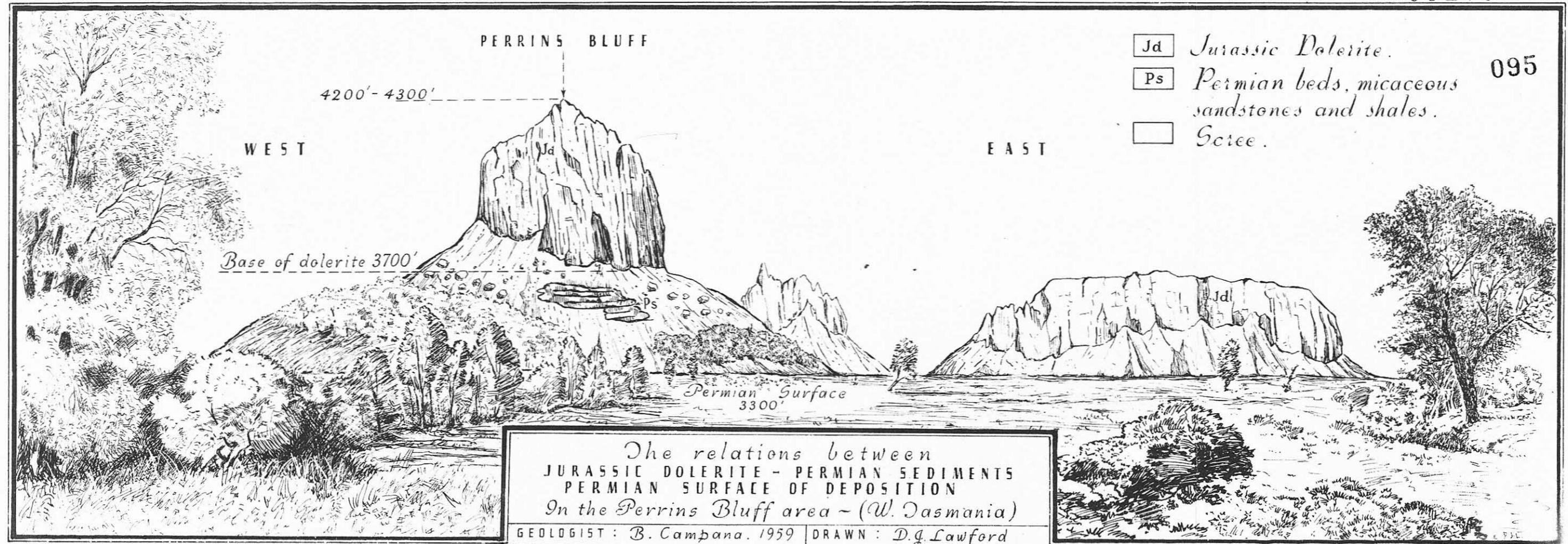| HOST ROCKS	REPLACEMENT DEPOSITS		FISSURE LODES
	Cambrian Metallogenic Epoch	Devonian Metallogenic Epoch	Devonian Metallogenic Epoch
Silurian (shales etc.)			Silver Bell, Silver King, Florence (Zeehan) N. of Firewood Siding.
Ordovician (Gordon Lst.)	~~~~~~~~~	Oceana, Mariposa, Despatch (Zeehan) White Hawk, Grieve Siding. ~~~~~	
Middle to Upper Cambrian (Dundas Group)	Cuni (Ni)	~~~~~ Razorback ~~~~~	Grand Prize, Federal and Dreadnought (Renison Bell). Exe River, Argent, Montagu, Maxim (Zeehan). Mt. Cleveland (?)
Lower to Middle Cambrian (Early Cambrian Sequences)	Mt. Lyell Hercules Rosebery Chester	Mt. Bischoff Renison Bell	Montana, Western, Oonah, Queen, Spray, Comstock, Sylvester (Zeehan) Comet-South Comet, Mt. Farrell-Sterling Valley, Success and Owen Meredith.

TABLE III

GEOPHYSICAL ANOMALIES AND RELATED GEOCHEMICAL AND GEOLOGICAL DATA (WEST TASMANIA, "STRAIGHTEDGE" ZONE)

| Locality	Geophysical Characteristics	Geochemical testing along the geophysical grid lines by field dithizone methods (unless otherwise indicated.)	Geological setting	General Assessment and Recommendations
Comstock	Four inductive anomalies two of which associated with significant & correlating ratio anomalies. Some positive gravity expressions correlate with both electrical systems. On geophysical evidence testing is recommended on line E at station 123 (McCarthy & Boniwell, 6/2/58).	Due to thick glacial and scree covering and to contamination from mining work geochemical testing has been omitted.	Cross-faulting zone towards the western edge of the Owen Graben (Comstock cross-fault zone). Country rocks are dynamo-metamorphosed Cambrian volcanics & (?) intrusive porphyries, largely covered by moraines & scree. Economic mineralisation occurs within a radius of ½ mile from any of these anomalies (Comstock & Tasman Cu-Pb ore-bodies). Geological environment generally favourable.	Decisions on drilling is to be made in relations to the results of testing by the Mt. Lyell Company.
West Sedgwick	Two separate areas of electrical disturbances. The first poorly defined to open to the east, with patchy correlations between peak phase & ratio anomalies, suggesting widespread haphazard pyritic mineralisation. No gravimetric correlation was obtained. The second is a well delineated system of two segments, with a fair order & good quality of the peak electrical anomalies. Broad ill-defined zone of positive gravity. On gravimetric evidence it is thought that only minor mineralisation can be present (Boniwell 7/3/58). However, the gravimetric data in this area are considered unreliable by McCarthy, who recommends the testing of the second anomaly.	The first (Lyell-Sedgwick) zone of electrical disturbance corresponds to a zone of positive geochemical reactions found in sandy silts along creeks. The second (West Sedgwick) corresponds to a well defined zone of geochemical anomalies measuring about 3500' in length & 600' in width. The ground is covered with scree from Owen Conglomerate to the east & only in few places residual soil at the western part of the anomaly is available for testing. The best parts of the zone show high mineralization but in Muceniekas' opinion this is due to high ion availability of wet soil-sands in citric acid extract. This was confirmed by three spectro-analysis samples showing that the surface mineralisation is only slightly above background. From our experience in West Tasmania samples of accumulated manganese dioxide with high Zn Pb and Co concentration can be taken only as a general indication of mineral occurrence.	Eastern edge of the Owen Graben (Straightedge) along or near the northern extension of the Mt. Lyell Shear. Country rocks are schisted Cambrian volcanics and slates. The nearest known ore-body is at a distance of about 2 miles (Mt. Lyell, Comstock). The area of geophysical anomalies is generally covered by heavy scree, but grey to black slates tectonically brecciated and showing sparse pyritic mineralisation occur at 200-400' from the second (West Sedgwick) anomalous zone. Felspathic breccias & agglomerates much altered & white hydrothermally (?) bleached material with pyritic veins occur at the eastern end of the geochemically-geophysically anomalous zone.	Drilling of the West Sedgwick is recommended on the following grounds: 1. Good electrical expression. 2. Remarkable geochemical correlation. 3. Favourable structural and stratigraphic environment. The drilling should reach a depth of 500 feet at least.
Howard	Four dominant linears & two lesser & more discrete anomalies have been recorded in the electrical surveys. These were partly covered by gravimetric pre-filling showing marked contrasts in density implicit to structures and/or geological contrasts. As these density boundaries conduct, the four main electrical linears are interpreted as arising from zones of bedrock shearing (Boniwell 8/5/59). The anomaly associated with the Owen Conglomerate contact is regarded to warrant more study.	The soil conditions are good for geochemical investigations except for some swampy areas to the north. In zone 1 of this area the best geochemical anomaly of West Tasmania has been recorded. Spectroanalysis of one sample indicates 1.5% Pb & 0.5% Zn. This anomaly extends in a north-south direction for 5000' with variable values. It correlates fairly well with one of the major linears described by Boniwell. A second anomaly has been recorded on the geophysical anomaly at the contact with the Owen Conglomerate. It shows a medium degree of mineralisation from the geophysical peak up to 200' to the east. It is considered significant owing to the fact that it is near the base of the Owen Congl. which is entirely barren, and also because it is definitely related to in situ rocks. In general the geochemical results of this area correlate well with geophysical indications.	Along the western edge of the Owen Graben, on or near the northern extension of the Mt. Lyell Shear (Owen Rift). Country rocks are Cambrian volcanics porphyries, keratophyres, etc.) & some slates. Surface mineralization has been noted within the area surveyed (Tyndall Mines, etc.).	Scout drilling of the electro-gravimetric anomaly at the contact of the Owen Conglomerate with the Cambrian volcanics now requires consideration on the following grounds: 1. The Lyell Shear (Owen Rift) has never been drilled in this zone. 2. Geophysical results, although difficult to interpret, leave at least room for possible mineralisation. 3. The setting is similar to that of the Corridor ore-body at Mt. Lyell. 4. Valuable data on the significance of geophysical anomalies in this area and on structural control would be obtained. Boniwell (8/5/59) recommends a 1000' drill-hole sited on line 48S at station 8E, bearing east, with a depression of 45 degrees. Some detailed geological & topographical survey is recommended before making final decisions on drilling operations. The zone showing a top geochemical anomaly coinciding with a strong electric conductor should also be tested, at least by trenching.
Lake Dora	Inductive anomaly near the contact Cambrian Volcanics - Owen Conglomerate. This anomaly is of good order & quality, & lies on the axis of the main aeromagnetic ridge of this area. The high conductivities suggest either fairly massive mineralisation or incidence of graphite. However gravimetric testing was negative, & no further work is recommended on geophysical evidence (Boniwell, 21/4/58).	The inductive geophysical anomaly correlates well with a group of high to medium geophysical anomalies (Muceniekas 25/4/58). It is considered as a second order anomaly.	Broadly speaking, the geological environment is favourable, as the geophysical & geochemical anomalies occur along a faulted (and mineralized) belt forming the eastern edge of the Owen Graben. However major ore-bodies are not known to occur along this belt, and the actual anomalous area is covered by soil and peat.	As a drilling target the Lake Dora anomaly appears doubtful. The remoteness of the area is also a serious disadvantage. No drilling work is therefore recommended at this stage.
Gooseneck	An important electromagnetic anomaly has been recorded over a length of 4000'. The disturbance has been proved to be due in part to sulphide mineralisation chiefly pyrite & pyrrhotite. Graphitic slates are also believed to be responsible for the conductor. Gravity correlation has been established; a magnetic anomaly was also present, although slightly offset to the east.	The area revealed a line of mineralisation coinciding with the geophysical anomaly. The results have been described in previous reports & have been taken into consideration in planning the drilling operations.	This anomaly occurs in what is believed to be the northern extension of the Mt. Lyell Shear zone (western edge of the Owen Graben). The structural and stratigraphic environment is considered very favourable.	The anomaly has been adequately tested by drilling. Mineralisation averaging 5-6% iron sulphide occurs but Cu Pb Zn content does not exceed 0.7%.
Sterling Valley	A major electrical conductor has been found in this area, crossing from north to south with only one apparent discontinuity. This conductor has been traced over a distance of 8000', and shows in places gravimetric effects which are considered by Boniwell as genuine expressions of excess of masses in situ (I. ITI 1955). A later test with afmag equipment and S.P. equipment confirmed the earlier results, although two conducting zones are indicated on line 52S (McCarthy 6/4/59)	The mineralized zones outlined by geochemical testing correlate in part with the geophysical anomalies. In particular anomaly 3 coincides with the northern end of the "shear" gravity anomaly (target No. 2 of Boniwell's report). This gravity anomaly has further mineralisation indicated by geochemical anomaly No. 4. The weak geochemical anomaly No. 5 coincides with the bedded anomaly of Boniwell.	The anomalous area occurs in strongly sheared slates, showing near-surface mineralisation at intervals and marking a major wrench-fault across the Owen Graben.	We are inclined to consider the type of mineralisation in the Sterling Valley-Mt. Farrell area as distinct in type and possibly in age from the Mt. Hercules-Rosebery mineralisation with Mt. Farrell deposits being narrow fissure infillings rather than replacement deposits. However drilling of the distinctive geophysical anomaly should no doubt be carried out.
Chester Pinnacles	Several narrow conductors have been found near the contact Cambrian slates-tuffs & porphyries between the Ballway Rivulet & north of Pinnacles. These conductors are however not regarded by Boniwell as related to sulphide mineralisation, as gravity testing being negative. At or near the Chester Mine conductors are generally weaker & of poorer quality except on line 112S. But a bright & stronger gravity anomalies are regarded by Boniwell (14/5/59) as due to large local density contrasts coupled with structural effects. Work in this area is still in progress.	Good geochemical correlations have been recorded on or very near the electrical conductors north of Pinnacles Mines (lines C.L. 4E) & south of this mine (lines 26S, 36S, 48E). Some of these are described as high Pb Zn anomalies (Muceniekas 2/4/59). Reconnaissance testing along the creek running west of Chester Mines has revealed a highly mineralized zone in clay flanking the creek over a distance of 200'. This anomaly lies about ½ mile south of Chester Mines, along the "Straightedge" line of mineralisation. The area has to be further investigated.	The structural zone in which these anomalies occur is considered by us as the northern extension of the Owen Rift, and it has many similarities with the Hercules-Rosebery Mines tectonic configuration. The Chester and Pinnacles ore-bodies prove the structure to be mineralized.	After completion and on the basis of the geochemical-geophysical works at Chester, the testing of this area by fairly deep drilling should be considered. It is also recommended to test by shallow drilling or trenching the geochemical-geophysical relations south and north of Pinnacles Mines.
White Spur	Three marked electromagnetic anomalies occur. The southern one appears to be formational, while the two others are discrete. Although field data are not fully analysed, it can be stated that one of these at least justifies testing by drilling. In fact it has been confirmed gravimetrically in an unambiguous manner, and also magnetically to certain extent (Mattocks, report in progress).	Apart from a few swampy patches, the soil conditions are favourable for geochemical testing. Scattered mineralisation has been placed only appear of interest from the geochemical viewpoint. Laboratory tests (HCl extract with dithizone carbon tetrachloride) showed low Pb-Zn content in slates, but none in porphyries. A few high readings along the contact shows Pb to be predominant (line 76S, 35S, 96S/100DH). Correlations with geophysical anomalies are poor. No marked results have been obtained on the anomalies.	These anomalies occur within the (offset) portion of the Owen Rift, in a belt of slates which are believed to represent the southern extension of the hanging-wall rocks of the Hercules Mines ore-bodies. Surface indication of mineralisation other than iron sulphide are scanty, but the general geological setting is favourable.	It is recommended that at least the more positive electromagnetic anomaly be drilled. In fact this anomaly is considered one of the more significant geophysical indications obtained in West Tasmania (Mattocks, report in progress).

The relations between
JURASSIC DOLERITE - PERMIAN SEDIMENTS
PERMIAN SURFACE OF DEPOSITION
In the Perrins Bluff area ~ (W. Tasmania)

GEOLOGIST: B. Campana. 1959 | DRAWN: D.J. Lawford
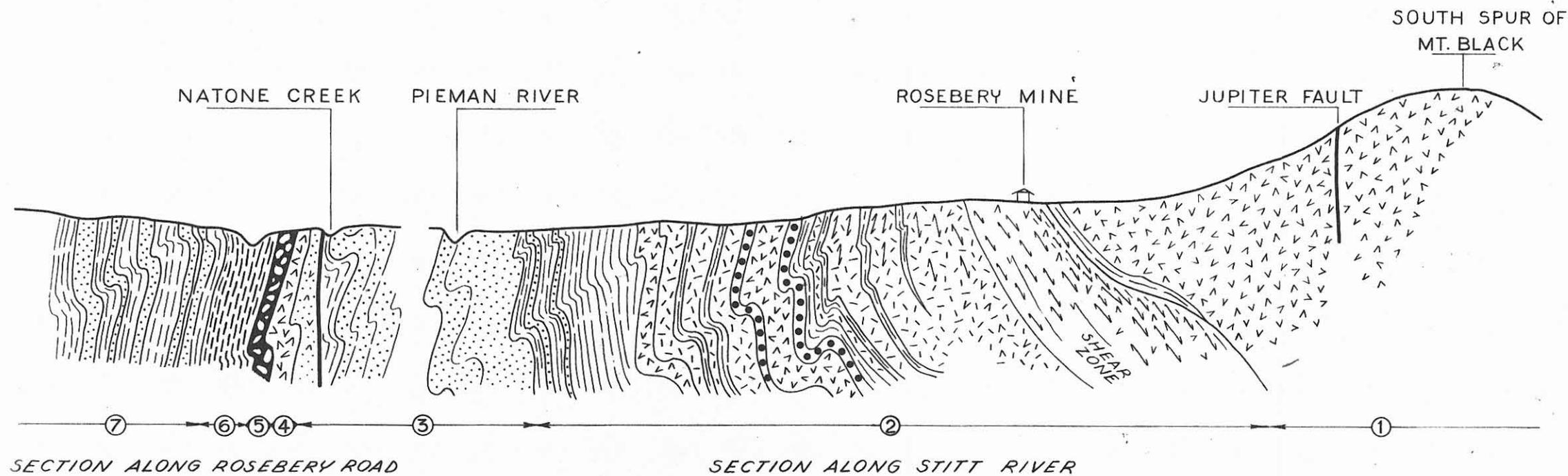
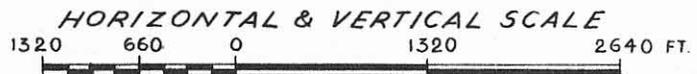THE EARLY CAMBRIAN SEQUENCE WEST OF ROSEBERY
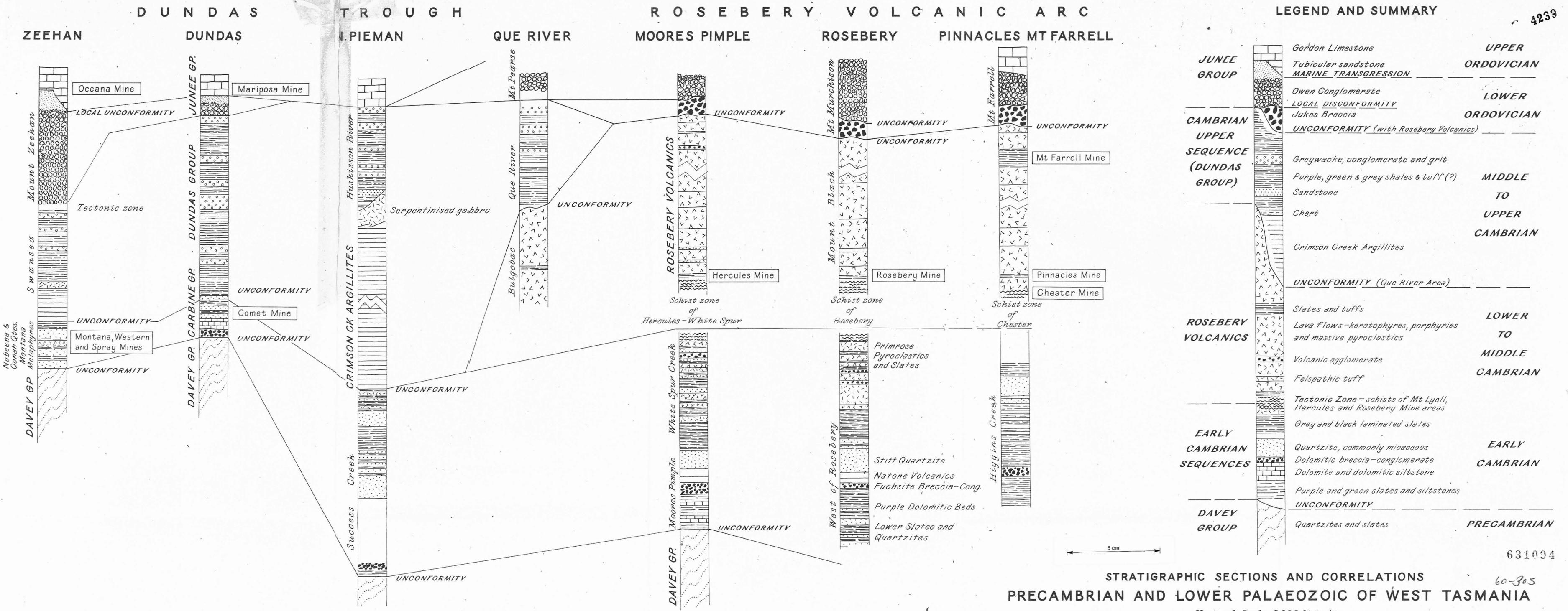
STRATIGRAPHIC SECTIONS AND CORRELATIONS

PRECAMBRIAN AND LOWER PALAEOZOIC OF WEST TASMANIA
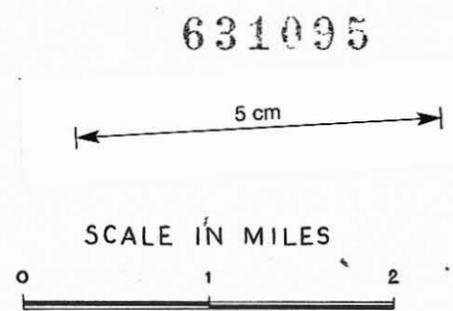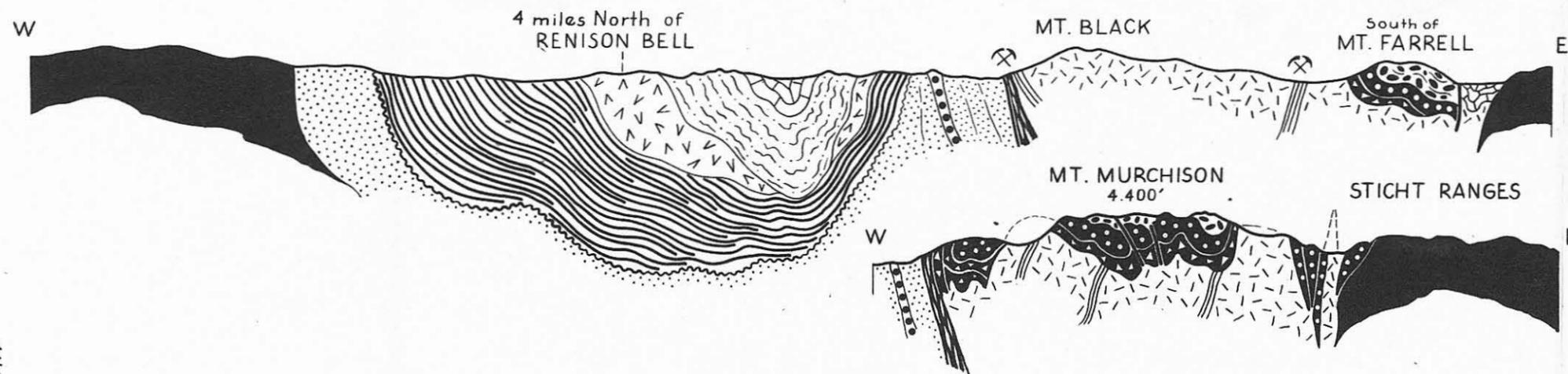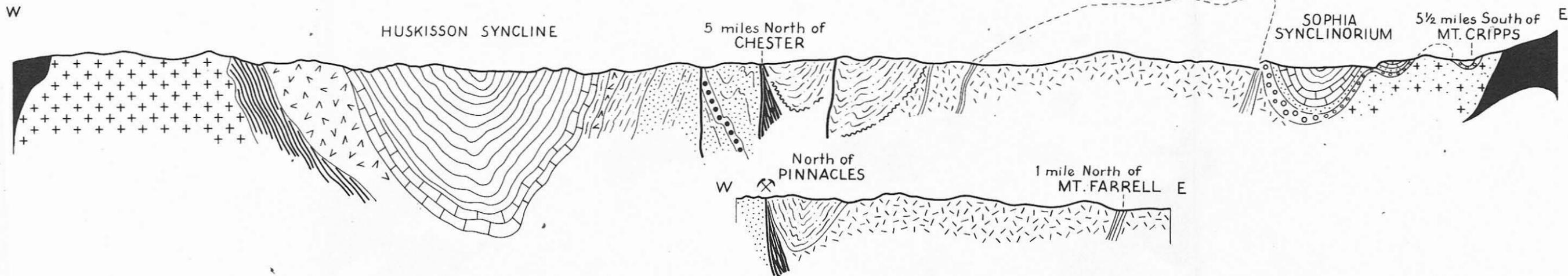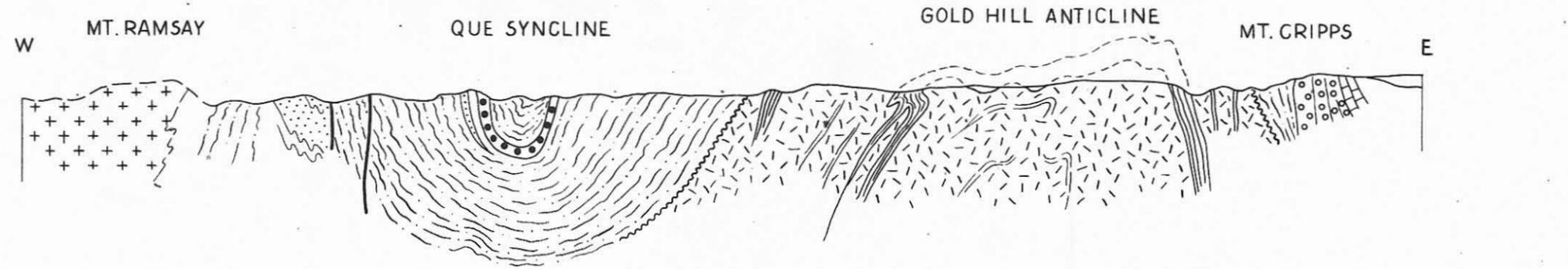
Vertical Scale 2,000 ft. to 1 in.

GEOLOGICAL SECTIONS
ACROSS THE
MT. RAMSAY - MT. CRIPPS -
-MT. MURCHISON AREA.
WEST TASMANIA.

W — MT. RAMSAY — QUE SYNCLINE — GOLD HILL ANTICLINE — MT. CRIPPS — E

W — HUSKISSON SYNCLINE — 5 miles North of CHESTER — SOPHIA SYNCLINORIUM — 5½ miles South of MT. CRIPPS — E

W — North of PINNACLES — 1 mile North of MT. FARRELL — E

W — 4 miles North of RENISON BELL — MT. BLACK — South of MT. FARRELL — E

W — MT. MURCHISON 4,400' — STICHT RANGES — E

631095

5 cm

SCALE IN MILES

0   1   2

090

LOWER DEV. TO SILURIAN

ELDON GROUP

ORDOVICIAN

GORDON LIMESTONE
UPPER OWEN CONGLOM.
MIDDLE OWEN CONGLOM.
LOWER OWEN CONGLOM.
JUKES BRECCIA

CAMBRIAN

GREYWACKE, SLATES, CONGL., TUFFS
ARGILLITES, CHERTS, BLACK SHALES
DUNDAS GROUP
UNCONFORMITY
ROSEBERY VOLCANICS AND INTERBEDDED SLATES
QUARTZITES, CONGL., DOLOMITES, PYROCLASTICS, SLATES.
TECTONIC SCHISTS

PRECAMBRIAN

QUARTZITES, SLATES, SCHISTS

DEVONIAN GRANITE
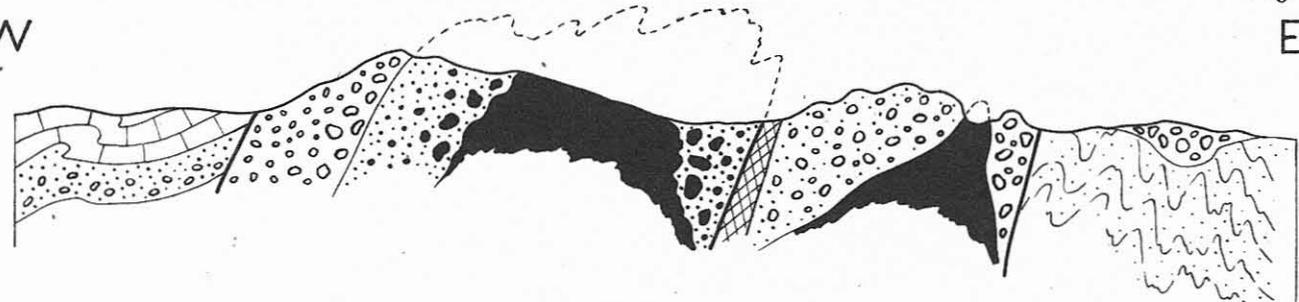CAMBRO-DEVONIAN BASIC ROCKS
CAMBRIAN GRANITE PORPHYRY

Fig 3

PLAN No 658

5

4
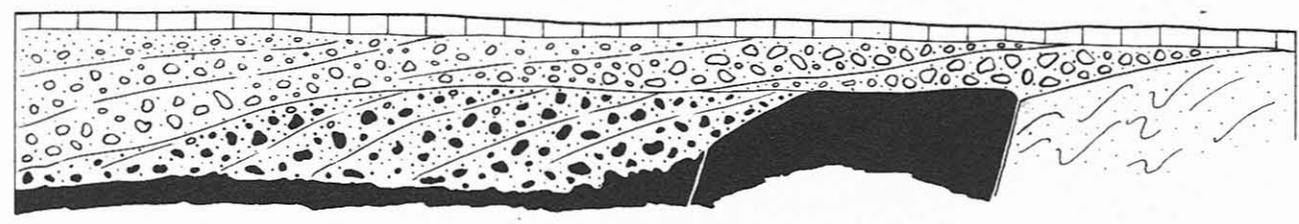
3
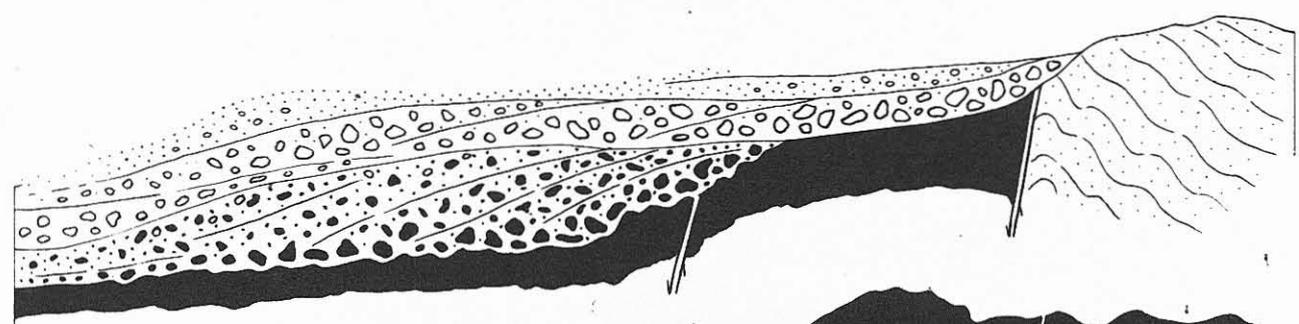
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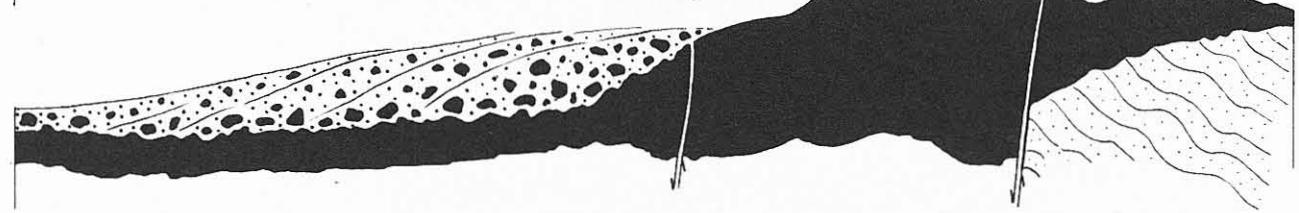
1
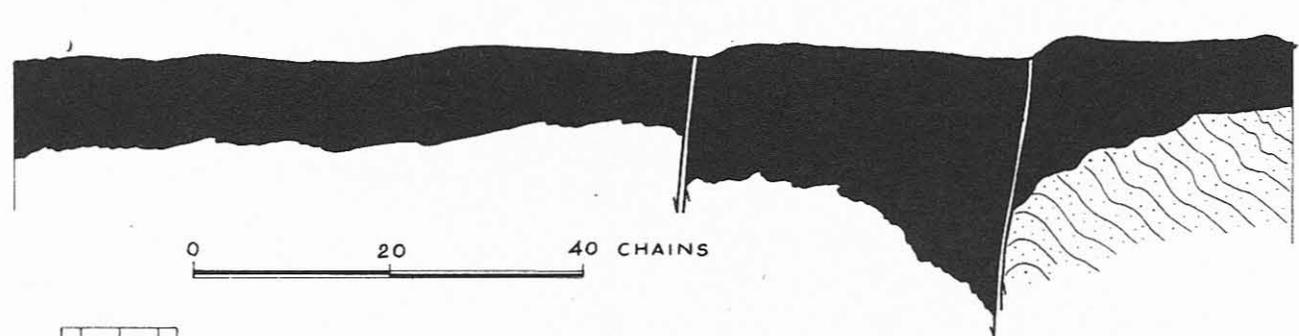
0   20   40 CHAINS
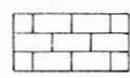
GORDON LIMESTONE : UPPER ORDOVICIAN

OWEN CONGLOMERATE (Quartzitic fragments) :

JUKES BRECCIA (Porphyritic fragments) :

                                   } LOWER ORDOVICIAN

PORPHYRITIC LAVAS, TUFFS, AGGLOMERATES : CAMBRIAN
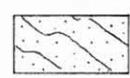
DENSE SILICIFIED QUARTZITES : PRECAMBRIAN

093

5 cm

631096   B.C., 1959.

TECTONIC STRATIGRAPHIC EVOLUTION AT THE EASTERN EDGE OF THE OWEN GRABEN (L. DORA AREA)

1 Late Cambrian faulting. 2 Terrestrial deposition of Jukes Breccia as product from the volcanic assemblage
3 Terrestrial deposition of the Owen Conglomerate as erosional product of Precambrian quartzites
4 Marine transgression deposition of Gordon Limestone
5 Devonian folding and present section

Plan Nº T605
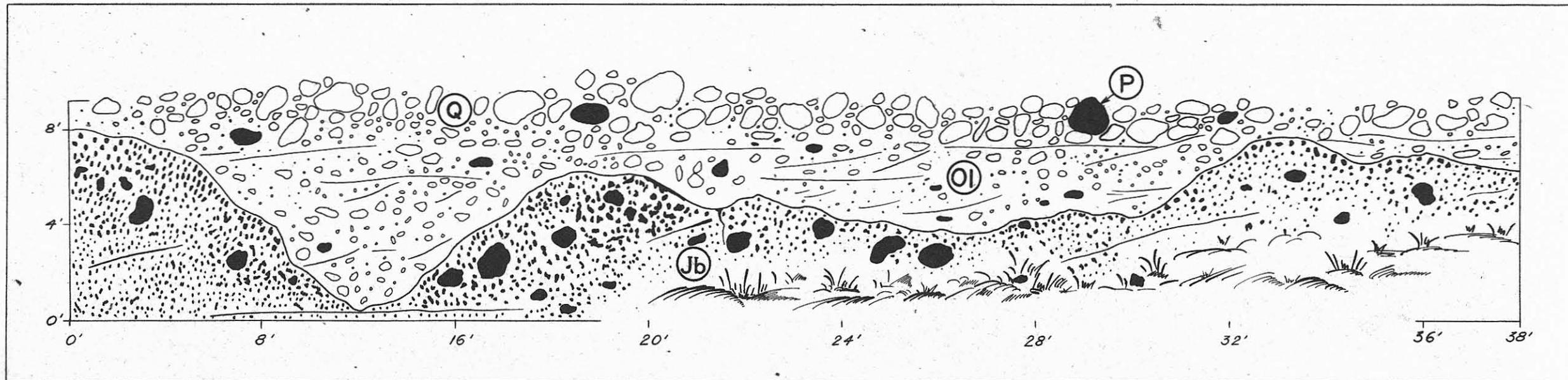
FIG. 5

CONTINENTAL DISCONFORMITY BETWEEN THE JUKES BRECCIA AND THE OWEN CONGLOMERATE.
Ol: Lower Owen Congl., Jb: Jukes Breccia, Q: quartz and quartzite fragments, P: porphyritic
fragments. 1 mile west of Mt. Murchison trig station.

5 cm

PLAN N° T 657

FIGURE 6

092

219

STRATIGRAPHY OF THE OWEN CONGLOMERATE—JUKES BRECCIA
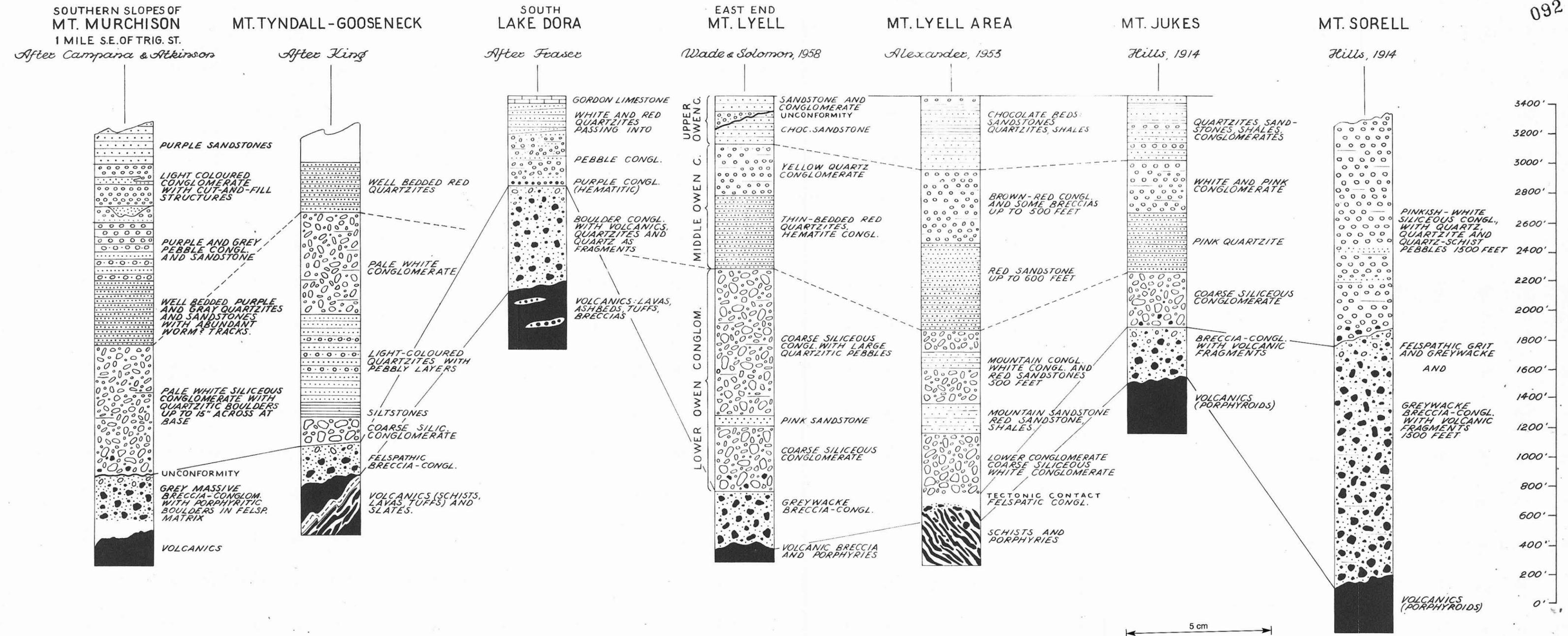
SOUTHERN SLOPES OF
MT. MURCHISON
1 MILE S.E. OF TRIG. ST.
After Campana & Atkinson

MT. TYNDALL-GOOSENECK
After King

SOUTH
LAKE DORA
After Fraser

EAST END
MT. LYELL
Wade & Solomon, 1958

MT. LYELL AREA
Alexander, 1953

MT. JUKES
Hills, 1914

MT. SORELL
Hills, 1914

B. CAMPANA, 1959.

Plan Nº T 609

631098

5 cm

Fig 7
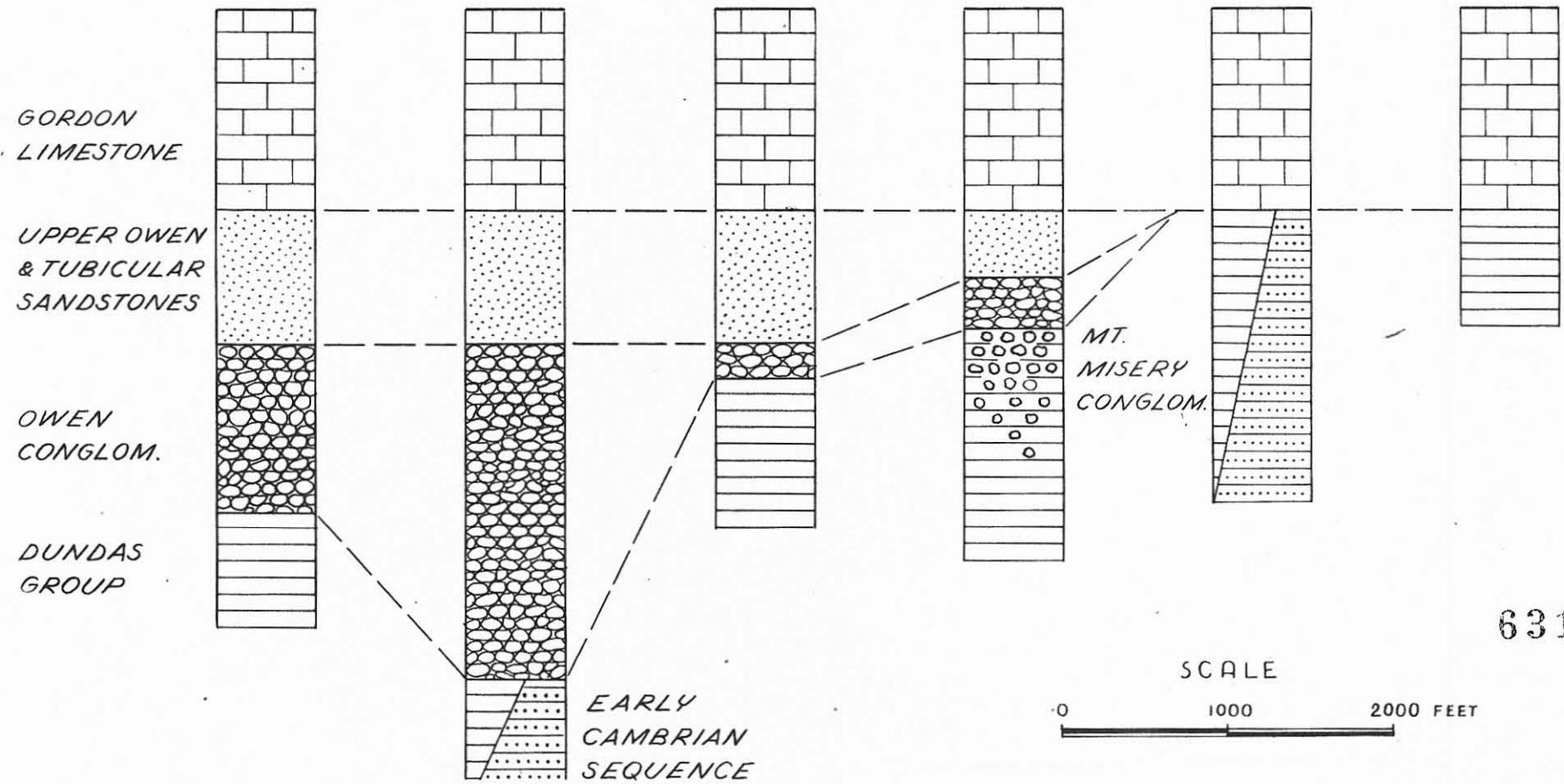
THE OWEN CONGLOMERATE SUCCESSION IN THE ZEEHAN-MT PROFESSOR AREA

Plan N°T648

THE WESTERN DOLERITE EDGE, STICHT RANGE, - WALFORD PEAK, TYNDALL MASSIF
Seen from east of Mt. Murchison

GEOLOGIST: B. Campana. 1959 DRAWN: D. J. Lawford.

Gl. Pleistocene moraines.
Jd. Jurassic dolerite.
Ps. Permian surface
O. Owen Conglomerate
C. Cambrian
pC. Precambrian

PLAN Nº T660

FIG. 8

096

PLATE V
631101

5 cm

NORTH

MT. CRIPPS

MT. RAMSAY

MT. ZEEHAN

ZEEHAN

RENISON BELL

CHESTER

TULLAH

ROSEBERY

DUNDAS

HERCULES
MT. READ

White Spur

Gooseneck

Howard

MT. MURCHISON

MT. TYNDALL

Lake Dora

West Sedgwick

Comstock

MT. PROFESSOR

MT. LYELL

QUEENSTOWN

Qt

Fe.Cu
Pb.Zn.Ag

Pb.Zn.Cu

Pb.As

Fe.Cu
Au.Ag

FOLDING & FAULTING SYSTEMS

Bedding strike and dip
Syncline axis   Anticline axis
Main lineation trends   Joint system in granites
Middle to late Devonian fault system, partly rejuvenated in Post-Permian time

15 Mt. Professor synclinorium   Middle Devonian folds
12 Zeehan syncline   with N-W axes: harmonic
11 Huskisson syncline   folding within plastic
                                     sedimentary successions
10 Que syncline
9   Sophia synclinorium   Middle Devonian folds
8   Lake Spicer syncline   of variable trends:
7   Mt. Tyndall anticline   disharmonic folding
6   Mt. Murchison synclinorium   within more rigid block

5 Mt. Read Block   Ordovician-Devonian N-E elements
4 Jupiter Wrench Fault   Probably uplifted area during the
3 Henty Wrench Fault   deposition of the Owen Cong. to the Sth & East
2 Dora Rift Zone   Primary Cambro-Ordovician
1 Owen Rift Zone   meridional fault system

STRATIGRAPHIC LEGEND AND PALAEOTECTONIC ELEMENTS

QUATERNARY   Qt   Glacial scree and alluvial beds (in areas where the structures are concealed

TERTIARY-   Basalt

JURASSIC   Doleritic sills

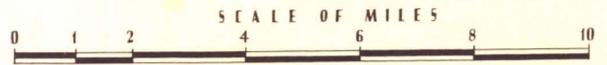PERMIAN   Zeehan Tillite, glacial beds of Mt. Dundas, Mt. Sedgwick etc.

MIDDLE DEVONIAN OROGENY
Intrusive granites

Quartzites, slates and shales. (Crotty Quartzites to Bell Shale formations)

Gordon limestone
MARINE TRANSGRESSION

Lower & Middle Owen Conglomerate

LOCAL DISCONFORMITY
Jukes Breccia
UNCONFORMITY

Rosebery Volcanics lavas and pyroclastics

Grano-syenitic body and granite porphyry

Slates, tuffaceous slates

Tectonic schists of Mt. Lyell, Rosebery, etc.

Cambrian undifferentiated
BASAL UNCONFORMITY

PRECAMBRIAN

UPPER SILURIAN TO LOWER DEVONIAN — ELDON GROUP
UPPER ORDOVICIAN — ZEEHAN GRABEN
MIDDLE TO UPPER CAMBRIAN DUNDAS TROUGH — DUNDAS GROUP
Argillites Greywacke-Cong.
EARLY CAMBRIAN

Tub. s. stone
Upper Owen Cong.
Gabbro etc.

LOWER ORDOVICIAN OWEN GRABEN
LOWER TO MIDDLE CAMBRIAN ROSEBERY VOLCANIC ARC

PRECAMBRIAN ROCKY CAPE GEANTICLINE
PRECAMBRIAN TYENNAN GEANTICLINE

ZEEHAN-ROSEBERY AREA | WEST COAST RANGE AREA

STRUCTURAL MAP of the MT. LYELL-ZEEHAN-ROSEBERY AREA WEST TASMANIA

Showing the palaeotectonic elements and the main folding and faulting systems

SCALE OF MILES
0 1 2 4 6 8 10

Operating mine
Abandoned mine   in the zone of detailed geol.,
Prospects   geoch. and geoph. investigations

Areas of geophysical & geochemical surveys
Ground geophysical anomaly

4237

60-305

T. 655

PLATE VI

631102

4238
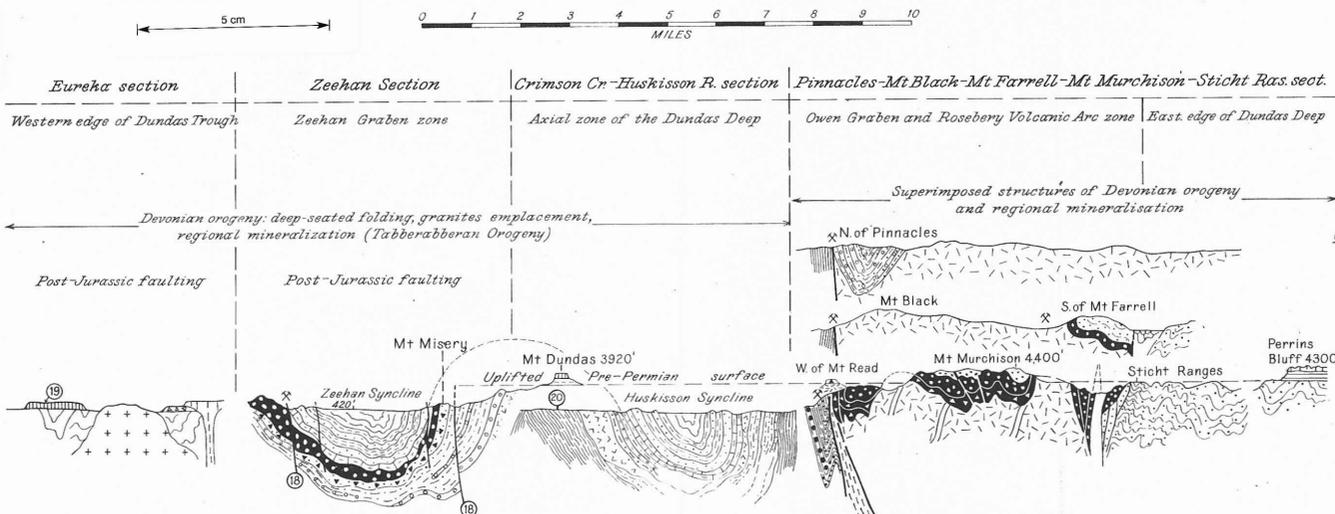
GEOLOGICAL EVOLUTION OF NORTH WEST TASMANIA

COMBINED CROSS-SECTIONS IN THE ZEEHAN-ROSEBERY-STICHT R. AREA, SHOWING THE RELATIONS BETWEEN TECTONISM, PALAEOGRAPHY, SEDIMENTATION, VOLCANISM AND METALLOGENESIS

5 cm

0 1 2 3 4 5 6 7 8 9 10
MILES

Eureka section	Zeehan Section	Crimson Cr-Huskisson R. section	Pinnacles-MtBlack-Mt Farrell-Mt Murchison-Sticht Ras.sect.
Western edge of Dundas Trough	Zeehan Graben zone	Axial zone of the Dundas Deep	Owen Graben and Rosebery Volcanic Arc zone	East. edge of Dundas Deep

Superimposed structures of Devonian orogeny and regional mineralisation

Devonian orogeny: deep-seated folding, granites emplacement, regional mineralization (Tabberabberan Orogeny)

N.of Pinnacles

Post-Jurassic faulting   Post-Jurassic faulting

Mt Black   S of Mt Farrell

Mt Misery   Mt Dundas 3920'   Uplifted Pre-Permian surface   Mt Murchison 4400'   Sticht Ranges   Perrins Bluff 4300'

Zeehan Syncline 420'   Huskisson Syncline

VIII. CRETACEOUS-PLEISTOCENE:
- ⑳ *Erosion:* Pleistocene glaciation, Recent deposits
- ⑲ *Volcanism:* emplacement of basaltic flows
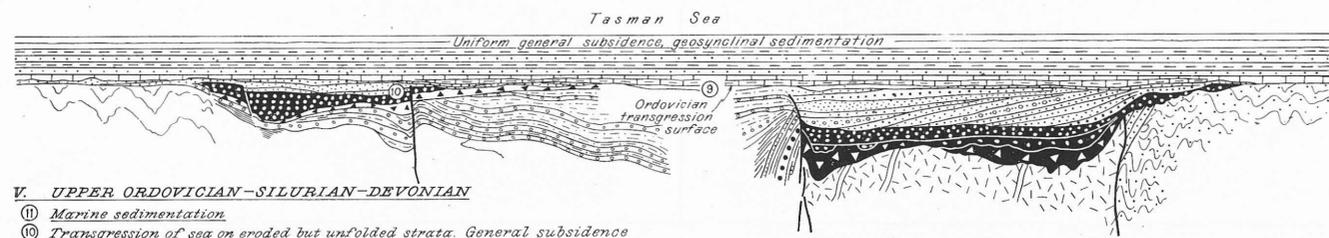- ⑱ *Faulting:* dismembering of Pre-Permian surface and differential uplift

Permo-Triassic basin Paralic sedimentation   Mt Murchison monadnock (in Permian times)
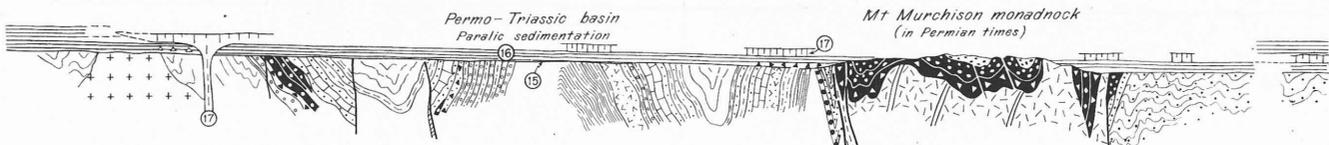
VII. PERMO-CARBONIFEROUS & TRIAS.
- ⑰ *Emplacement of Jurassic dolerite sills*
- ⑯ *Subsidence, paralic deposition:* Zeehan tillite at base, marine beds of Permo-Triassic coal measures, oil shales
- ⑮ *Peneplanation of the Tabberabberan chains*

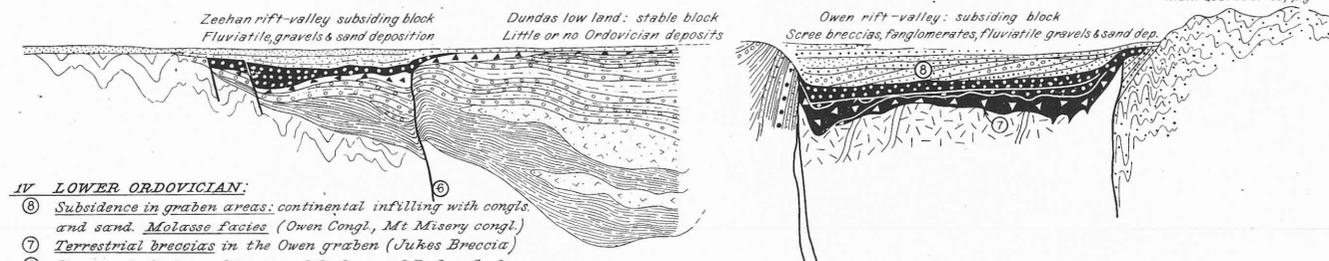Tabberabberan geosynclinal chains   60~305
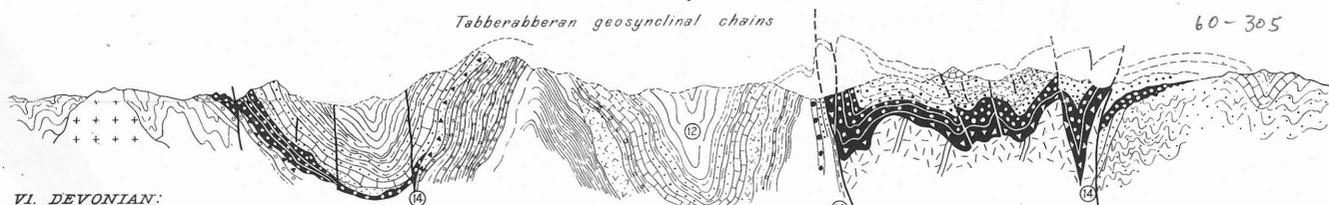
VI. DEVONIAN:
- ⑭ *Regional mineralization,* mainly along the old graben structures
- ⑬ *Emplacement of granites (Heemskirk and Meredith Ranges)*
- ⑫ *Folding of the Tasman Geosyncline and formation of the Tabberabberan chains. Uplift of the Owen Graben*

Tasman Sea
Uniform general subsidence, geosynclinal sedimentation

Ordovician transgression surface

Stichtian Chains rising block Main source of supply

V. UPPER ORDOVICIAN-SILURIAN-DEVONIAN
- ⑪ *Marine sedimentation*
- ⑩ *Transgression of sea on eroded but unfolded strata. General subsidence*
- ⑨ *General peneplanation and aggradation*

Zeehan rift-valley subsiding block Fluviatile, gravels & sand deposition   Dundas low land: stable block Little or no Ordovician deposits   Owen rift-valley: subsiding block Scree breccias, fanglomerates, fluviatile gravels & sand dep.

IV. LOWER ORDOVICIAN:
- ⑧ *Subsidence in graben areas:* continental infilling with congls. and sand. *Molasse facies (Owen Congl., Mt Misery congl.)*
- ⑦ *Terrestrial breccias in the Owen graben (Jukes Breccia)*
- ⑥ *Large scale faulting; formation of the Owen and Zeehan Graben*

Rosebery Volcanic Arc

Axial zone of the Dundas Trough   Greywacke-Flysch facies
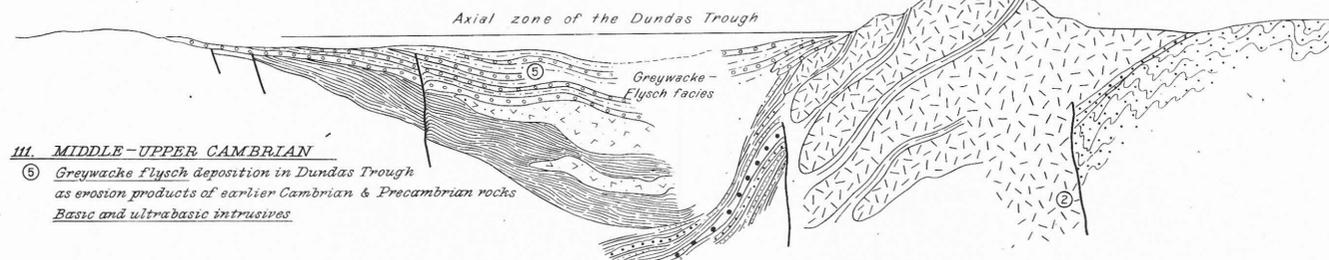
III. MIDDLE-UPPER CAMBRIAN
- ⑤ *Greywacke flysch deposition in Dundas Trough as erosion products of earlier Cambrian & Precambrian rocks Basic and ultrabasic intrusives*

Rosebery Volcanic Arc

Dundas Trough
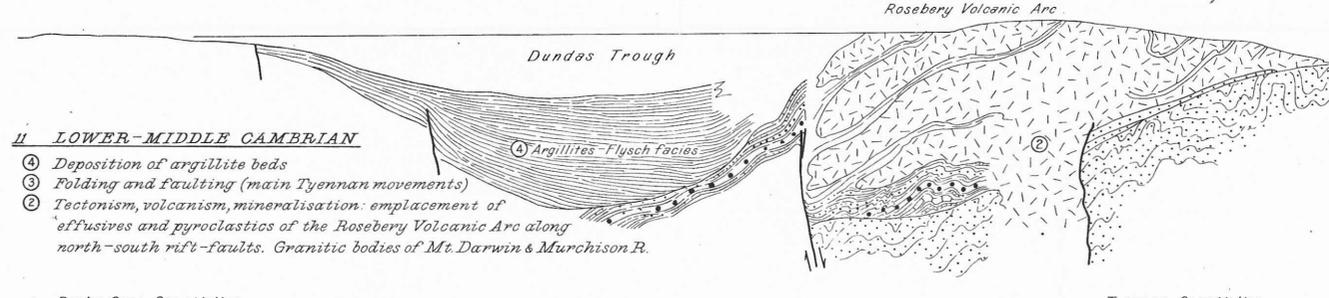
II. LOWER-MIDDLE CAMBRIAN
- ④ *Deposition of argillite beds*
- ③ *Folding and faulting (main Tyennan movements)*
- ② *Tectonism, volcanism, mineralisation:* emplacement of effusives and pyroclastics of the Rosebery Volcanic Arc along north-south rift-faults. Granitic bodies of Mt Darwin & Murchison R.

Argillites-Flysch facies

Rocky Cape Geanticline   Early Cambrian Basin   Tyennan Geanticline
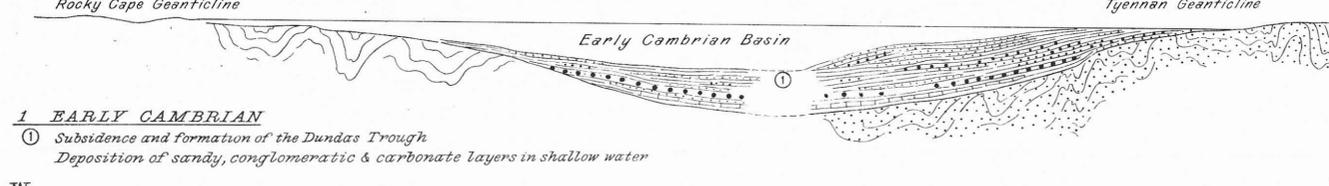
I. EARLY CAMBRIAN
- ① *Subsidence and formation of the Dundas Trough Deposition of sandy, conglomeratic & carbonate layers in shallow water*

W   E

TERTIARY	Volcanism	Basalt flows
JURASSIC	Volcanism	Dolerite sills
	Paralic sedimentation	Shales, siltst, ss, coal seams Zeehan Tillite
DEVONIAN	Geosynclinal folding and granite emplacement	Granitic elements of Heemskirk and Meredith Ranges — Tabberabberan orogeny & Devonian-Carboniferous erosion
LOWER DEVONIAN TO UPPER ORDOVICIAN	Marine sedimentation, neritic in facies, of the Tasman Geosyncline 9000'	Marine transgression
LOWER ORDOVICIAN	Molasse sedimentation essentially arenaceous continental sediment ation of late infilling stage 0-4000'	Tubicolar ss. U. Owen beds Middle Owen Conglom. Lower Owen Conglomerate of Mt Zeehan Mt Misery Conglomerate	Marine transgression Middle Owen Conglomerate Local unconformity Lower Owen Conglomerate Continental unconformity Jukes Breccia Jukesian continental unconf.	of the Owen Graben
MIDDLE TO UPPER CAMBRIAN	Greywacke-Flysch sedimentation in the Dundas Trough 6000'	Succession of slates, shales greywacke and subgreywacke, grits, conglomerates and tuffs of the Razorback area	Mainly pyroclastics and effusive rocks, with slates as interflow deposits	of the Rosebery and Lake Dora-Anthony River zones
	Volcanism	Gabbros, serpentines, peridotites	Quartzites, conglomerate, slates, tuffs & carbonate layers Stictian unconformity
CAMBRIAN	Argillaceous-Flysch sedimentation in the Dundas Trough +12000'	Crimson Cr. argillites, red, green purple agillites, black shales, cherts, with thin tuff beds ? & some lava
LOWER TO MIDDLE CAMBRIAN (Inferred)		Tyennan unconformities Sandstones, quartzites, slates and tuffs of Success Ck, Rosebery, etc. Basal Cambrian unconformity	Quartzites, slates and schists of the Sticht Ranges
PRECAMBRIAN (inferred)		Quartzites and slates of the Heemskirk-Rose Peak area

B. Campana, 1959
Drawn: J.A. Boag. Plan No T 595