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THE GEOLOGY OF CENTRAL WESTERN TASMANIA

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ABSTRACT

The Queenstown-Zeehan-Rosebery area is geologically complex. It lies on a belt of folded Eocambrian and early Palaeozoic rocks which were deposited in the Dundas Trough, a rift structure which developed between the metamorphosed Precambrian rocks of the Cradle Mountain-Frenchmans Cap area (Tyennan Nucleus) to the east and the relatively unmetamorphosed Proterozoic rocks of the Rocky Cape Geanticline to the west. Quartz sandstone and shale sequences, with dolomite and conglomerate horizons, of the Eocambrian Success Creek and Rosebery Groups represent the earliest deposits of the trough, and are conformably overlain by mudstone, greywacke and minor spilite of the Crimson Creek Formation. Partly serpentinised ultramafic and associated spilitic rocks occur towards the western margin of the trough, and represent fault-emplaced blocks of oceanic crust originally formed by rifting of the Precambrian basement.

A major belt of acid volcanic rocks, the Mt Read Volcanics, was erupted along the eastern margin of the trough, and consists largely of rhyolite lava and tuff, including a significant proportion of hot ash-flow deposits. This volcanism commenced prior to deposition of the Rosebery Group in the Eocambrian, and the final eruptions were in the Late Cambrian. The Mt Read Volcanics are the host rocks to mineralisation at Mt Lyell, Rosebery, Hercules, Mt Farrell and Que River.

A change to compressional conditions occurred within the Trough prior to deposition of the Dundas Group in the Middle Cambrian. This sequence of mudstone, conglomerate and turbidite sandstone contains the earliest macrofossils of the region. It was largely derived from locally-uplifted blocks, including ultramafics, within the trough, with an increasing contribution from the Precambrian rocks to the east in the Late Cambrian. Further uplift of the Precambrian areas resulted in deposition of thick fans of siliceous Owen Conglomerate, particularly along the eastern margin of the trough, where the earlier volcanic rocks were largely blanketed. The westward spread of this detritus in the Queenstown area was limited by the active scarp of the Great Lyell Fault, and only the uppermost few metres (Pioneer Beds) overlapped this fault in the Early Ordovician. Conditions stabilised after this, when most of western Tasmania formed a gently subsiding shelf covered by a shallow sea from which carbonate mud and shelly detritus accumulated to form the Gordon Limestone. Fossiliferous marine sandstone and mudstone of the Eldon Group were deposited conformably above this in the Silurian and Early Devonian.

The Tabberabberan Orogeny in the Middle Devonian brought an end to sedimentation and resulted in folding of the rocks on two major trends. In general, the north-trending folds are earlier than those trending WNW. The latter fold phase affected the Precambrian rocks on either side of the Dundas Trough, and is associated with steep reverse faults and normal faults, some of which show minor sinistral transcurrent movement. Granite and adamellite bodies which were intruded during the Late Devonian were responsible for the replacement cassiterite-sulphide mineralisation at Renison Bell and probably the vein mineralisation in the Zeehan-Dundas area.

Marine glacigene sediments were deposited on the eroded earlier Palaeozoic rocks in the Late Carboniferous, and were followed by fossiliferous Permian sediments. The horizontally-bedded remnants of these, and of the dolerite sheets which intruded them in the Jurassic, can be seen on Mt Dundas and Mt Sedgwick. Block-faulting in the

Tertiary produced the 10 km wide Macquarie Harbour Graben, a trough containing at least 220 m of non-marine sands, clays and lignites, much of it lying below present sea level. Boulder beds containing Jurassic dolerite clasts occur along the eastern margin of this trough north and south of Strahan.

The early Tertiary graben deposits, and the adjacent older rocks, were truncated to form the prominent Henty Surface in the late Tertiary. Evidence for two periods of Pleistocene glaciation is present in some areas, the earlier, more extensive one probably reaching the coast at the King River.

INTRODUCTION

The geology of western Tasmania is almost unique in Australia in its variety, and includes rocks of nearly every geological system as well as a wide range of mineral deposits. Early exploration and development was almost entirely directed towards recovery of the minerals, and the major towns have grown as a consequence of mineral extraction. The economic interest of the area is reflected in the large number of published geological papers dealing with particular aspects, but the study of the regional geology has tended to lag behind the local studies, and there is still a paucity of accurate geological maps of much of the area.

Several reviews and compilations of the geology have been published recently, in particular the 1:250 000 maps, with explanatory notes, of the Queenstown and Burnie sheets (Corbett and Brown, 1976; Williams and Turner, 1974), and the structural map of the pre-Carboniferous rocks (Williams, 1976). The geological setting of the mineral deposits has been reviewed by Williams, Solomon and Green (1976).

In the following review, the sections on the Success Creek and Rosebery Groups, the ultramafic and mafic rocks, the Mt Read Volcanics in the Rosebery, Tullah and Pieman River areas, and the Late Devonian granitic rocks, have been written by G.R. Green, and the sections on Precambrian rocks, Silurian-Devonian sediments, and the Tabberabberan Orogeny, by P.R. Williams.

PRECAMBRIAN ROCKS

Precambrian basement rocks occur to the east, north-west and south-west of the area. Those to the east, in the Cradle Mountain-Frenchmans Cap area (Tyennan region), comprise quartzite, phyllite and schist belonging to the greenschist facies or epidote-amphibolite facies of regional metamorphism. They have been deformed during two Precambrian folding events of the Frenchman Orogeny (Spry, 1962; Gee, 1963; Turner, 1971; Williams, 1971). Folds of the first event are rarely found in outcrop, and the amplitude and wavelength of the first-order early folds is not known. A well developed S_1 cleavage is usually parallel to bedding. At Raglan Range (Gee, 1963) the S_1 surface has been folded into large recumbent folds plunging WNW during the second deformation. A crenulation cleavage has developed parallel to the axial surface of the second folds. F_2 folds are variable in style. Garnet-grade metamorphism occurred pre-, syn- or post-kinematically to D1. At Mt McCall biotite and garnet also formed post-kinematically to D2.

On the western part of the Sorell Peninsula, interbedded quartzite and phyllite, with minor conglomerate, has been deformed in four phases and undergone lower greenschist-facies metamorphism. The deformation of these rocks is similar to that of rocks of the Tyennan region (Baillie *et al*, in press).

The Precambrian rocks west of Zeehan and Renison Bell form the southern part of the Rocky Cape region. The main unit is the Oonah Quartzite and Slate, which consists of relatively unmetamorphosed siliceous siltstone and fine-grained quartzite. Thin dolomite horizons and basic volcanic rocks occur in the upper part of the sequence near

Zeehan (Blissett, 1962). The Arthur Lineament, in the lower Pieman River area, is a belt of phyllite, quartz-mica schist, and quartzite, representing metamorphosed equivalents of the adjacent sedimentary rocks (Williams, Solomon and Green, 1976).

In the Dundas area, a large inlier of Precambrian rocks consists of correlates of the upper part of the Oonah Formation. The Concert Schist, which occurs in the central part of this inlier, is considered by Turner (in press) to be a more strongly deformed and metamorphosed equivalent of the surrounding rocks. The deformation of these rocks, and those of the Rocky Cape region, took place during the Penguin Orogeny (Spry, 1962).

A structural discordance has been implied between the Oonah Formation and the overlying Success Creek Group on the Pieman River (Taylor, 1954; Williams, Solomon and Green, 1976), and unconformity with the Crimson Creek Formation has been suggested in areas where the Success Creek Group is absent (Williams, 1976).

EOCAMBRIAN AND CAMBRIAN ROCKS

Success Creek Group and Rosebery Group

A trough-like depositional basin, referred to as the Dundas Trough, developed approximately along the boundary between the Precambrian rocks to the east (Tyennan Geanticline) and the Rocky Cape Geanticline in the late Proterozoic, and remained the locus of sedimentation and igneous and tectonic activity until the Early Ordovician. The earliest sedimentary rocks of the western part of this trough belong to the Success Creek Group (Taylor, 1954), the upper members of which have been traced south into the Renison Bell area (Newnham, 1975). The group consists of quartz sandstone overlain by dolomite, black shale, hematitic chert and sandstone, and minor conglomerate with acid volcanic detritus (Patterson, 1976). The dolomite units are host to the massive pyrrhotite-cassiterite replacement deposits at Renison Bell, this mineralisation being genetically related to Devonian granitic intrusions (Patterson and Ohmoto, 1976; Newnham, 1976). Microfossils recently recovered from the shale horizons indicate an Eocambrian (Vendian) age (G. Vidal, pers. comm.).

On the eastern margin of the Dundas Trough, the Rosebery Group (Taylor, 1954) is faulted against the Mt Read Volcanics (Green and Williams, 1975). The group consists of basal massive volcaniclastic sandstone, derived from the Mt Read Volcanics, intercalated with black slate. This is overlain by the Stitt Quartzite, a formation of quartz sandstone, siltstone and black slate which shows evidence of deposition under shallow water conditions. In the Pieman Gorge north of Rosebery this formation is overlain by a unit of thinly-bedded, graded dolomitic siltstone and shale in which there are several slide conglomerates containing clasts of chert-replaced carbonate, dolomite and quartzite. Higher in the sequence is a unit of quartz-phyric vitric-crystal tuff, the Natone Volcanics, which is similar to parts of the Massive Pyroclastics at Rosebery. This is overlain by a polymict conglomerate containing clasts of quartz sandstone, black shale, acid tuff and the chromium mica fuchsite. Dolomite horizons occur at several places within the Rosebery Group.

Both the Rosebery Group and the Success Creek Group are overlain conformably by the Crimson Creek Formation, and both contain Eocambrian microfossils (G. Vidal, pers. comm.). Further, the presence of quartz sandstone low in the succession, and of acid volcanic detritus and dolomite horizons in both sequences, suggests a broad correlation (Green and Patterson, in prep.). The evidence from the Rosebery Group demonstrates that acid volcanism had commenced prior to deposition of the lowest-exposed sedimentary unit on the eastern margin of the Dundas Trough, and was in part coeval with this early sedimentation.

Crimson Creek Formation

Conformably overlying the Success Creek Group and the Renison Bell sequence is a thick sequence of purple to green argillite and lithic-wacke turbidites, with minor basic lavas, known as the Crimson Creek Formation (Taylor, 1954). Microfossils recovered from drill core material at Renison Bell suggest that at least the lower part of the formation is Eocambrian in age (G. Vidal, pers. comm.). Correlates of this formation extend into the upper Husskisson River area, where they include mudstone-greywacke sequences with minor bedded limestone (Barton *et al*, 1966). Similar lithologies occur in the Rosebery area, where the coarser horizons consist of lithic-wacke rich in basic volcanic detritus.

Undifferentiated Sedimentary Sequences

Unfossiliferous greywacke-shale sequences of Cambrian or Eocambrian age occur east and south of Mt Dundas, in the lower King River, and south of Macquarie Harbour. The sequence east of Mt Dundas contains intercalations of acid volcanics near the margin of the Mt Read Volcanic belt, and is intruded by several gabbroic bodies. Pillow basalts occur just south of the Henty River, and fossils from this area (Blissett, 1962) indicate that at least part of the sequence is Middle or Late Cambrian in age.

In the Yolande River area, near The Sisters, a west-facing sequence of shale, greywacke and conglomerate is interbedded with acid volcanic units (Corbett *et al*, 1974). In the lower King River the sequence includes acid to intermediate tuffs and minor andesitic and dacitic lavas (Baillie *et al*, in press).

Ultramafic and Mafic Rocks

In the central West Coast region there are two main associations of mafic and ultramafic rocks.

(i) Ultramafic-mafic complexes of the Huskisson River, Serpentine Hill, Razorback and Trial Harbour.
(ii) Gabbro intrusions, probably unrelated to the above, at McIvors Hill, Cuni and the upper Henty River.

The Huskisson River belt consists mainly of serpentinite, serpentinised pyroxenite and minor gabbro (Taylor, 1954), and serpentinised dunite is the major rock type at Trial Harbour (Green, 1966a). The Serpentine Hill Complex (Rubenach, 1974) consists of partly-serpentinised harzburgite and pyroxenite passing upward into layered gabbro and microgabbro. Minor amphibolite lenses are present. A poorly exposed dolerite and basalt sequence occurs adjacent to these rocks, but its relationship to the ultramafic-gabbro association is unknown. On the basis of petrology, chemistry and lithological association, Rubenach (*op. cit.*) considers the Serpentine Hill Complex to be a fault-dismembered ophiolite. Detritus from the complex occurs in the lower members of the Dundas Group (*ibid*).

The ultramafic rocks at Razorback consist of serpentinite and pyroxenite, and are faulted against the Dundas Group in the vicinity of the Razorback tin mine. In this area, the serpentinite has been dolomitised, and the secondary dolomite replaced by pyrrhotite-cassiterite mineralisation which has been deeply weathered to produce a stanniferous gossan (Padmasiri, 1974).

Mt Read Volcanics

This complex belt of acid to intermediate rocks, with minor basic varieties, is 10-15 km wide and is continuous along the eastern margin of the Dundas Trough. It plunges beneath younger rocks at South Darwin Peak but reappears further south. Small granite bodies, assumed to be of sub-volcanic origin, intrude the sequence at Mt Darwin and Mt Murchison. Primary structures which are preserved in many places indicate that lava flows, ash-flow tuffs, ash-fall tuffs, laharic breccias, volcaniclastic sediments, and small to large intrusions all occur, in complex associations. There is also superimposed local hydrothermal alteration and regional lower greenschist-facies metamorphism, as well as considerable structural complexity. The most abundant rock types are of rhyolitic and dacitic composition, with andesitic and basaltic types only locally abundant. Two of the most characteristic lithologies are a quartz-feldspar porphyry, with or without ferromagnesian phenocrysts, and a feldspar porphyry, with a fine-grained, commonly spherulitic groundmass. Albite, quartz, sericite and chlorite are the characteristic minerals, with lesser hornblende, clinopyroxene, biotite, K-feldspar, epidote and carbonate.

Queenstown-Mt Darwin area. Recent mapping between Queenstown and Mt Darwin has shown that the volcanic belt in this area consists of three major sequences younging eastwards (Corbett, 1975b and 1976a, b, c; Corbett *et al*, 1974). The oldest sequence forms the western part of the belt, and consists of interbedded slate, greywacke, sandstone, fine vitric tuff, quartz-feldspar-phyric crystal tuff, and agglomerate, intruded by a series of elongate quartz-feldspar porphyry bodies. The porphyry bodies are similar in composition to the quartz-bearing tuff units in the sequence, and the fact that they are virtually restricted to the western sequence suggests they may be largely sub-volcanic. Some bodies show autobreccia texture suggestive of flows or very shallow intrusions.

Basic to intermediate hornblende-pyroxene-feldspar porphyry bodies are prominent within the western sequence in the Lynch Creek area, south of Queenstown. The largest of these bodies, the 'Lynch Creek basalt' (Solomon, 1960), shows breccia textures with vesicular fragments, but has discordant contacts with the surrounding greywacke-slate sequence and appears to be intrusive. A Precambrian-derived quartz sandstone unit, the Miners Ridge Sandstone, forms a mappable marker horizon between the King River Gorge and Queenstown. Microfossils from shale within the western sequence indicate an Eocambrian (Vendian) age (G. Vidal, pers. comm.).

Conformably overlying the western sequence is a central sequence dominated by feldspar-phyric rhyolitic flows and tuff, with only minor sedimentary intercalations. Rocks with quartz phenocrysts are rare within this sequence south of Queenstown but increase in abundance to the north. The most common rock type in the Mt Darwin-Mt Jukes area is massive, pink to pale grey, fine-grained rhyolite, with small albite phenocrysts in a groundmass which commonly shows micro-spherulitic texture. Well-developed columnar jointing occurs at Mt Jukes and in several localities around Queenstown. Some of the rocks show prominent flow banding and autobrecciation textures and are probably lava flows, while others show flattened and welded pumice fragments and are the deposits of hot ash-flows. Ash-fall tuff and breccia are also common, while some of the massive, featureless porphyry bodies may be intrusives or domes. Fragmental rocks appear to be more abundant in the Queenstown area than further south.

Intrusive hornblende-pyroxene andesite bodies, some showing characteristic breccia texture, are common within the central sequence in the Queenstown area, and intermediate dykes and small stocks, some almost completely altered to chlorite, are abundant in the mine area.

An elongate stock of coarse-grained granitic rock about 5 km long and 1.5 km wide, intrudes the pink rhyolite on the South Darwin Plateau (Solomon, 1960). A pink orthoclase-quartz-plagioclase variety, and a white plagioclase-quartz variety, are present.

Practically all the significant sulphide mineralisation in the Mt Darwin-Queenstown area occurs within the central sequence, and most of the major deposits appear to lie on or near the contact with the overlying sequence (Corbett, 1975b). Hydrothermal alteration of the volcanic rocks is generally associated with the mineralisation, *e.g.* there is chloritisation associated with the disseminated pyrite-chalcopyrite deposits at Prince Lyell, Cape Horn and Prince Darwin, and extensive development of pyritic quartz-sericite schist in the Crown Lyell area (Reid, 1976). This alteration preceded cleavage development (Solomon, 1964; Loftus-Hills *et al*, 1967).

The third sequence is best developed along the eastern flanks of Mt Darwin and Mt Jukes. It unconformably overlies the Darwin Granite (White, 1975), and the basal units contain abundant blocks of granite and rhyolite, as well as hematite pebbles, near South

Darwin Peak. The sequence in this area consists of interbedded volcaniclastic conglomerate, sandstone, quartz-feldspar-phyric tuff and quartz-porphyry lava (Corbett, 1976a). At Lake Jukes, the rhyolite basement forms a mineralised knob partly surrounded by the younger sequence, which here includes a large proportion of banded and autobrecciated quartz-porphyry flows (Corbett, 1976b). On the north face of Mt Jukes the contact with the central sequence extends subvertically for some 600 m to the King Gorge, and appears to be a fault. The sequence wedges out near Mt Huxley, where it appears to unconformably overlie the central belt (Corbett, 1976c).

A third sequence is also present in the Mt Lyell area, where it overlies the altered and mineralised older volcanics, but correlation with the third sequence at Jukes-Darwin has not been conclusively established. The sequence was first recognised in the Comstock Valley (Green, 1971), where it has a lower unit of shale and tuff containing a lens of fossiliferous marine limestone of late Middle Cambrian age (Jago *et al*, 1972). Above this is a distinctive sequence of about 300 m of brown-weathering quartz-feldspar-phyric crystal tuff, agglomerate, shale and volcaniclastic conglomerate. The tuff show a characteristic pink and green banding accentuated by preferential secondary albitisation. These two lower units form the Comstock Tuff (Corbett *et al*, 1974). Conformably overlying this is a unit of volcaniclastic conglomerate and sandstone, with minor tuff horizons (including ignimbrite), originally termed the 'Jukes Formation' (*ibid*) but now thought to be older than the Jukes Conglomerate *sensu stricto*. The sequence as a whole is known as the Tyndall Group.

The Comstock Tuff also occurs just west of the Mt Lyell Company mill, where the basal shale rests abruptly on a sequence of basic to intermediate agglomerate and lava. In the Lynchford area, brown-weathering Comstock-type tuff and agglomerate is conformably underlain by white quartz-rich tuff which in turn appears to be conformable on shale and greywacke of the western sequence. The brown tuff in the Lynchford area contains clinopyroxene crystals, possibly derived from weathering of the underlying Lynch Creek basalt, and has previously been referred to as augite trachyte (Solomon, 1960). A sequence of brown-weathering, graded-bedded, agglomerate and tuff, with interbedded shale and sandstone, overlies massive pale rhyolite of the central sequence on Whip Spur, and may also be a correlate of the Comstock Tuff.

At the eastern end of Mt Lyell, pale cleaved quartz-porphyry lavas in the core of an anticline are overlain by brown-weathering tuff and agglomerate, and volcaniclastic beds, comparable to the Tyndall Group.

Red Hills-Mt Read area. An extensive sequence of grey to pink feldspar-phyric lavas and pyroclastics which occurs at Red Hills (Corbett, 1975a) is similar to the central sequence of the Queenstown area. Similar rocks occur on the eastern flanks of Mt Read, and are intruded by a complex series of basic dykes in the vicinity of the Henty Fault Zone. Overlying these rocks, with possible unconformity, is a sequence consisting of up to 400 m of pink quartz-feldspar-phyric lava at the base, followed by Comstock-type quartz-phyric tuff and agglomerate, with volcaniclastic beds and lenses of the pink lava. This sequence, which is correlated with the Tyndall Group (*ibid*), is overlain (conformably in some places, disconformably in others) by a marine sandstone-shale-conglomerate sequence forming the lower part of the Owen Formation and containing middle Late Cambrian fossils.

Rosebery-Mt Black area. The Mt Read Volcanic belt in this area comprises the older Primrose Pyroclastics to the west overlain by the Mt Black Volcanics to the east. The Primrose Pyroclastics consist dominantly of ash-flow tuff (Green and Williams, 1975; Green, 1976) of rhyolitic composition (Anderson, 1972). A diagnostic feature is the widespread presence of chloritised flattened pumice fragments or 'fiamme', giving a compaction foliation which is parallel to bedding in intercalated sedimentary horizons. Deformed shards and high-temperature devitrification textures, such as axiolitic texture (Ross and Smith, 1961) and micropoikilitic quartz, or snowflake texture (Lofgren, 1971), are all consistent with deposition from hot ash-flows in a sub-aerial environment.

The lowest member of the Primrose Pyroclastics consists dominantly of feldspar-phyric (albite or K-feldspar) vitric-crystal ash-flow tuff. In the vicinity of the Rosebery mine this unit has been extensively altered over an outcrop area of 1.2 km^2 to a quartz-sericite mineralogy with variable amounts of chlorite, carbonate and pyrite. Similar alteration occurs in other patchy zones within this unit (the 'footwall pyroclastics' of Hall *et al*, 1965). This alteration preceded cleavage formation.

The footwall pyroclastics are overlain by a number of siltstone-shale lenses, including the host rocks to the Rosebery and Hercules conformable massive sulphide deposits (Brathwaite, 1974). Away from zones of mineralisation the host rock consists mainly of thinly-interbedded grey siltstone, shale and volcaniclastic sandstone. A thin unit of quartz-feldspar-phyric crystal-vitric tuff within the host rock one kilometre north of Rosebery contains moulded glass shards indicating a hot ash-flow origin, and consequently a shallow-water environment is inferred for the sulphide precipitation at Rosebery (Green, 1976).

Overlying the host rock at Rosebery and Hercules is a unit of black slate with a few intercalated, weakly-graded, volcaniclastic sandstone beds. The slate in places contains disseminated biogenic pyrite (Loftus-Hills, 1968; Solomon *et al*, 1969) and up to 0.67% non-carbonate carbon (Gee, 1970). These features imply quiet-water reducing conditions during shale deposition, interrupted by occasional density currents. Microfossils from near the host rock-black slate contact, 2 km south of Rosebery, indicate an Eocambrian (Vendian) age (G. Vidal, pers. comm.).

The overlying massive pyroclastics also consist dominantly of ash-flow tuff. They differ from the footwall pyroclastics in the presence of quartz phenocrysts in many units and in the absence of K-feldspar phenocrysts. A unit of ash-flow breccia containing clasts of black shale and quartz porphyry is a distinctive lithology found only in the massive pyroclastics (Green and Williams, 1975).

The Primrose Pyroclastics from Mt Read to north of the Pieman River are overlain conformably to the east by the Mt Black Volcanics, the lowest unit of which is generally a massive, plagioclase-phyric rhyolite lava. In the Pieman River, about 500 m above the base of the lava, repetitions of autoclastic breccia overlying flow-banded lava indicate a continuation of the east-facing of the Primrose Pyroclastics. In general, however, facing indicators are lacking in the monotonous lava sequence. To the east, the rocks become more mafic, with dacitic, andesitic and basaltic crystal tuff and lava present (Anderson, 1972). The relationship of these rocks to the rhyolite lava sequence is unknown, but they are texturally and mineralogically similar to parts of the Comstock Tuff (Collins, 1975), particularly from the Lynchford area. These rocks were included in the Mt Black Volcanics by Brathwaite (1970, 1972).

Tullah area. The Farrell Slates occupy a 10 km long, NNE-trending zone adjacent to the northward continuation of the Henty Fault Zone and east of the Mt Black Volcanics. Rock types include strongly cleaved black slate, tuff, and volcaniclastic sandstone (Brooks, 1962; Rivers, 1976). The Farrell Slates zone is host to Pb-Zn-Ag mineralisation, the major deposits being the post-cleavage argentiferous galena-sphalerite-tetrahedrite veins at Mt Farrell (Brooks, 1962; Burton, 1976). Sulphur isotope analyses suggest the deposits may represent remobilised ores of volcanic origin (Solomon *et al*, 1969).

East of the Farrell Slates the volcanic sequence includes massive potash rhyolite similar to that of the Jukes-Darwin area (Solomon, 1964; Solomon *et al*, 1976). This unit is intruded by the complex Murchison Granite, which includes adamellite dated at 515 ± 15 Ma by the K-Ar method on hornblende (McDougall and Leggo, 1965), although the rock is visibly altered.

Area north of the Pieman River. Collins (1975) has traced the Mt Black Volcanics north-eastwards into the Que River area, where the lava sequence is overlain to the west by the fossiliferous Que River Beds (Gee *et al*, 1970). The latter consist of carbonaceous shale and siltstone, with intercalated tuff horizons, and contain a late Middle or early Late Cambrian marine fauna (*ibid*). The lava sequence includes a large andesite body which passes east into altered rhyolitic tuff and lava containing lenses of massive sulphide mineralisation (Cominco Geological Staff, pers. comm. 1976). To the west of the Que River Beds a sequence of tuff, greywacke, siltstone and shale is intruded by quartz-feldspar porphyry bodies (Collins, *op. cit.*).

Dundas Group and Correlates - Middle to Late Cambrian Fossiliferous Sequences

Fossiliferous Cambrian sequences occur in the Dundas area, in the Huskisson River area, near the Professor Range, and in several small localities near Zeehan. The sequence at Dundas between the Razorback ultramafic body and Misery Hill is known as the Dundas Group (Elliston, 1954; Banks, 1956, 1962a; Blissett, 1962). It comprises some 3000-4000 m of interbedded purple to green lithic-wacke sandstone, siltstone, slate and conglomerate, with minor acid tuff units and acid volcaniclastic beds. The conglomerate is up to boulder grade in places, with clasts composed mainly of trough-derived chert, jasper and argillite, but with abundant Precambrian quartzite detritus in some horizons. Spilite detritus and minor ultramafic detritus occurs in the base of the group above the Serpentine Hill ultramafic complex (Rubenach, 1974). Trilobite faunas rich in agnostids, and dendroid-hydroid faunas, are known from a number of localities, and range in age from middle Middle Cambrian (*Ptychagnostus gibbus* Zone) to possibly upper Late Cambrian.

The top formation of the Dundas Group is the Misery Conglomerate, a unit about 150 m thick of purple to red conglomerate, containing cobbles and boulders of quartzite and chert, which is conformable and gradational with the underlying fossiliferous sequence (Williams, 1974). Some authors have correlated this unit with the Mt Zeehan and Owen Conglomerate (*e.g.* Blissett, 1962).

In the lower Huskisson River, a fossiliferous sequence of about 1200 m of shale, siltstone, quartz sandstone, greywacke, tuff and siliceous conglomerate overlies a large sill-like ultramafic body (Taylor, 1954; Blissett, 1962). A trilobite fauna near the top of this sequence indicates a middle Late Cambrian age.

To the south and east of the Professor Range, a sequence of at least 900 m of green siltstone, shale, lithic-wacke, quartz-wacke, and siliceous conglomerate contains middle Late Cambrian trilobites at two localities (Corbett and Brown, 1976; Baillie *et al*, in press). Many of the sandstone and conglomerate beds show graded bedding and sole-marks, and are interpreted as proximal turbidites. The conglomerate contains rounded clasts to cobble size of quartzite, chert, jasper and minor acid volcanic rocks. The sequence is disconformably overlain by a correlate of the Mt Zeehan Conglomerate to the west, and probably unconformably overlain by siliceous conglomerate correlated with the upper part of the Owen Formation at The Sisters.

Late Cambrian to Early Ordovician Owen Conglomerate and Correlates

The Owen Conglomerate is the most spectacular mountain-forming unit in western Tasmania. It forms most of the peaks of the West Coast Range, where it overlies the Mt Read Volcanics in a broad anticlinal structure. It consists essentially of siliceous, pebble-cobble conglomerate and sandstone, in which the tightly-cemented clasts and grains are composed almost entirely of quartzite or quartz-schist derived from the Precambrian rocks to the east. Boulder-size clasts occur in the lower part of the formation in some areas. The clasts are generally well-rounded. The characteristic red to purplish colour is due to disseminated hematite in the matrix and to a limonite-hematite coating on many of the pebbles.

The thickness of the formation is highly variable, from a maximum of at least 1200 m on Mt Sorell to less than 100 m. The locus of maximum thickness shifts eastward from the Mt Sorell-Mt Strahan area to the Mt Owen-Mt Murchison area, and is apparently related to the controlling effects of major meridional faults. The influence of one of these, the Great Lyell Fault, is evident at Queenstown, where only the uppermost ten metres or so of the formation, the Pioneer Beds, lap across the fault onto the volcanic rocks to the west. The great bulk of the conglomerate in this area was deposited in a trough against the active fault scarp (Corbett *et al*, 1974), and the beds were dragged upwards by movements on the fault before being eroded and covered by the Pioneer Beds. The angular discordance so formed is known as the Haulage Unconformity (Wade and Solomon, 1958).

The Owen Formation is largely unfossiliferous, but poorly preserved marine fossils of probable Early Ordovician age occur in sandstones in the upper part, which is gradational into the Gordon Limestone. The age of the base of the sequence has long been a problem, but fossils are now known from a basal marine facies at the northern end of the Tyndall Range, and are of middle Late Cambrian age (Corbett, 1975a). This basal facies, the Newton Creek Sandstone Member, is some 700 m thick and consists of interbedded siltstone, shale, quartz-wacke turbidites, siliceous conglomerate and slump sheets, and represents in part a submarine fan complex. It is comparable in lithology, depositional environment and age with the upper part of the Dundas Group and correlates. It is apparently conformable with the underlying Tyndall Group rocks in places, but disconformably overlaps them near Red Hills (*ibid*).

The Pioneer Beds at Queenstown consist of sandstone, grit and pebble conglomerate, and contain abundant detrital chromite. A similar chromitiferous sandstone-grit forms the base of the Ordovician succession at the Henty Bridge, some 12 km north-west of Queenstown, where there is unconformity with underlying Cambrian sediments and volcanics. North of this, in the Dundas-Zeehan area, the base of the Ordovician succession in many places comprises a thin sandstone unit resting directly on Cambrian or older rocks, and this contact may represent the Haulage Unconformity.

The Mt Zeehan Conglomerate is similar to the Owen Formation, and forms a wedge up to 450 m thick (Blissett, 1962). It is overlain by a more widespread marine sandstone unit up to 360 m thick. Clasts in the conglomerate are mainly of quartzite, quartz and chert. A similar conglomerate-sandstone sequence occurs at the Professor Range. At The Sisters, up to 500 m of siliceous conglomerate and sandstone occurs in a faulted syncline but the conglomerate wedges out rapidly to the north and is only a few metres thick at the Henty Bridge.

TECTONIC HISTORY OF THE EARLY DUNDAS TROUGH

Several lines of evidence indicate that the Dundas Trough developed by rifting and extension of a continental area rather than by closing of a broad oceanic basin between separated blocks (cf. Solomon and Griffiths, 1974). The locus of rifting did not correspond exactly with the original boundary between the Rocky Cape and Tyennan regions, but appears to have transgressed it from north to south. At Dundas, the inlier of basement rocks correlated with the Oonah Formation is located east of the major ultramafic bodies, which probably represent new ocean floor created by the rifting. To the south at Cape Sorell, however, multiply-deformed Precambrian rocks similar to those of the Tyennan region lie west of the major ultramafic bodies in the southerly continuation of the Dundas Trough.

The early rifting or extension probably commenced in the Late Proterozoic, and was accompanied by deposition of shallow-marine quartz sandstone, shale and minor dolomite of the Success Creek Group at the western margin of the trough. Similar shallow-water sediments accumulated at about this time towards the eastern margin to form the Rosebery Group. The Mt Read Volcanic belt, was was already in existence, shed detritus into the base of the Rosebery Group, and at least one ash-flow tuff was later deposited in the Rosebery Group basin. The preliminary microfossil data (G. Vidal, pers. comm.) suggests that the western sequence of the Mt Read Volcanics at Queenstown was also deposited at this time.

As the trough deepened the early shallow-marine deposits were conformably followed by the deeper-water mudstones, lithic-wacke turbidites, cherts and basic volcanics of the Crimson Creek Formation. The lower part of this formation is probably also Late Proterozoic in age (G. Vidal, pers. comm.). Geochemical studies of the basic volcanics indicate that they are ocean-floor tholeiite type (Foden, in press). The ultramafic bodies, particularly those with ophiolite affinities such as Serpentine Hill and Heazlewood River (Rubenach, 1972, 1974) probably represent remnants of new ocean floor formed by the rifting. The amount of new ocean floor created is difficult to estimate, but was probably not great considering the relatively small amount of ultramafic rocks now present and the lack of evidence for extreme later shortening within the Dundas Trough (Williams, 1976).

A change from extensional to compressional conditions appears to have occurred within the Dundas Trough prior to deposition of the Dundas Group, which accumulated under tectonically-active conditions in the Middle and Late Cambrian. The ultramafic bodies were disrupted and tectonically emplaced along steep faults into the overlying parts of the Crimson Creek Formation. In places they were exposed to erosion, and ultramafic and spilitic detritus was shed into the lower members of the Dundas Group. The pattern and tempo of sedimentation changed, with conglomerate, coarse greywacke, and mudstone being deposited in actively-subsiding basins. The abundance of chert and argillite detritus in the Dundas Group indicates considerable local uplift and erosion of the earlier trough sequences, and there was also an increasing influx of quartzite detritus from the reactivated Precambrian basement blocks.

Within the Mt Read Volcanic belt, this change to compressional conditions may be reflected in the major hiatus indicated by the erosional unconformity on the Darwin Granite beneath the eastern sequence at Jukes-Darwin. This hiatus probably corresponds to the base of the fossiliferous Tyndall Group at Queenstown and in the Red Hills area. Much of the sulphide mineralisation may have been removed by erosion during this period.

There is little conclusive evidence of folding in the Dundas Trough during the compressional period, although there may be considerable masking of early structures by the much more intense Devonian deformation. A possible angular discordance of about 20° at the base of the Dundas Group is indicated at Serpentine Hill (Rubenach, 1974). There was at least local cleavage development in the Cambrian, since disoriented cleaved clasts of quartz porphyry occur in the eastern volcanic sequence at South Darwin Peak (Corbett, 1976a). These clasts have a penetrative cleavage which is crenulated by the cleavage in the host rock (S.F. Cox, pers. comm.). The angular discordance at the base of the Owen Conglomerate and correlates in places, *e.g.* near the Henty Bridge (Baillie *et al*, in press), on Mt Sedgwick (E.B. Corbett, pers. comm.), and at South Darwin Peak (Corbett, 1976a), also indicates at least local folding in the Middle or Late Cambrian.

The Mt Read Volcanic belt was active throughout Dundas Group time, as indicated by the presence of acid tuffs and detritus in the type area of the group, and by the occurrence of fossils of Dundas Group age within the upper volcanic sequence at Que River and at Comstock. However, the volcanism appears to have declined rapidly in the Late Cambrian, when there was considerable erosion of the volcanic pile to produce the volcaniclastic breccias and conglomerates of the Tyndall Group. The unconformity-disconformity between the Tyndall Group and correlates and the overlying siliceous Owen Conglomerate marks the close of the volcanism, in the middle part of the Late Cambrian. This unconformity is most pronounced at South Darwin Peak (Corbett, 1976a), but in other places there is apparent conformity (Corbett *et al*, 1974).

The influx of siliceous detritus to the trough increased markedly after the middle Late Cambrian, attesting to rapid uplift of the Precambrian areas, and particularly of the Tyennan Geanticline. The Great Lyell Fault became a dominating feature in the Queenstown area, and formed a scarp which prevented the spread of siliceous material to the west. While much of the gravel and sand of the Owen Formation accumulated under shallow-marine or non-marine conditions, some of it was deposited in deeper water as submarine fan complexes, such as that forming the Newton Creek Sandstone Member (Corbett, 1975a). A significant amount was also deposited in the central part of the Dundas Trough, to form the siliceous conglomerate units at the top of the Dundas Group. Along the margin of the Tyennan Geanticline, the irregular topography of the Mt Read Volcanics was buried by the conglomerate, although the higher, more resistant peaks such as Mt Darwin and Mt Read, may not have been covered until very late in the depositional episode.

The final significant event in this period of tectonic activity is represented by the Haulage Unconformity, and probably occurred in the Early Ordovician. The Pioneer Beds, which lie above the unconformity, represent a major marine transgression which spread across the now inactive Great Lyell Fault and covered the upturned earlier Owen beds as well as the remnants of the Tyndall Group and older volcanic rocks west of the fault. Further study is required to determine the significance of the Haulage Movement beyond the Queenstown area, but there is evidence to suggest that it could separate the Early Ordovician sequence from the underlying Dundas Group and older rocks in the central part of the trough.

ORDOVICIAN GORDON LIMESTONE

The marine transgression of the Early Ordovician spread siliceous sand over most of the Dundas Trough and onto the bounding Precambrian areas. Although some areas within the trough may have continued to be sites of more rapid subsidence, the dominating role of the trough as the major depositional basin is no longer evident after this transgression. A shallow sea submerged most of western Tasmania, and the supply of land-derived detritus dwindled until most of the deposition was in the form of carbonate mud and skeletal material from shelly fossils. This accumulated on extensive tidal flats and shoals to form the Gordon Limestone.

The thickness of the limestone in western Tasmania varies from only a few tens of metres to several hundred metres, in contrast to the much greater thicknesses (up to 1800 m) in the Florentine Valley and Mole Creek areas. The limestone in most areas has weathered to a black puggy clay, as a result of solution by acid groundwater, and generally occurs in valleys with a cover of superficial gravels derived from the adjacent ridges. Corals and other fossils of Middle and Late Ordovician age are known from Zeehan and Queenstown (Banks, 1957, 1962b). In some areas, as at Rinadeena (Baillie *et al*, in press), a largely terrigenous facies of calcareous siltstone and shale occupies the stratigraphic position of the limestone. The limestone has been quarried as a smelting flux at Zeehan, Queenstown and Darwin.

SILURIAN AND DEVONIAN SEDIMENTS

Conformably overlying the Gordon Limestone in most areas is a sequence of quartz-sandstone, siltstone and shale, ranging in age from Silurian to Early Devonian and known as the Eldon Group. The type sequence is in the Zeehan area, where Gill and Banks (1950) defined five formations. At the base the Crotty Quartzite consists of 500 m of poorly fossiliferous quartzite with some thick bands of quartzitic grit. The Amber Slate consists of 250 m of grey slate, originally a siltstone, and is overlain by the Keel Quartzite, consisting of 130 m of blue-grey, poorly fossiliferous quartzite with some ripple-marked beds. Above this, the Florence Sandstone is 500 m thick and contains a rich Early Devonian shelly fauna and some calcareous sandstone beds. It is overlain by 430 m of shale with thin sandstone beds defined as the Bell Shale. This formation contains Early Devonian fossils, and is the youngest stratigraphic unit affected by the Tabberabberan Orogeny.

Blissett (1962) included another formation, the Austral Creek Siltstone (70 m), between the Keel and Florence Formations.

The Bell Shale correlate in the Strahan area has been described by Baillie and Williams (1975), who suggest that deposition took place in shallow water and partly under lagoonal conditions. This and other formations in the Strahan area can be correlated with the Zeehan sequence on lithological and palaeontological grounds (Baillie *et al*, in press), although the Strahan sequence is much thicker.

Eldon Group correlates with similar stratigraphy occupy a large syncline in the Huskisson River area (Taylor, 1954), and form a wide belt along the King River valley from the Eldon Range southwards (Reid, 1963).

TABBERABBERAN OROGENY

A major period of folding and faulting in the Middle Devonian, the Tabberabberan Orogeny, affected all the Eocambrian to Early Devonian rocks of western Tasmania. The upper age limit for this orogeny is given by undisturbed cave deposits of late Middle Devonian age within folded Gordon Limestone at Eugenana, near Devonport (Burns, 1965). The folds produced in the Eldon Group rocks by this orogeny are particularly well expressed in the topography around Zeehan, Strahan and the Huskisson River, where competent units such as the Crotty Quartzite form continuous strike ridges.

The folds in western Tasmania were formed during two main deformation phases. The first phase produced structures generally trending north-south. The Precambrian rocks of the Rocky Cape region and the Tyennan region acted as competent blocks at this stage, and closure between these blocks is thought to have determined the strain pattern (Williams, 1976). The second phase of deformation produced folds generally trending north-west, although numerous west-north-west and west-trending structures also occur. During this phase the Tyennan region yielded and was itself folded (*ibid*).

West Coast Range Structures

The West Coast Range is a broad north-south trending anticlinal structure in Owen Conglomerate, with the core of volcanic rocks exposed in many places. Folds related to this structure are mostly gently plunging, slightly asymmetrical structures with associated axial surface cleavages dipping steeply to the west. An overturned fold has been mapped at Mt Farrell (Barton *et al*, 1966). Suggested up-dip movement on the Great Lyell Fault during folding (Wade and Solomon, 1958; Corbett, 1975a), and the westerly dip of the axial surfaces implies transportation of material from the west against a competent unit to the east. A large north-south trending synclinal structure in Eldon Group rocks is wedged between the West Coast Range Anticline and the Precambrian rocks of the Tyennan region in the King River Valley.

At Mt Lyell, the north-south trend is disturbed by faults and folds on a west-north-west trend (Linda Fault System), which continues to the east and west (Solomon, 1962). The faults are steeply dipping, with north-side-down movement south of Mt Lyell and south-side-down movement north of Mt Lyell. The faults are generally high-angle reverse faults with some late sinistral transcurrent movement. East of Mt Lyell this zone of deformation continues into the Raglan Range area as folds and faults (*e.g.* at Bubs Hill). Spry and Gee (1964) showed that the faults and large-scale open folds in the Precambrian metamorphic rocks of the Raglan Range are the result of the Tabberabberan Orogeny, and that the Palaeozoic fold axes are similar in direction to the Precambrian axes. At Mt McCall, a major antiform in the Precambrian rocks is also a Tabberabberan structure (Williams, 1971).

Structures North-East of Strahan

Two generations of structures have been recognised in the Bell Shale correlate in the Strahan area (Baillie and Williams, 1975). The earlier phase produced north-

north-west trending folds which also affected the Florence Sandstone correlate and the Cambrian rocks below. The plunge of the major syncline varies from vertical in the south to 40° NNW to 15° SSE further north. The variation in plunge is within the axial surface of the early folds. The folds produced a good axial surface cleavage which dips steeply north-east.

Further north, towards the Henty River, the folds plunge gently to the west-north-west and have a primary axial surface cleavage associated with them. These folds are related to the second deformation phase. A crenulation cleavage occurs parallel to this trend in some areas. Baillie and Williams (*op. cit.*) argue that the earlier folds die out to the north near the Firewood Siding Fault, and that the effects of the second phase were localised around that structure. The Firewood Siding Fault is a westerly extension of the Linda Fault System. West of Queenstown the second phase caused folding of the Florence Sandstone around a hinge plunging steeply to the west.

Structures around Zeehan and the Huskisson River

In the Little Henty River area, south of Zeehan, the Eldon Group rocks are folded into a series of variably-plunging anticlines and synclines trending north-west or west-north-west (Blissett, 1962). The north-west trending folds plunge at about 40°, and have been warped into the more westerly trend. At Mt Zeehan, the major fold plunges south-east and has been warped into the more westerly trend by later movements. Reversals of plunge along major synclines suggest east-west cross-folding (Blissett, *op. cit.*).

The syncline structure in the Huskisson River area is a variably-plunging asymmetric structural basin with the Bell Shale correlate in the fold core. The southern part plunges 30°-40° to the north-west, while the northern part plunges gently south (Taylor, 1954; Blissett, 1962). The axial surface trace changes in trend from north-west in the southern part to east of north near the Meredith Granite. The western limb dips at between 50° and 70° to the north-east, and the eastern limb is either vertical or dips steeply south-west or north-east. This indicates an axial surface dipping steeply north-east (Taylor, 1954). The complex form of this structure suggests that more than one episode of folding has occurred.

LATE DEVONIAN GRANITIC ROCKS

The late Devonian granitic rocks of western Tasmania were emplaced between 349 Ma and 365 Ma, based on Rb-Sr dates on the Heemskirk (Brooks and Compston, 1966), Pieman, Meredith and Renison Bell Granites (Brooks, 1966), and K-Ar dating of the Granite Tor stock (McDougall and Leggo, 1965). Dominant rock types are porphyritic and non-porphyritic biotite adamellite and granite (*e.g.* Groves *et al*, 1972, Klomínský, 1972; Patterson, 1976). In general the intrusives show discordant boundaries with their country rocks and metamorphic aureoles up to 3 km wide. Contact metamorphism reached the pyroxene hornfels facies around the Heemskirk Granite (Green, 1966b) and the Meredith Granite (Groves *et al*, 1972). Hydrothermal alteration and tourmalinisation of parts of the plutons is common, and hydrothermal zonation of Sn, Zn, Pb and Ag mineralisation is a marked feature, particularly in the Zeehan ores around the Heemskirk Granite (Both and Williams, 1968).

CARBONIFEROUS-PERMIAN ROCKS

Flat-lying Late Carboniferous and Permian beds lie unconformably on the folded Palaeozoic rocks on the Eldon Range, at Mt Sedgwick, Mt Dundas and Mt Read, in several areas north-west of Zeehan, in the lower Henty River, and near Strahan. Basal tillite is present in most of these areas. On Mt Sedgwick and Mt Read, the tillite rests on a hummocky, glaciated surface of Mt Read Volcanics, and contains boulders of porphyry and Owen Conglomerate as well as other rock types (Banks and Ahmad, 1962). Tillite which occurs 6 km north-west of Zeehan has been overthrust by Precambrian rocks, and was earlier thought to be of Late Proterozoic age (Blissett, 1962).

A thick section of Permian beds, dipping gently west, occurs between the lower Henty River and Trial Harbour (Baillie *et al*, in press; Blissett, 1962; Banks and Ahmad, 1962). It includes basal tillite, with intercalated rhythmites, overlain by fossiliferous marine pebbly siltstone and sandstone, and non-marine micaceous sandstone and carbonaceous shale with plant fossils.

JURASSIC DOLERITE

Dolerite which intruded and baked the basal Permo-Carboniferous beds forms a capping on Mt Sedgwick and Mt Dundas. A faulted sill about 220 m thick dips gently southwest in the area north of the lower Henty River, and was intruded in the upper part of the Permian sequence (Blissett, 1962). The Eureka Cone Sheet, 15 km north-west of Zeehan, is an oval ring of dolerite which has intruded the Oonah Formation basement (Spry, 1958).

TERTIARY SEDIMENTS

Tertiary sediments filling the northern part of the 10 km wide Macquarie Harbour Graben are exposed along the eastern side of the harbour and in a belt between Strahan and the lower Henty River. The sediments have a minimum thickness of 220 m, and a bore hole at Farm Cove indicates that at least 168 m of this is below present sea level (Scott, 1960). The beds were deposited in a fault-controlled trough in which the bounding fault scarps were eroded back and eventually covered by the upper part of the sequence (Cox, 1975).

On the eastern shore of the harbour there are cliff exposures of gently-dipping, poorly- to well-consolidated sand, silt and clay, with lignite horizons. Channel structures up to 30 m wide, filled with cross-bedded coarse sand and grit, indicate fluvial deposition on a flat alluvial flood plain. The presence of marine dinoflagellates as well as spores and pollen in some beds (W. Harris, pers. comm., *in* Cox, 1975) suggests the occasional encroachment of coastal lagoons or tidal swamps. The beds contain an Eocene microflora at Sophia Point (*ibid*), and a Palaeocene age is accorded to similar beds at Strahan (Harris, 1968; Cookson and Eisenach, 1967).

Coarse conglomerate is a major component of the sequence along the eastern margin of the trough between Pine Cove and Mt Sorell. Clasts in the lowest-exposed conglomerate include up to 15% fresh Jurassic dolerite as well as locally available Owen Conglomerate, Eldon Group rocks, and Cambrian volcanics and sediments (Cox, 1975). The nearest known sources for the dolerite are Point Hibbs to the south, the lower Henty River area to the north, and Mt Sedgwick. Overlying this conglomerate is at least 50 m of sand, silt, grit, clay, and pebble to cobble conglomerate in which dolerite clasts are absent. The microflora in the upper beds again suggests an Eocene age (*ibid*). Similar coarse conglomerate containing boulders of dolerite overlaps the Carboniferous tillite between Strahan and the lower Henty River area (Baillie *et al*, in press; Banks and Ahmad, 1959).

The Tertiary deposits, Permian Beds, and folded Palaeozoic rocks, were eroded in the late Tertiary (?) to form the extensive Henty Surface (Gregory, 1903), a seaward-sloping peneplain rising from about 150 m near Strahan to about 360 m around the West Coast Range. Secondary surfaces or terraces occur at lower levels in many areas (*e.g.* Banks and Ahmad, 1959).

PLEISTOCENE GLACIATION

Pleistocene glacial deposits and erosional features have long been recognised in western Tasmania, but the number and extent of the glacial periods is presently under review. Most of the early studies were summarised by Lewis (1945), who postulated three stages of glaciation and correlated them with European stages. Jennings and Banks (1958) and later workers (*e.g.* Derbyshire and Peterson, 1971; Davies, 1974) rejected much of the evidence for Lewis' early stages, and suggested that most of the glacial features could be accounted for by the last glaciation, with a few possible exceptions.

More recent studies, particularly in northern Tasmania, have revealed extensive older glacial deposits in areas far beyond the previously accepted limits of glaciation, and three glacial stages are now considered probable (Colhoun, 1975). The oldest of these, in the Early Pleistocene, is known only from evidence at Lemonthyme, on the Forth River. The succeeding stage - the Forth Glacial - occurred in the Late Pleistocene, and is well documented from many areas. It was clearly the most extensive glaciation, with valley glaciers reaching the coast in several places. The Last Glacial, which is subdivided into two substages, was responsible for most of the obvious glacial features and deposits seen in the Central Highlands and the mountains of western Tasmania.

Documentation of the effects of the Forth Glacial (c. 14 000 B.P.) in western Tasmania is still in the preliminary stages. Outwash deposits beneath interglacial backswamp silts at the lower Pieman H.E.C. dam site probably belong to this stage, as does till and outwash material beneath organic clays and younger till at the Henty River bridge on the Zeehan Highway (Colhoun, *op. cit.*). The King River Valley below Crotty, although narrow, has a form suggestive of a glacial origin, and poorly-sorted boulder deposits which occur on the south flank of the gorge at Teepookana (S.F. Cox, pers. comm.) may be moraine or outwash remnants. Unconsolidated till-like deposits north of Strahan suggest the possibility that ice flowed north from the King River towards the Henty (Colhoun, 1975).

Features of the Last Glacial Stage (7500-10 000 years B.P.) are prominent in many places. A large ice mass in the Eldon Range-Mt Tyndall-Mt Murchison area had major outlet glaciers into the King, Henty and Pieman Rivers, and end moraines occur at Crotty (Ahmad, Bartlett and Green, 1959), the Henty bridge (Banks and Ahmad, 1959) and west of Rosebery (Blissett, 1962). Moraines in the Linda, Comstock and Nelson Valleys resulted from ice pushing up tributary valleys from the main King glacier.

Many other valleys in the area also appear to have been glaciated, *e.g.* those of the Clark River and Garfield River near Mt Darwin, and that of the Queen River at Queenstown. Glaciers from the upper Queen River area and Conglomerate Creek appear to have coalesced at the Queenstown football ground, and the Queen River valley below this has a glaciated form, and shows high-level perched gravels, at least as far south as Lynchford. High level glacial features, such as cirques, moraines and lakes, occur on most of the peaks of the West Coast Range.

THE DARWIN METEORITE CRATER

A large, circular, flat-bottomed depression, about one km wide, occurs within Eldon Group rocks near the Andrew River, and is believed to be a meteorite crater (Ford, 1972). The Darwin glass, which has long been known as small beads and fragments occurring at the base of the surface peat layer between Crotty and Mt McCall, was probably formed by melting and splashing of the country rocks during the meteorite impact. The glass has also been found on the Tertiary surface west of Mt Sorell and Mt Strahan, and has been dated at about 710 thousand years (early Pleistocene). The crater has been modified by fluvial and peri-glacial erosion, and is partly filled with lake deposits (R.J. Ford, pers. comm.).

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FIG. 1. - Distribution of pre-Carboniferous rocks in central western Tasmania. Modified from Corbett and Brown (1976) and Williams and Turner (1974), with additions from Newnham (1975) and unpublished work by the authors.