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TASMAN FOLD BELT SYSTEM IN TASMANIA

EXPLANATORY NOTES FOR THE 1:500 000 STRUCTURAL MAP OF PRE-CARBONIFEROUS ROCKS OF TASMANIA

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ADDENDA AND CORRIGENDUM

page 14, paragraph 5, fourth line from bottom, insert after

volcanic rocks (Foden *in press*)

page 16, paragraph 2, six lines from bottom, insert after

early *marginal trough* (G.R. Green and D.J. Patterson, in *prep.*)

page 16, paragraph 3, line 2 delete

(Foden *in press*) and *insert after* trough development on *line 3*.

CONTENTS

INTRODUCTION

The geology of the folded rocks of western Tasmania differs considerably from that of north-eastern Tasmania, east of the Tamar River [500430][1].

In western Tasmania Lower Palaeozoic deposition began in narrow troughs developed between and within Precambrian regions. The Precambrian regions became geanticlines during the Cambrian, and when the troughs filled and deposition spread onto the geanticlines, their margins influenced local deformation. Later, during the period of major folding of Devonian age, the Precambrian regions acted as blocks whilst the younger rocks were folded in a number of directions.

In contrast, the sedimentary rocks of north-eastern Tasmania, which are of Early Ordovician to Early Devonian age, constitute a portion of a large elongate depositional basin that exhibits comparatively simple folding.

PRECAMBRIAN FRAMEWORK OF WESTERN AUSTRALIA

The largest Cambrian geanticline is the Tyennan Geanticline[2], which extends north from the south-west coast to the Central Highlands, and consists of rocks metamorphosed during the Precambrian Frenchman Orogeny. Similar rocks constitute the small Forth Geanticline at the north coast. The small Badger Head Geanticline, some 25 km to the east of the Forth Geanticline, and the large Rocky Cape Geanticline, 5 km to the west, consist of comparatively unmetamorphosed Precambrian rocks extensively folded in the Penguin Orogeny.

TYENNAN GEANTICLINE

This geanticline is flanked to the north and west by Eocambrian and Cambrian sequences, but much of the eastern margin is hidden under Permian and younger rocks. In the main it consists of deformed and metamorphosed sequences of interbedded siltstone and orthoquartzite.

In the Cradle Mountain area (415385; Gee, Marshall and Burns, 1970) the main phase of metamorphism reached the upper greenschist facies with the growth of pre-kinematic almandine garnet. Metamorphism of this early phase continued during the development of early flexural folds, which vary in style from rounded to highly flattened with a half wave-length of up to 200m. Limb-thrusts, parallel to an axial surface schistosity, commonly bound the folds, which have highly variable plunges believed to be due to the interference of folds sharing the same axial surfaces (Burns, Shepherd and Gee, in prep.). Albite crystallised in the inter-kinematic period before a later fold phase, which was associated with a minor metamorphism and a regional transposition resulting in near-vertical east-trending shear zones containing detached fold cores.

A similar sequence of events has been recorded at the Raglan Range (400335; Gee, 1963) and Frenchmans Cap (405320; Spry, 1963), where again the main phase of metamorphism started before the earliest recorded folding which is now represented by isolated fold cores. The metamorphism continued until after the early folding, and involved the growth of chlorite, biotite, almandine and kyanite in a zonal sequence. A talc-garnet-kyanite-quartz schist has indicated conditions of 600 ±20°C and $\geq$ 1 MPa (Råheim and Green, 1974). Albite crystallised in the inter-kinematic period, which was followed by

1 Co-ordinates refer to 1:500 000 map grid.
2 See map for location of Cambrian palaeogeographical elements.

recumbent folding and thrusting accompanied by minor metamorphism.

In the south, at Davey River (415225; McClean, 1974), the earlier and main phase of metamorphism of garnet grade accompanied an early deformation characterised by the development of discontinuous intraformational lenses. Albite growth separated this early metamoprhism from a minor metamorphic phase associated with patchily developed crenulation cleavage.

Throughout the Tyennan Geanticline quartzite petrofabric diagrams invariably show quartz c-axes in well-defined patterns related to multiphase deformation. Multiple folding and an early main period of metamorphism define the Frenchman Orogeny (Spry in Spry and Banks, 1962, p. 107-126).

FORTH GEANTICLINE

The Forth Geanticline (Burns, 1965) at the north coast consists of rocks similar to those of the Tyennan Geanticline. Quartzite, schist and amphibolite are interlayered, with layers ranging in width from about a kilometre to microscopic scale. Quartzite petrofabric diagrams show quartz c-axes in well-defined patterns. Conglomerate horizons show strong alignments of stretched pebbles and tectonic inclusions. Most layering is of mechanical origin, but those of finer scale may be metamorphic or possibly bedding. Metamorphism to almandine garnet grade accompanied the earlier deformation, whereas a minor metamorphism to chlorite grade occurred during a later deformation, which is characterised by upright, flattened isoclinal folds. Deformation and metamorphism is attributed to the Frenchman Orogeny.

Folded turbidite quartz-wacke successions are thrust onto the metamorphic rocks at the western margin of the Forth Geanticline. These comparatively unmetamorphosed rocks are correlated with identical sequences of the Precambrian Burnie Formation of the large Rocky Cape Geanticline, 5 km to the west, and similar formations constituting the Badger Head Geanticline, 25 km to the east.

BADGER HEAD GEANTICLINE

Eocambrian(?) and Cambrian beds everywhere dip and face away from this fault-bounded geanticline, indicating that it is constituted of Precambrian rocks. The geanticline consists of a stratigraphic sequence of at least 900 m of comparatively unmetamorphosed, interbedded turbidite quartz-wacke, siltstone and phyllite. The sequence has been correlated with the Precambrian Burnie Formation of the Rocky Cape Geanticline. The beds are tightly folded, and the earlier minor folds are of a flattened flexural type. These early folds have fanned sandstone cleavage, and an axial surface slaty cleavage. Later minor folds, which are also of a flattened flexural type, have modified earlier structures and are associated with well-developed crenulation cleavage. Studies of bed-facing and the vergence of minor folds indicate the overall structure is of a limb of a synformal anticline.

ROCKY CAPE GEANTICLINE

This extensive geanticline occupies the north-west of Tasmania. The north-west area of the Rocky Cape Geanticline consists of the unmetamorphosed Rocky Cape Group. The group is separated by an 8 to 15 km wide belt of metamorphic rocks from different unmetamorphosed rock successions of the Burnie Formation and the Oonah Formation, at the eastern and south-eastern margins of the geanticline respectively.

The Rocky Cape Group (Gee, 1971) consists of two formations of supermature orthoquartzite, each more than 1200 m thick, and formations of cleaved siltstone. Adjacent to the metamorphic belt the rocks exhibit a series of north-easterly plunging, asymmetrical folds of 1.5 km half wavelength. High-angle thrusts, dipping to the north-west, commonly occur parallel to an axial cleavage. To the west, away from the metamorphic belt, the folds become broad and symmetrical.

At the north coast and to the east of the metamorphic belt (Gee, in press) occurs a complexly folded sequence more than 5000 m in thickness of interbedded slaty black mudstone, turbidite quartz-wacke and rare occurrences of altered pillowed spilite of the Burnie Formation. The distribution of the Burnie Formation indicates that it accumulated in a basin between the Rocky Cape Group to the west and the metamorphic rocks of the Forth Geanticline. The rocks were folded during a five-phase deformation, which involved the repeated development of mesoscopic, co-axial, flattened, flexural folds. The complex folding resulted in regional overturning.

Sodic dolerite sills and dykes occur in the Rocky Cape Geanticline (Spry in Spry and Banks, 1962, p. 124; Gee, in press). In the Rocky Cape Group dolerite often occurs along high angle thrust faults associated with folding, and thin sills have been folded with the bedding of the surrounding rocks. The folded sills and dykes show cleavages of the same orientation as those of the enclosing sedimentary rocks. Similarly, transgressive sheets of dolerite, of the same petrological suite as those in the Rocky Cape Group, are deformed by the later folds in the Burnie Formation. The dolerite, which was evidently intruded during folding, has a minimum age of 720 m.y. by K-Ar determination (Richards, J.R. *in* Solomon and Griffiths, 1974, p. 21).

The metamorphic belt separating the Rocky Cape Group from the Burnie and Oonah Formations extends south-westerly from Wynyard [395463], at the north coast, to the west coast (Banks, 1965; Gee, 1967). The metamorphic rocks appear to be derived from the surrounding sedimentary rocks and syntectonic dolerite (McNeil, 1961; Longman and Matthews, 1962; Gee, in press). In the north, the western margin of the belt grades from the unmetamorphosed rocks of the Rocky Cape Group through a zone of phyllite, schistose quartzite, albite-chlorite schist to schist with biotite. At the west coast the metamorphic belt exhibits transitional boundaries with the flanking rocks (Blissett, 1962), which at the southern boundary are of the Oonah Formation, consisting of more than 1500 m[1] of dominantly siliceous siltstone and fine-grained sandstone. Within the metamorphic belt regional schistosity occurs parallel to the trend of the fold hinges in the surrounding unmetamorphosed beds. There is no evidence of the polymetamorphism with accompanying deformation characteristic of the Frenchman Orogeny.

The movements resulting in the folding and the development of the metamorphic belt in the Rocky Cape Geanticline constitute the Penguin Orogeny (Spry in Spry and Banks, 1962, p. 124; Gee, in press), which is regarded as younger than the Frenchman Orogeny.

EARLY PALAEOZOIC TROUGHS IN WESTERN TASMANIA

SMITHTON TROUGH

Sequences of Precambrian and Cambrian deposits which filled the Smithton Trough crop out along some 40 km of coastline near Smithton [342475], on the far north-west coast, and they extend 55 km southward to within the Precambrian Rocky Cape region. At the eastern margin of the trough (354476; Gee, 1968) a thin layer of quartz sandstone and conglomerate at the base of

1 Thicknesses are estimates based on field measurements, which have not usually been corrected to allow for modifications during folding.

a massive dolomite, the Smithton Dolomite, rests with angular unconformity on beds of the folded Precambrian Rocky Cape Group. The Smithton Dolomite is extensive and its distribution indicates a regional angular unconformable relationship with underlying beds (McNeil, 1961; Longman and Matthews, 1962; Spry, 1964). The formation consists of 600 m of interbedded shallow-marine, stromatolite-bearing dolomite (Griffin, in press), oolitic limestone, chert and carbonaceous siltstone. The Smithton Dolomite is succeeded by 30 m of dolomitic breccia, with fragments from the underlying beds containing a stromatolite considered to be Baicalia, of an age range of approximately 680-1000 m.y. (Press, W.V. in Griffin, in press). The dolomitic beds are followed conformably by sequences of up to 750 m of massive fine-grained tholeiitic basalt, pillowed basalt, tuff and volcanic breccia, and sequences of up to 750 m of fossiliferous interbedded siltstone and greywacke. The tholeiitic suite shows similarities in its trace elements to modern abyssal tholeiite (Foden, in press). Only 600 m of unfossiliferous sedimentary strata separate the Precambrian dolomite from the oldest fossiliferous Cambrian siltstone horizons, which have yielded agnostids (Jago, 1971) indicating the late-Middle Cambrian *Lejopyge laevigata* Zone of the Queensland Middle Cambrian are listed by Öpik (1960). The beds of the Smithton Trough usually show gentle folds with northerly-trending hinges, and the basic volcanic rocks show alteration by either spilitisation or lower greenschist facies metamorphism (Foden, in press).

A conformably succession similar to that of the Smithton Trough occurs in the east of King Island [255565], where an interbedded sequence of dolomite and mudstone is followed by a breccia, which may be of glaciogene origin (Carey, 1947; Jago, 1974*b*), and a basic volcanic suite. The succession contrasts with comparatively strongly deformed Precambrian sequences of interbedded quartzite and mudstone to the west, which have been intruded by adamellite and granodiorite. The granitic masses are highly deformed and have been dated at 715 and 750 m.y. by K-Ar and Rb-Sr methods respectively (McDougall and Leggo, 1965).

DUNDAS TROUGH AND ASSOCIATED IGNEOUS ROCKS

In western Tasmania the Rocky Cape and Tyennan Geanticlines flanked a meridional trough of Eocambrian and Cambrian rocks some 25 km wide, within which are lithologically distinctive belts distributed parallel to the margins (Map, sections AB, CD).

WESTERN BOUNDARY WITH THE ROCKY CAPE GEANTICLINE

The boundary with the Rocky Cape Geanticline appears to have been the site of an angular landscape unconformity, although relationships are masked by young faults. In the Pieman River [362375] the Precambrian Oonah Formation of the Rocky Cape Geanticline consists of interbedded siltstone, fine-grained quartz sandstone and laminated mudstone. It is overlain with an inferred angular unconformity by the Success Creek Group (Taylor, 1954), which is correlated on stratigraphical considerations with the basal dolomite and quartz sandstone of the Smithton Trough. The group is unfossiliferous and consists of 820 m of massive coarse-grained quartz sandstone interbedded with laminated fine-grained quartz sandstone. To the east, at the stratigraphical top, occurs up to 150 m of a sequence of interbedded hematitic chert and calcareous sandstone (Newnham, 1975), followed conformably by unfossiliferous mudstone of the Crimson Creek Formation (Taylor, 1954; Blissett, 1962). The formation, which is about 2500 m thick, consists of fine-grained mudstone, characteristically purple or green in colour, with occasional turbidite lithic-wacke layers increasing in number in the younger sequences. Near Zeehan [362361], 10 km south of the Pieman River, the Success Creek Group is absent, and the Crimson Creek Formation overlies the Oonah Formation, which here includes occasional beds of limestone, dolomitic limestone, and some horizons of lava flows and pyroclastic deposits. Although the Oonah Formation and the overlying Crimson Creek Formation display a degree of regional conformity around Zeehan (Blissett, 1962), the relationship is believed to be similar to that noted at Mt Bischoff [375412]. At Mt Bischoff beds similar to the Oonah Formation form a Precambrian inlier which is partly surrounded by unfossiliferous Eocambrian or Cambrian sequences. The sequences show a regional conformity (Groves and Solomon, 1964). However, recent sluicing at the southern margin of the Mt Bischoff inlier has uncovered a few hundred metres of a fault zone contact (Groves, 1971). A comparison of minor folds across the contact demonstrated a structural hiatus, with the Precambrian rocks exhibiting earlier additional folds to those developed in the Eocambrian or Cambrian. The fault zone was probably active during the deposition of the basal Eocambrian or Cambrian beds, into which slumped large fragments of Precambrian rocks.

ULTRAMAFIC AND MAFIC BODIES

A number of ultramafic and mafic complexes have been emplaced within a belt extending from south of Macquarie Harbour [361285] to near Mt Cleveland [360410]. The complexes occur within the unfossiliferous mudstone of the Crimson Creek Formation, and at the structurally conformable, but erosional, boundary between the mudstone and overlying fossiliferous turbidite Dundas Group to the east. Gabbro and dolerite of the complexes are petrologically distinct from those constituting other numerous small bodies intruded into the Crimson Creek Formation and the Dundas Group.

The largest complex occurs near Mt Cleveland (Rubenach, 1973) and it consists of orthopyroxenite, peridotite and dunite, with interstitial plagioclase. The ultramafic rocks are associated with basaltic and dacitic volcanic rocks and are intruded by dolerite dyke swarms. Similarities of the volcanic rocks to oceanic tholeiitic suites, have been indicated by trace element studies (Foden, in press). The relationship of this probable ophiolite remnant with the surrounding unfossiliferous Cambrian beds has been obscured by faulting.

The Serpentine Hill Complex (370368; Rubenach, 1974), 8 km north-east of Zeehan, is regarded as a tectonically emplaced dismembered ophiolite. It consists of fault-bounded areas of layered cumulate ultramafic rocks of dominantly orthopyroxenite and harzburgite, in part preferentially replaced by serpentinite, and layered cumulate hypersthene gabbro. They have been intruded by tabular dykes of microgabbro and pegmatitic gabbro. An adjacent area of dominantly basic altered volcanic rocks include massive amygdaloidal lava, tuff and agglomerate, which have been intruded by dolerite dykes. Alteration of the volcanic rocks, which has not been accompanied by deformation, is believed to have resulted from a burial or hydrothermal metamorphism.

The Serpentine Hill Complex has a thrust fault or re-intrusive western contact with the underlying Crimson Creek Formation, which has not been deformed or altered by the emplacement. Poor exposure renders interpretation of the eastern margin against the fossiliferous Dundas Group difficult. However, detritus of rocks similar to those of the complex occur in the basal conglomerate of the adjacent Dundas Group, and the margin is considered to be an erosion level.

DUNDAS GROUP AND CORRELATES

The Crimson Creek Formation is followed to the east by the fossiliferous Dundas Group. Comparison of the rock units across the boundary, which is usually marked by young faults, or, as at Serpentine Hill, by an ultramafic and mafic complex, indicates a structural conformity.

The Dundas Group, occurring 7 km east of Zeehan (Elliston, 1954; Blissett, 1962), consists of mudstone, some acid volcanic layers and sequences rich in turbidite lithic-wacke, chert conglomerate and paraconglomerate. The group is about 3800 m thick, and a number of fossiliferous horizons occur. The oldest is of the *Ptychagnostus gibbus* Zone (Öpik, 1956) of the early-Middle Cambrian, and the youngest have yielded *Lotagnostus*(?) of the late-Franconian Stage of the late-Late Cambrian (Jago, 1973). Immediately to the north of the Pieman River [371377] a similar turbidite sequence has yielded *Glyptagnostus reticulatus* (Angelin) of the middle-Dresbachian Stage of the middle-Late Cambrian (Öpik in Blissett, 1962; Jago, 1974a).

At a number of localities the Dundas Group and its correlates pass gradually upward into a dominantly poorly sorted conglomerate sequence with clasts of chert and quartzite, some hematised, set in a sandy matrix of similar material. The conglomerate sequence is followed conformably by grey and pink sandstone with subordinate conglomerate, containing clasts of quartzite. At Misery Hill [367361] 5 km east of Zeehan, some 400 m of conglomerate and sandstone, which are overlain by Early Ordovician limestone, are believed to be the equivalent of the Owen Conglomerate and its associated basal beds at the margin of the Tyennan Geanticline.

EASTERN BOUNDARY OF THE DUNDAS GROUP

The Dundas Group and its correlates are usually delimited to the east by a northerly-trending fault-bounded structural high of older rocks. In the Pieman River [377372], the older rocks consist of correlates of the Crimson Creek Formation and the Success Creek Group (G.R. Green, in prep.). To the south [372363] 8 km east of Zeehan, the older rocks include not only those of the Crimson Creek Formation but also correlates of the younger sequences of the Precambrian Oonah Formation of the Rocky Cape Geanticline. The Oonah Formation correlates, in which limestone beds occur (Elliston, 1954; Blissett, 1962), are in part metamorphosed (N.J. Turner, pers. comm.) to quartz schist and quartz mica schist of the Concert Schist. A transitional boundary is exposed between the Oonah Formation correlate and the Concert Schist. The schists show well-defined patterns of quartz c-axes developed during a penetrative structural metamorphism, which is a characteristic known only of Precambrian deformations.

MT *READ VOLCANIC BELT*

A considerable pile of dominantly acid to intermediate volcanic material accumulated between the trough in which the Dundas Group and its correlates were deposited and the Tyennan Geanticline. These volcanic rocks, of estimated thicknesses exceeding 2400 m (Campana and King, 1963), constitute the Mt Read Volcanic Belt, which extends from the west coast, at Elliott Bay, [385240] through Queenstown [381341] to north of Rosebery [390390].

The volcanic rocks include lava flows, volcanic breccia, tuffs and the products of sub-aqueous pyroclastic flows and intrusive bodies (Solomon, 1960; Corbett et al., 1974). They are dominantly of altered rhyolite and dacite, with small amounts of andesitic and basaltic types. Alteration has resulted in spilite-keratophyre mineralogy, which consists largely of quartz, albite, chlorite and sericite. Compositional characteristics show that the volcanic rocks are calc-alkaline (Spry in Spry and Banks, 1962 p. 280-281; Solomon, 1964; Anderson, 1972), and trace element studies indicate that they may be compared with modern Andean suite rocks (Solomon and Griffiths, 1974; Foden, in press).

The Mt Read Volcanic Belt is associated with granite intrusions. At Mt Darwin [383320], 25 km south of Queenstown, a granite sheet intrudes a rhyolite sequence, and pebbles of this granite occur in the overlying Jukes Breccia, a formation of the volcanic belt (Bradley, 1956; Solomon, 1960). On the west coast, at Elliott Bay, dacite and rhyolite are intruded by two adamellite masses, one of which has a minimum age of 407 m.y. by K-Ar dating of biotite (McDougall and Leggo, 1962). In the north, 30 km east of Zeehan, the Murchison Granite [388373], which is dominantly of adamellite, has been emplaced in rhyolitic rocks, and K-Ar dating of hornblende indicated 515 ±15 m.y. minimum age (McDougall and Leggo, 1962).

The oldest limit of the Mt Read Volcanics has not been determined, although a similar adjacent volcanic unit near Rosebery has been considered to underlie the Crimson Creek Formation (Loftus-Hills et al., 1962; Brathwaite, 1972). The bulk of the volcanic rocks, however, is probably younger than the basic rocks of abyssal tholeiitic affinities occurring to the west. The volcanic rocks interfinger with fossiliferous Dundas Group (Blissett, 1962), and about 25 km north of Rosebery they are interlayered with mudstone containing agnostid trilobites of the *Ptychagnostus nathorsti* Zones of the Middle Cambrian (Gee, Jago and Quilty, 1970; Jago, 1974a).

Within the Mt Read Volcanics at Comstock [383346], on the margin of the Tyennan Geanticline near Queenstown, an inferred angular unconformity separates lower schistose pyroclastic rocks, with their genetically related mineralisation, from an overlying barren sequence of volcanic rocks, including the Jukes Breccia, and sedimentary beds. The overlying barren succession has a basal limestone containing trilobites indicating a late-Middle or early-Late Cambrian age (Jago et al., 1972). At Red Hills (382360; Corbett, 1975*b*), 14 km north of Comstock, barren volcaniclastic rocks are up to 300 m thick, and are overlain conformably by a locally developed turbidite quartz-wacke sequence which passes into overlying shallow-marine and terrestrial Owen Conglomerate. The turbidite sequence has yielded trilobites of Late Cambrian, probably Franconian age. This age is the youngest known limit for the rocks of the Mt Read Volcanic Belt.

The Comstock-Red Hills angular unconformity is extensively developed along the Tyennan Geanticline margin. Above this unconformity is a regionally conformable sequence of beds, which range in age from late-Middle or early-Late Cambrian of the basal limestone at Comstock, through Ordovician and Silurian to Early Devonian. These deposits accumulated on the filled Cambrian troughs as well as lapping onto the Cambrian geanticlines.

FOSSEY MOUNTAIN TROUGH

Deposits of the Dundas Trough and associated igneous rocks continue into the east-south-easterly directed Fossey Mountain Trough (Jennings, 1958; 1963; in press), situated between the Tyennan Geanticline and the Forth and Badger Head Geanticlines at the north coast. The trough has a maximum width of some 30 km and was filled with some 3600 m of turbidite lithic-wacke sequences, volcanic rocks, and chert. Detritus of earlier rocks commonly occurs in later beds, indicating the active development of the trough during deposition.

At the southern boundary, against the Tyennan Geanticline, are dominantly acid and intermediate volcanic rocks, similar to those of the Mt Read Volcanic Belt. Adjacent to the Fossey Mountain Trough boundary are three small plutons of variable granitic composition, which are probably of Late Cambrian age [422397; 427398; 435394]. To the north, the volcanic rocks are considered to be transitional with underlying turbidite lithic-wacke sequences of some 800 m thickness, which at one locality yielded fossils, including agnostid trilobites of Late Cambrian age (Öpik, A.A. in Jennings, in press). Further north, a horizon of 400 to 500 m thickness consists of lenticular bodies of basic volcanic and sedimentary rocks, which are associated with a thick underlying chert sequence believed to be the oldest member of the exposed successions within the trough.

Correlates of the Owen Conglomerate of Queenstown rest unconformably on the Fossey Mountain Trough deposits, and were derived for most part from the Tyennan Geanticline. An angular unconformable relationship can be observed at the base of the conglomerate at a number of localities, and can be established by regional mapping. However, difficulties in determining the nature of the boundary occur in some areas near the Tyennan Geanticline. Where the basal beds of the overlying conglomerate reflect the composition of underlying acid and intermediate volcanic rocks an erosional contact only can be identified. Further difficulties in interpretation are encountered 5 km south of Cethana [431407] and 2 km south-west of Deloraine (471400; Pike, 1973), where thin acid igneous intrusions, petrologically identical to the underlying rocks, invade the basal beds of the unconformably overlying correlate of the Owen Conglomerate.

DIAL RANGE TROUGH

The Dial Range Trough (Burns, 1965), situated between the Rocky Cape and Forth Geanticlines, is northerly directed and is only 5 km wide at the north coast (Map, section MN). The chert and basic volcanic formations of the Fossey Mountain Trough extend into this trough, where the chert forms an 850 m thick tongue. The chert is followed conformably by some 450 m of altered pillowed basic lava, which is geochemically similar to modern abyssal tholeiites (Foden, in press). Relationships at the base of the chert unit are obscured by faulting, but they may be unconformable. However, structurally underlying the chert is a 1000 m thick mudstone sequence, which includes beds of turbidite lithic-wacke conglomerate and tuff. The mudstone is fossiliferous containing agnostids of the late-Middle Cambrian (Öpik, A.A. in Burns, 1965, p. 34). Conformably overlying the basic volcanic horizon is another dominantly mudstone sequence containing in the upper beds agnostid trilobites of the *Lejopyge laevigata* Zone of the Middle Cambrian (Palmer, A.R. in Burns, 1965, p. 47). Deposition in the Dial Range Trough closed with the accumulation of some 150 m of breccia with fragments of various lithologies up to 120 m long set in a matrix of lithic-wacke and conglomerate. The breccia appears to have been formed by gravity down-sliding of large masses of semi-indurated material from unstable flanks of the trough. This may be associated with uplifts of large regions of the trough deposits, from which chert detritus accumulated immediately to the west as thick terrestrial and shallow marine conglomerate beds, which are correlated with the Owen Conglomerate. This conglomerate overlies beds of the Dial Range Trough and Precambrian rocks of the surrounding geanticlines with angular unconformities, both observed and inferred from regional mapping.

BEACONSFIELD-PORT SORELL AREA

Eocambrian(?) and Cambrian beds dip and face away from the fault-bounded Badger Head Geanticline (Gee and Legge, 1974). At Port Sorell [465550], on the western flank, more than 700 m of conformable sequences of unfossiliferous turbidite lithic-wacke, chert and dolomite are preserved. On the eastern flank of the geanticline, around Beaconsfield [483438], structural slices include conformable suites of chert, mudstone and turbidite lithic-wacke, with minor altered andesite (Map, section OP; Gee and Legge, 1974; Green, 1959). In one slice a fossiliferous horizon yielded trilobites of the Dresbachian Stage of early-Late Cambrian.

Within a structural slice adjacent to the eastern margin of the geanticline an ultramafic complex has been emplaced in Cambrian rocks. The complex (Green, 1959; Gee and Legge, 1974) consists of serpentinite and pyroxenite grading upward, by interlayering, into gabbro. The pyroxenite and gabbro are cumulates and display laminations, layering and occasional cross bedding. Albitites occur in small bodies throughout the complex, which also includes hornfels septa paralleling the regional igneous layering and outlining an antiformal structure plunging to the north-west. The complex is considered to have been a portion of a once floored gabbro magma chamber that was tectonically emplaced at about 500°C, within strata which have been metamorphosed to andalusite hornfels.

The structural slices include correlates of the Owen Conglomerate consisting of shallow-marine quartz sandstone with lenses of chert conglomerate. The contact with the underlying Cambrian beds is nowhere exposed. The boundary, however, is interpreted as a marked erosional level since heavy minerals derived from the ultramafic complex are present in the overlying sandstone (Green, 1959), and the clasts of the conglomerate are of predominantly Eocambrian or Cambrian chert (Gee and Legge, 1974).

ADAMSFIELD TROUGH

The northerly-trending Adamsfield Trough is situated at the south-eastern margin of the Tyennan Geanticline, which forms its western boundary. The trough disappears eastward beneath a cover of younger rocks, but in the south-east it is bounded by a Cambrian geanticline consisting of probable Precambrian sequences of dolomite and quartzite. East of the exposed part of the trough, windows in the cover of flat-lying Permian and younger rocks show underlying Ordovician beds as well as rocks similar to those constituting the geanticline. Further east, at Hobart [525255], cleaved basalt, of high alumina content and a chemical composition very similar to the basalt of the Mt Read Volcanics, was recovered from a bore hole which penetrated the cover of younger rocks (Leaman, 1972; Solomon and Griffiths, 1973).

The rock units of the trough are distributed in belts parallel to the northerly-trending boundary of the Tyennan Geanticline. The oldest deposits are at the western margin where they rest on the Precambrian rocks of the geanticline with an inferred angular unconformity (Turner, in prep.). The basal beds consist of unfossiliferous mudstone, turbidite sandstone and conglomerate, with clasts derived from the Tyennan Geanticline. These coarse siliceous beds are associated with a disrupted sequence of interbedded poorly sorted sandstone, chert and mudstone (Brown and Turner, in prep.). Some basic and intermediate volcanic horizons are present.

A northerly-trending ultramafic body has been faulted into the unfossiliferous rocks. This steeply-dipping mass (Brown, 1972) consists of lenses of partially serpentinised and fresh peridotite sheathed by serpentinite, which is sheared parallel to the bounding faults. The peridotite, which has an extremely low aluminium content, is of massive dunite, olivine pyroxenite and pyroxenite. Although cataclasis has disturbed textures the layering may be of cumulate origin. The ultramafic body, which is not accompanied by a thermal aureole in the surrounding country rocks, was tectonically emplaced before the deposition of mudstone beds near its southern end [448256], for they contain ultramafic detritus as well as hydroids and dendroids, considered to be of Middle or early-Late Cambrian age (Quilty, 1971).

The lower unfossiliferous beds are overlain at their eastern edge, with an inferred angular unconformity, by a 500 m thick siliceous clastic succession derived from the Tyennan Geanticline (Corbett, 1975a; Brown and Turner, in prep.). The sequence, which has yielded agnostid trilobites of late-Middle

Cambrian age, consists of conglomerate, sandstone and siltstone, with turbidite quartz-wacke beds in the upper part.

Further east, correlates of the Owen Conglomerate, with locally distinctive basal beds, rest with an angular unconformity on the rocks of the Adamsfield Trough, and they were derived from the Tyennan Geanticline. The local basal beds, which are of Late Cambrian age, include a turbidite quartz-wacke sequence in the Denison Range [440290], near Adamsfield, and a shallow marine conglomerate of ultramafic detritus at Adamsfield [446270].

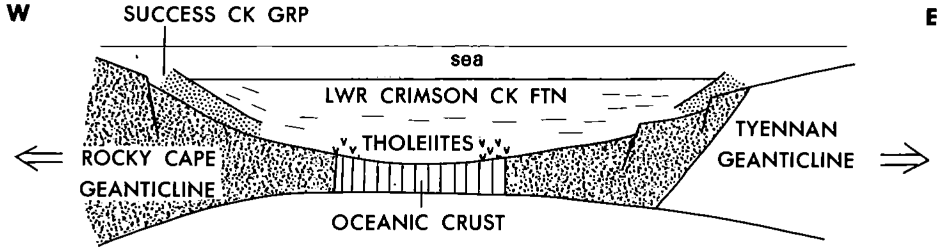
CAMBRIAN DEFORMATION

The Dundas and Dial Range Troughs developed along the northerly-trending Precambrian boundary between the comparatively unmetamorphosed rocks of the Rocky Cape Geanticline to the west, and the metamorphic rocks of the Tyennan and Forth Geanticlines in the east. The existence of the Precambrian boundary is indicated by the remnants of the Rocky Cape rock-types present at the eastern margins of the troughs.

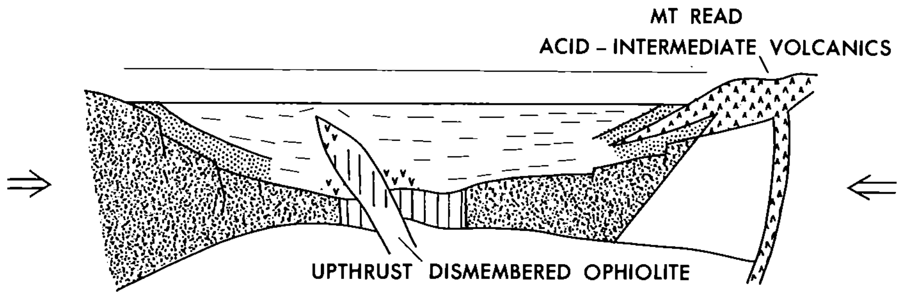
Initial deposition in the Dundas Trough smoothed irregularities in the basement Oonah Formation. Later deposition was accompanied by extension of the continental basement resulting in outpourings of oceanic basic lava types and the exposure of oceanic crust (fig. 1a), fragments of which were later emplaced as dismembered ophiolites along steep thrusts into Crimson Creek sediment (fig. 1b). The complete rifting of the continental basement was local, since, apart from the presence of oceanic tholeiitic lavas in the Dial Range and Fossey Mountain Troughs, there is an absence of ophiolites or any other evidence to indicate complete disruption of the underlying continental rocks.

The upthrusting of ophiolite fragments was accompanied by negligible deformation of the enclosing sediments. This compressional phase, however, changed the configuration of the Dundas Trough floor sufficiently to allow erosion of the sedimentary pile to expose dismembered ophiolites, which contributed detritus to the overlying fossiliferous Middle Cambrian sediment of the Dundas Group. The compressional phase may have also heralded the vulcanism responsible for the bulk of acid-intermediate rocks of the Mt Read Volcanic Belt (Foden, in press), with its small granite intrusions. The ophiolite fragments may have been upthrusted on a number of occasions over a long period of time, and most of the Mt Read volcanic rocks may have accumulated before deposition of the Dundas Group. This compressional phase may have been important throughout the accumulation of the volcanic rocks, for during the waning stages of vulcanism in the Late Cambrian, movements were up-dip along the westerly dipping Great Lyell Fault [382347], which governed deformation and deposition at the margin of the Tyennan Geanticline (fig. 1c).

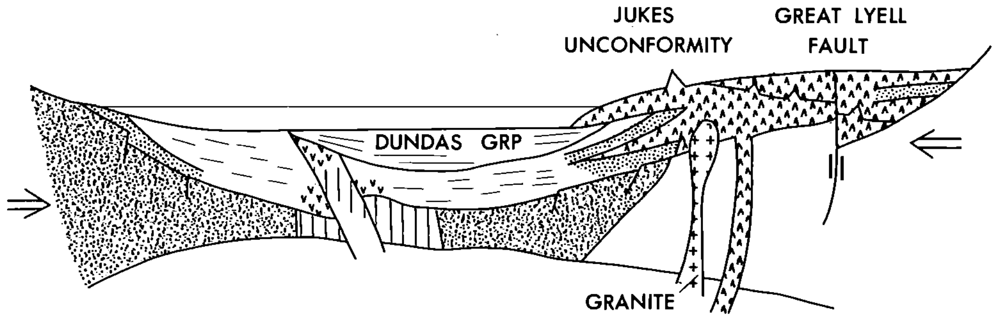
The deformation associated with the Great Lyell Fault, although important along the margin of the Tyennan Geanticline, did not extend over the Dundas Trough, for at several localities the Dundas Group passes conformably into the overlying correlates of the Owen Conglomerate. Near the Tyennan Geanticline margin, however, an elongate basin formed on the eastern side of the Great Lyell Fault (Reid, 1976). In this basin were deposited conformable successions of volcaniclastic beds, including the Jukes Breccia, occasional turbidite quartz-wacke sequences (Corbett, 1975*b*), and shallow-marine and terrestrial Owen Conglomerate. The conglomerate was derived from the Tyennan Geanticline, the emergence of which was associated with the fault movements. The basin deposits rest on the underlying mineralised rocks of the Mt Read Volcanic Belt with an angular unconformity, known as the Jukesian Unconformity (Corbett, et al., 1974). Continued movements along the Great Lyell Fault



a. EARLY DEVELOPMENT (RIFT CONDITION)



b. END OF UPPER CRIMSON CREEK FORMATION DEPOSITION (COMPRESSIONAL CONDITION)



c. BEGINNING OF OWEN CONGLOMERATE DEPOSITION

Figure 1. DEVELOPMENT OF DUNDAS TROUGH

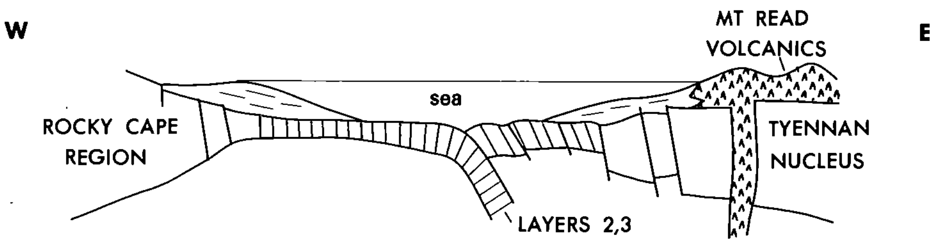


Figure 2. EASTERN PLUNGING SUBDUCTION ZONE MODEL
IN EARLY CAMBRIAN FOR DUNDAS TROUGH
(after Solomon and Griffiths, 1974)

formed zones of schist in the mineralised volcanic rocks and caused drag-folds in lower members of the Owen Conglomerate. This resulted in upper members resting on lower members with a marked angular unconformity, known as the Haulage Unconformity (Reid, 1976).

The development of the Dundas Trough and its associated igneous rocks outlined above is similar to that described by Campana and King (1963), which was supported by Corbett, Banks and Jago (1972). Recently, attempts have been made to relate the Mt Read Volcanic Belt to a zone of subduction. A model involving a westward plunging zone of subduction between the volcanic belt and the Tyennan Geanticline (Solomon and Griffiths, 1972) has been shown to be incorrect (Corbett et *al.*, 1972). Amongst the reasons listed against the model were the close association between the acid volcanic rocks and the Tyennan Geanticline, as well as the complete absence of any trench deposits at the postulated site of subduction. An eastward plunging subduction zone at the western boundary of the volcanic belt has also been considered a possibility, despite an absence of deformation characteristic of past subduction (Solomon and Griffiths, 1974; Corbett et al., 1972; fig. 2). The former existence of such a subduction zone, however, is unlikely, since a comparatively minor presence of oceanic crust in Cambrian times is indicated by the occurrence of similar Precambrian Rocky Cape and early marginal trough sequences on either side of the relatively simply deformed deposits of the Dundas and Dial Range Troughs. Perhaps the most complicated structure noted in the Dundas Trough is near Rosebery, where the beds form an antiformal syncline [376378]. However, recent mapping has shown this structure to be locally developed and to have no regional significance (G.R. Green, in prep.).

In the Smithton, Dial Range and Fossey Mountain Troughs basic volcanic rocks of oceanic tholeiitic characteristics (Foden, in press) were probably associated with basement extension in the trough development. The basic volcanic rocks and associated chert beds in the Dial Range Trough are exceptional in that they occur amongst fossiliferous Middle Cambrian successions, although relationships with the structurally underlying fossiliferous beds are obscured by faulting. In the Fossey Mountain Trough (Jennings, in press; 1963) basic volcanic accumulations and chert deposits are considered to belong to the oldest trough sequences present, and they contributed much to the material making up the later lithic-wacke beds within the trough. The spatial association between the acid-intermediate volcanic rocks and the Tyennan Geanticline appear to be similar in both the Fossey Mountain and Dundas Troughs. In the Fossey Mountain Trough the volcanic rocks are near the northern margin of the Tyennan Geanticline, where there are small Cambrian granite intrusions.

The instability of the flanks of the Dial Range Trough during the closing stages of deposition, indicated by the occurrences of sedimentary breccia, was the start of movements which changed the general configuration of the Dial Range and Fossey Mountain Troughs. Throughout the region the movements caused deposition of thick terrestrial and shallow-marine correlates of the Owen Conglomerate, and they rest with angular unconformity on underlying rocks. The conglomerate at the western margin of the emerged rocks of the Dial Range Trough was derived, in the main, from chert immediately to the east. In the south, on the site of the Fossey Mountain Trough, the Owen Conglomerate correlates were derived from the emerged Tyennan Geanticline.

To the north of the Tyennan Geanticline, the angular unconformity at the base of the correlate of the Owen Conglomerate and associated conformable beds has been attributed to broad and gentle folding of the underlying rocks (Burns, 1965; Jennings, 1963). However, the fold hinges and any cleavage that may have formed do not diverge from those developed later during the Middle Devonian. The Late Cambrian deformation is associated with emergence of the Tyennan Geanticline. The effect of the movements over the whole of the Fossey Mountain and Dial Range Troughs suggests that the rocks of the Tyennan Geanticline continued beneath the sedimentary and volcanic trough accumulations to reappear constituting the Forth Geanticline.

In the Adamsfield Trough the initial tectonic emplacement of the ultramafic bodies resulted in the development of an inferred angular unconformity at the base of the overlying Middle Cambrian beds. Further deformation occurred prior to the deposition of the correlates of the Owen Conglomerate and associated conformable strata. However, the general northerly trend of the rock units parallel to the margin of the Tyennan Geanticline suggests that the behaviour of the geanticline, as determined elsewhere in western Tasmania, strongly influenced the deformation of the Adamsfield Trough deposits.

OWEN CONGLOMERATE AND ASSOCIATED CONFORMABLE STRATA

Locally, the regionally developed Owen Conglomerate and its correlates are conformably underlain by deposits filling depressions in the surface of tilted and eroded underlying rocks. At Comstock [383346], near Queenstown, these basal beds consist of late-Middle or early-Late Cambrian limestone followed by up to 300 m of volcaniclastic rocks (Jago et al., 1972). At Red Hills (382360; Corbett, 1975*b*), the volcaniclastic rocks are succeeded by more than 500 m of a turbidite quartz-wacke sequence of probably the Franconian Stage of the Late Cambrian. A similar turbidite quartz-wacke sequence, more than 700 m thick, and of a Franconian-Late Cambrian age occurs in the Denison Range [440290], near Adamsfield (Corbett, 1975a). At Adamsfield [446270], a basal sequence of shallow-marine conglomerate and siltstone, derived from the ultramafic mass, contains a fauna that includes nepeid trilobites, Eoorthis, and Billingsella of the upper Dresbachian or lower Franconian stages of the Late Cambrian (Öpik in Spry and Banks, 1962, p. 137). In the Dial Range, at one locality [419446], the basal beds include 9 m of purple mudstone.

The Owen Conglomerate and its correlates consist of terrestrial fans of siliceous conglomerate, and shallow-marine conglomerate and quartz sandstone (Banks in Spry and Banks, 1962, p. 147-176). Some 1200 m were deposited in an elongate basin which developed at the eastern side of the Great Lyell Fault (385352; Wade and Solomon, 1958), more than 1500 m near Adamsfield (Corbett, 1975a), about 550 m in the Dial Range (Burns, 1965), and some 500 m over the side of the Fossey Mountain Trough (Jennings, 1963). The lower members are probably of Late Cambrian age, but the upper sandstone members contain a marine Arenigian fauna (Banks in Spry and Banks, 1962, p. 165-168).

The distribution of the succeeding conformable beds shows deposition to have extended over much of the earlier Cambrian geanticlines. The thickest deposits, however, are on the sites of the Cambrian troughs, where there was considerable uninterrupted subsidence to receive the sediment.

The transgressive siliceous clastic deposits are followed conformably by shallow-marine Early to Late Ordovician Gordon Limestone (Banks in Spry and Banks, 1962, p. 169-174). The limestone deposits, which are of warm inundating seas, covered much of western Tasmania, and attained a thickness of 2000 m near Adamsfield (Corbett and Banks, 1974). The Gordon Limestone is succeeded conformably by the Eldon Group and its correlates, which are of shallow-marine interbedded quartz sandstone and mudstone, that attained a thickness of about 1800 m at the site of the Dundas Trough (Banks in Spry and Banks, 1962, p. 177-187). The youngest known beds of the Eldon Group and its correlates contain a brachiopod Siegenian fauna of middle-Early Devonian age (Flood, 1974). In general, little tectonic activity accompanied the accumulations of the Early Ordovician to Early Devonian deposits.

The easternmost occurrence of correlates of the Owen Conglomerate and the associated conformable strata is at the eastern margin of the Badger Head Geanticline. Further east, on the east bank of the Tamar River, rocks of comparable age, the Mathinna Beds, are very different.

MATHINNA BEDS OF NORTH-EASTERN TASMANIA

Conformable sequences of mudstone, and of interbedded turbidite quartz-wacke, siltstone and mudstone occupy large areas of eastern Tasmania and the Furneaux Group of Islands. These sedimentary rocks are folded, and they constitute the Mathinna Beds, the thickness of which is unknown.

The oldest beds occur near the east bank of the Tamar River, where a succession of dominantly slaty, argillaceous layers have yielded graptolites of probable Early Ordovician age (Banks and Smith, 1968). To the east, the Mathinna Beds are more arenaceous and contain younger fossils. Near Scamander [606409], on the east coast, graptolites, including the Early Devonian Monograptus aequabilis (Přibyl), have been recovered from thin mudstone layers (M.R. Banks, pers. comm.), whereas the turbidite quartz-wacke layers, contain transported fragments of marine fossils (Walker, 1957). At a number of localities the quartz-wacke beds include fragments of the vascular plant *Hostimella* (Cookson, 1937), believed to indicate an Early Devonian age.

The Mathinna basin of deposition was filled without any interruption by graptolite-bearing mud and sand, containing fragments of marine fauna and plants, transported by turbidity currents from the western margin (Williams, 1959; Marshall, 1969).

DEVONIAN DEFORMATION

The Cambrian to middle-Early Devonian rocks of Tasmania are extensively deformed by flattened parallel folds. In western Tasmania, quarrying at Eugenana [442433], near Devonport, exposed undisturbed terrestrial cavern fillings containing blocks of deformed Gordon Limestone from the cavern walls (Burns, 1965). Spore analysis of carbonaceous siltstone of the cavern fillings indicated a flora of late-Middle Devonian age (Balme, 1960). Evidently the Gordon Limestone and the beds of Silurian to middle-Early Devonian age following conformably were deformed before the accumulation of the late-Middle Devonian cavern deposits.

Folds of the north-eastern Tasmania Mathinna Beds are probably the same age as those affecting the middle-Early Devonian and older rocks of western Tasmania. In north-eastern Tasmania the folds involve Early Devonian sequences and are discordantly intruded by granitic bodies of minimum ages ranging from about 373 to 350 m.y. (McDougall and Leggo, 1965). This widespread Tasmanian deformation, which is correlated with the Tabberabberan Orogeny of eastern Australia, has been much studied (Carey, 1953; Bradley, 1956; Jennings, 1958; 1963; Jennings et *al.*, 1959; Solomon in Spry and Banks, 1962; Solomon, 1965; Burns, 1965).

WESTERN TASMANIA DEFORMATION

In western Tasmania the geanticlines of Cambrian times behaved as relatively competent blocks during the Devonian deformation, which is expressed by two main phases of folding. In the earlier phase folds developed in zones of closure between converging blocks, and the competent behaviour of the Tyennan Block largely determined the fold patterns of the northerly West

Coast Range/Valentines Peak trend[1], and of the easterly Loongana/Wilmot trend. The dominantly later folds in northern Tasmania are of the north-westerly and northerly Deloraine/Railton trend, which resulted from movement from the north-east. During this later deformation phase the Tyennan Block yielded in a narrow zone of folding of the north-westerly Zeehan/Gormanston trend, which extends into the Rocky Cape Block.

EARLY FOLD PHASE

West Coast Range/Valentines Peak trend

The distribution of the lithologically distinctive belts of rocks within the meridional Dundas Trough and the associated Mt Read Volcanics, was largely determined during their accumulation parallel to the trough margins in Eocambrian and Cambrian times. However, the distribution of the Ordovician Gordon Limestone and the Siluro-Devonian Eldon Group, which were most probably deposited over the entire region, show that earlier rock-type patterns have been enhanced by northerly-trending open folds of a half wave-length of up to 15 km.

The deformation associated with this fold trend culminated near the western margin of the Tyennan Block where folds, usually gently plunging and with an approximately 2 km half wave-length, indicate transportation from the west. The folds have an axial cleavage, and are often asymmetrical and overturned, with axial surfaces dipping steeply to the west, as for example at Mt Farrell (387380; Barton et al., 1966). In the Tyndall Range they are associated with renewed up-dip movements along the westerly dipping Great Lyell Fault (Corbett, 1975*b*).

The West Coast Range/Valentines Peak trend also includes symmetrical folds of 2 km half wave-length at Lake Lea (409404; Barton et al., 1966), and symmetrical folds of 5 km half wave-length at Valentines Peak (396421; Jago, Pike and Mills, 1975), where they may reflect a buried Precambrian basement margin.

In general, the overall fold pattern of the West Coast Range/Valentines Peak trend indicates a zone of closure between the relatively competent Rocky Cape and Tyennan Blocks. The Rocky Cape Block was itself deformed, however, for broad northerly-trending folds affect the rocks of the little-known Smithton Trough situated within the block. These movements may also have resulted in the northerly-trending folds associated with westerly dipping thrusts in the Owen Conglomerate at the western margin of the Cambrian Dial Range Trough (Burns, 1965).

At the south-eastern boundary of the Tyennan Block, northerly-trending Devonian folds of a half wave-length of some 8 km affect the deposits of the Adamsfield Trough and the associated Ordovician and Silurian beds. The hinges of the comparatively open folds are usually sub-horizontal and the axial surfaces dip steeply. To the south-east of the Adamsfield Trough correlates of the Owen Conglomerate rest on dolomite and quartzite sequences of probable Precambrian age with an angular unconformity, known as the Tyennan Unconformity (Carey and Banks, 1954). This unmapped Cambrian geanticline has been referred to as the Jubilee Block (Corbett et al., 1972), although its role during deformation is unknown.

Loongana/Wilmot trend

At the site of the Fossey Mountain Trough the general distribution of

[1] See map for location of folds.

the Lower Palaeozoic rocks shows easterly-trending folds of some 5 km half wave-length, which parallel the northern margin of the Tyennan Block. They are shallowly plunging, symmetrical and open with limb dips of the order of 20°. These folds of the Loongana/Wilmost trend are considered to be the oldest Devonian folds in the region (Jennings, 1963), and they resulted from the initial convergence of the Tyennan Block and the northern blocks of Precambrian rocks.

LATE FOLD PHASE

Deloraine/Railton trend

The folds of the north-westerly to northerly Deloraine/Railton trend, which occur in northern Tasmania, have a half wave-length of about 2.5 km. They exhibit a consistent asymmetry with axial surfaces and associated thrusts dipping to the north-east, indicating that they developed during transportation from this direction. Primary cleavage in the Cambrian to Early Devonian rocks of northern Tasmania is usually associated with folds of this trend.

Near Deloraine [471400], a period of Cambrian deformation is indicated by the occurrence of an angular unconformity between beds df the Fossey Mountain Trough and the Owen Conglomerate correlate (Pike, 1973). However, primary cleavage in the Cambrian rocks is geometrically consistent with its formation in Devonian folds, which are the product of the earlier and later fold phases, for the Loongana/Wilmot trend and Deloraine/Railton trend merge and share the same fold hinges.

The folds of the Loongana/Wilmot trend and the Deloraine/Railton trend diverge in the Fossey Mountains [436405], and where they interfere with each other the later folds are doubly plunging, and show sigmoidal outcrop bounded by marginal thrusts (Jennings, 1963). In general, within the folds of the Deloraine/Railton trend, the siliceous clastic correlate of the Owen Conglomerate behaved competently and deformed by slip along bedding, which was accompanied by break-thrusting (Map, sections IJ, KL). The associated thrusts dip as little as 30° to the north-east and commonly pass laterally into small, but complex, wrench faults. Cambrian rocks, already affected by Cambrian deformation and earlier Devonian folding, behaved incompetently during the later folding, and have a well-developed primary cleavage related to it.

At the eastern margin of the Badger Hill Block (Gee and Legge, 1974) are north-westerly trending fault-bound slices of Ordovician, Eocambrian(?) and Cambrian rocks. The slices dip and face north-east, and have a primary cleavage dipping steeply north-east. Consideration of the outcrop distribution and the occurrences of younger beds structurally underlying older, indicate that the slices are of an imbricate thrust system, with the thrust planes dipping steeply north-east (Map, section OP). This system, which is of the Deloraine/Railton trend, was formed when the Lower Palaeozoic rocks were pushed against the Precambrian rocks of the Badger Hill Block.

Zeehan/Gormanston trend

During the later Devonian deformation phase the Tyennan Block yielded in a north-westerly trending narrow zone and behaved as two blocks, the Cradle Mountain Block to the north and the Prince of Wales Range Block to the south. Within the zone separating these blocks late phase folds of the Zeehan/Gormanston trend have deformed the Precambrian metamorphic rocks and the unconformably overlying beds of the Owen Conglomerate correlate and associated conformable younger strata. Folds of this trend occur in the Frenchmans Cap region (400320; Spry and Gee, 1964; P.R. Williams, 1972), at Adam Range

(415315; Spry and Zimmerman, 1959) and in the northernmost part of the Adamsfield Trough (440300; N.J. Turner, pers. comm.). Around Frenchmans Cap the folds are upright and open, and have a half wave-length of some 5 km.

Near Queenstown (385342; Solomon, 1965), the Zeehan/Gormanston trend is represented by a 6 km wide fault-bounded structural trench, known as the Linda Disturbance, which deformed the northerly-trending Great Lyell Fault and its associated folds of the earlier Devonian fold phase. Within the structural trench west-north-westerly trending asymmetrical folds have developed with a half wave-length of about 2.5 km (Map, section GH). The folds have an axial cleavage, which dips south-west, and they are associated with steep reverse faults, along some of which there has been sinistral lateral movement. Fault systems continue from this disturbed zone both to the east and to the west.

The deformation zone continues into the Zeehan district, north-west of Queenstown, where it broadens, and the folds are the product of movements of the earlier deformation phase as well as of the later phase (Map, section EF; Blissett, 1962; Solomon in Spry and Banks, 1962). Evidence of modification of earlier Devonian structures is common, as for example west of Queenstown [370340], where a fold hinge of a broad synclinal structure ranges in trend from north-north-westerly in the south to west-north-west in the north. The swing in fold trend is accompanied by crenulation of the primary cleavage near a Devonian fault associated with the Zeehan/Gormanston trend (Baillie and Williams, 1975). Faults developed during this later folding occur throughout the region, but in many cases their significance has been masked by later post-Devonian movements along them.

Folding of the Zeehan/Gormanston trend extends north-west of Zeehan into the Rocky Cape Block [345390]. Near the mouth of the Pieman River these late folds are probably responsible for the change in trend of the metamorphic belt and of the fold hinges of the adjacent unmetamorphosed Precambrian rocks.

NORTH-EASTERN TASMANIA DEFORMATION

In the Mathinna Beds, folds have north-westerly trending hinge lines, which are often horizontal or gently plunging to the south-east. The folds are typically asymmetrical, long-limbed and with narrow flattened hinge zones. Their axial surfaces usually dip steeply to the south-west, and a primary slaty cleavage, associated with the folds, displays divergent fans in the sandstone layers, and convergent fans in the relatively incompetent mudstone beds. The fanning of the cleavage occurred during later movements, which tightened the hinges of the earlier formed folds (Powell, 1967; Williams, 1970), and caused some of the common crenulation of the cleavage.

The folds are of many orders of size, and the largest usually determined in mapping is of 1 to 2 km half wave-length (Threader, 1967; Groves, in press). Much larger folds are present, however, and, although they may have been dislocated by many undetected large normal faults, their half wave-length can be estimated to be about 20 km. An example of the larger regional folds occurs some 25 km east of the Tamar River where there is a north-westerly trending hinge zone of a recumbent syncline with an axial surface dipping to the south-west (505450; Gee and Legge, 1974). The smaller folds of the overturned western limb over-ride down to the south-west, whereas those of the eastern limb over-ride up to the north-east. This sense of fold vergence continues east for 22 km to a locality near the western margin of the Scottsdale Batholith [536433], where folds are symmetrical and are in the hinge-zone of a regional anticline.

The folding in north-east Tasmania indicates a tectonic transportation from the south-west. This direction of movement is opposite to that which resulted in folds of the similar aged Deloraine/Railton trend immediately west of the Tertiary Tamar Trough.

LATE DEVONIAN GRANITIC EMPLACEMENTS

Rocks of the most important period of granite emplacement in Tasmania have given isotopic minimum ages ranging from 375 to 335 m.y. (McDougall and Leggo, 1965; Brooks and Compston, 1965; Brooks, 1966). The bodies are essentially post-kinematic in that they truncate the fold structures of the surrounding country rocks.

In western Tasmania the granitic rocks have given minimum ages from 335 to 365 m.y. The largest body, the markedly discordant Meredith Adamellite [360395], covers an area of about 300 km^2. It has a narrow contact aureole up to 2.5 km in width in which metamorphism locally reached the grade of pyroxene hornfels facies. The adamellite is associated with cassiterite-bearing quartz porphyry dykes at Mt Bischoff (375412; Groves, 1971). The Heemskirk Granite [350360], at the west coast, is another large granitic mass. Although it has a narrow metamorphic contact zone less than 3 km in width, regionally developed hydrothermal zoning involves the progressive change of gangue mineralogy of lead-zinc ore veins from pyritic, through sidero-pyritic, to siderite over some 9 km in plan eastward from the granite margin. In general, the Heemskirk Granite is discordant with respect to the structural trends in the country rocks. However, at its northern boundary near the coast [335374], the granitic intrusion appears to have rotated the fold hinges within the Ordovician and younger rocks from a north-westerly to an easterly trend.

In the north-east of Tasmania most of the isotopic ages of the granitic rocks vary from 373 to 360 m.y., and this age range has been regarded as significantly older than those obtained for the western Tasmanian granitic rocks (McDougall and Leggo, 1965). The larger batholiths, which appear to be high level intrusions, are composite. They have sharp discordant boundaries, which appear to be controlled by fractures usually parallel to, but occasionally cross-cutting, the pre-intrusion folds of the surrounding Mathinna Beds. Contact metamorphic aureoles are narrow, ranging in width from 0.5 to 2 km. The Blue Tier Batholith [590440], which covers an area of about 1800 km^2, is predominantly adamellite. The batholith was intruded passively in an evolutionary sequence from early mafic granodiorite to late leucocratic granite, which is associated with cassiterite mineralisation (Groves, in press). The Scottsdale Batholith [550430] covers an area of 750 km^2, and is dominantly of granodiorite, which commonly includes remnants of roof pendants (Longman, 1966) and xenoliths aligned in a northerly trend.

There is much evidence for permissive, rather than forceful, emplacement of the granitic bodies (Gee and Groves, 1971). However, local folding is associated with the intrusion of the Scottsdale Batholith at Bridport (533463; Marshall, 1969), and of the Blue Tier Batholith at, for example, Dianas Basin (607420; Gee and Groves, 1971). Furthermore, regional doming of the country rocks is indicated by the near vertical axial surfaces of the folds of the Mathinna Beds near the western margin of the Scottsdale Batholith [536433], and at the south-western boundary of the Blue Tier Batholith [605386].

Foliations, defined by mineral alignments, are common throughout large regions of the north-eastern granite masses. In the Blue Tier Batholith the dominant north-westerly to northerly-trending foliation shows discordance with the contact against the country rocks at Piccaninny Point in the south

(607384; Gee and Groves, 1974), and around Mt Horror in the north (565460; Turner, in prep.). The foliation resulted from later deformations, which crenulated the primary cleavages of the pre-intrusion folds in the Mathinna Beds, where the cleavages were at a sufficiently large angle to the maximum east-west flattening direction. The northerly-trending foliation of the Blue Tier Batholith, the parallel crenulation cleavage in the Mathinna Beds to the west, and the foliation of the Scottsdale Batholith further west have been related to these later deformations (Turner, in prep.).

TAMAR FRACTURE SYSTEM

There is a considerable difference between the pre-Carboniferous geology of western Tasmania and the region east of the Tamar River [500430].

In western Tasmania, Lower Palaeozoic deposition began in narrow troughs formed during rifting by extension of Precambrian regions, which became geanticlines during the Cambrian. The troughs were filled by Late Cambrian to Early Ordovician times, when deposition of shallow-marine and terrestrial Owen Conglomerate and its correlates spread onto the geanticlines, the margins of which influenced early local deformation. The succeeding conformable beds are of the Gordon Limestone and the Eldon Group. The limestone, which is of Early to Late Ordovician age, was deposited in warm and shallow inundating seas. The Eldon Group consists of shallow-marine quartz sandstone and siltstone of Silurian to Early Devonian age. The influence of the Precambrian regions continued and they acted as blocks during the late-Early to early-Middle Devonian period of deformation, which is characterised by folds of a number of trends. On the west bank of the Tamar River, the main folds are of the north-westerly Deloraine/Railton trend, resulting from a tectonic transportation from the north-east.

There is no transition between the shelf deposits of the Gordon Limestone and the Eldon Group of western Tasmania, and the deeper water Mathinna Beds of a similar age range, occurring east of the Tamar River. The Mathinna Beds, which consist of interbedded turbidite quartz-wacke and mudstone, constitute a portion of an elongate basin of deposition. The beds display comparatively simple folds developed during tectonic transportation from the south-west.

The abrupt change in sedimentary rock-types and structural characteristics between western and north-eastern Tasmania indicates that the Tamar River is the site of a fracture along which lateral movements brought the contrasting regions into juxtaposition (Williams and Threader, 1971; Williams, Solomon and Green, 1976). The distribution of the contrasting rock-types in Tasmania suggests that the Tamar fracture system probably continues to the south-east, passing between Maria Island [590280] and Hobart [525255]. A fracture of similar location and trend has been referred to as an extension of a mega-shear postulated for a Palaeozoic re-assembly of Australia and Antarctica (Crawford and Campbell, 1973; Harrington, Burns and Thompson, 1973).

The large adamellite and granodiorite masses that were emplaced in Late Devonian times throughout Tasmania are essentially post-tectonic with respect to the late-Early to early-Middle Devonian folds. However, later deformations involving east-west flattening, indicated by foliations in the batholiths of north-east Tasmania and crenulation of the cleavage of the Mathinna country rocks, may be related to the Tamar fracture system. Such a relationship suggests that any lateral movement along the north-westerly trending wrench fault would be sinistral.

Later, Tasmania was part of a craton and prolonged erosion of the granite and older rocks was followed by the deposition of Late Carboniferous and younger beds, which are flat-lying and have undergone epeirogenic deformation only. The Late Carboniferous to Late Triassic Parmeener Super Group, which is some 1250 m thick, was intruded by Jurassic dolerite as sheets of more than 450 m thick. A period of considerable erosion and normal faulting preceded Cainozoic deposition. The faults, which probably followed older fracture systems (Williams, 1969), are of dominantly northerly, north-westerly and westerly trends, and are probably related to the fragmentation of the ancient Gondwanaland continent (Griffiths, 1971). A number of narrow fault-bounded Tertiary troughs formed, (Longman and Leaman, 1971) one of which developed on the boundary between the contrasting pre-Carboniferous rocks of western and north-eastern Tasmania along the Tamar River.

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