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The Mt Read Volcanics and associated rocks in the Lake Margaret Road - East Queen River area, Queenstown

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TASMANIA DEPARTMENT OF MINES

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1981/53. The Mt Read Volcanics and associated rocks in the Lake Margaret Road-East Queen River area, Queenstown.

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Abstract

A correlate of the Pioneer Beds in the lower East Queen River rests unconformably on a truncated Tyndall Group sequence, which in turn rests abruptly and possibly discordantly on massive andesitic pyroclastic rocks. Near the Comstock Valley, the relationship of the Tyndall Group to underlying rocks is not clear. Stratigraphy and facies relationships in the complex sequence below the Tyndall Group are difficult to determine. A western volcano-sedimentary sequence of shale, sandstone, tuff, and agglomerate is generally east-facing and appears to interfinger with a sequence rich in eutaxitic ash-flow like tuff, feldspar porphyry, and agglomerate referable to the central volcanic sequence elsewhere. A sequence of andesitic agglomerate, tuff, and lava within the central sequence on 'Agglomerate Hill' possibly represents a volcanic centre.

Intrusive andesite bodies (plagioclase-pyroxene-hornblende porphyries) occur throughout the area, and range from large stocks up to two kilometres long down to small chloritised dykes. A large quartz-feldspar porphyry body within the western sequence is apparently dextrally displaced by about two kilometres on a major NW-trending fault which transects the area. A strong subvertical cleavage trending generally NW cross-cuts the generally N-S trending steep to vertical bedding throughout the area.

INTRODUCTION

This report derives from mapping in the Lake Margaret Road area carried out by the author and his wife (E.B. Corbett, then geologist with the Tasmania Department of Mines) in the winters (May-July) of 1971 and 1972, and some further mapping by the author in the East Queen River area in July-August 1975. A small amount of mapping done by G.R. Green in the East Queen River area in about June 1972, has also been incorporated. Some use has been made in the present report of petrological descriptions prepared by E.B. Corbett in 1972-73 of thin sections and samples collected from the area.

Most of the field work was undertaken during the period when mapping of the adjacent Strahan Quadrangle was the major summer project for the Regional Mapping Section of the Geological Survey. An attempt at mapping the highly complex Mt Read Volcanics sequence in the Queenstown area was made to determine whether detailed mapping of these rocks could produce worthwhile results in terms of delineating and understanding the rock types involved and determining the stratigraphic relationships. Later work by the author in other parts of the Mt Read Volcanics belt has indicated that the Lake Margaret Road-East Queen River area is one of the most complex and difficult in the belt, both in terms of original complexity and subsequent deformation and disruption.

This report is aimed at providing a general description of the sequences and rock types present in the area, backed up with thin section petrography of an essentially reconnaissance nature. Some preliminary interpretations of depositional processes and environments are suggested, but much further work will be necessary before definite conclusions can be

drawn. Detailed structural analysis has not been attempted, nor has metamorphism been studied.

QUATERNARY DEPOSITS

Recent alluvium

Small areas of sandy to gravelly alluvium have been mapped on the West Queen River upstream of No. 3 Dam, and on the East Queen River near its confluence with the West Queen. The latter area marks the upstream end of an extensive alluvial plain developed along the Queen River north and south of Queenstown township.

Bouldery fan and scree deposits

Extensive fans of bouldery scree-like material are present on the western flanks of the Sedgwick Plateau and in the upper reaches of the West Queen River. The deposits consist mostly of Owen Conglomerate detritus, and include large boulders up to several metres across. The location of the deposits is topographically controlled, suggesting that they were formed by gravity controlled mass movement processes. Dissection of the deposits by the present drainage has produced arcuate sharp-crested ridges in places. Variations in morphology and soil and vegetation cover suggest that several overlapping fans may be present. The deposits appear to grade downstream into gravelly alluvium.

Pleistocene moraine - Lake Margaret area

A large ridge of coarse morainal detritus overlies Cambrian volcanic rocks to the east and north of Lake Margaret township, and represents the southern continuation of the Hamilton Moraine. The deposit is dominated by Owen Conglomerate detritus, and includes large boulders.

Pleistocene morainal deposits near Mt Lyell Company mill

A moraine-like deposit, dominated by rounded cobbles and small boulders in a sandy-clayey matrix, overlies Pioneer Beds and Comstock Tuff just west of the Mt Lyell Company mill. The contact with bedrock is steep to subvertical in places, and in one locality contortions in underlying leached limestone clay are suggestive of glacial overriding. The deposit is at least 15 m thick, and is apparently unsorted and unbedded. Clasts are mainly of Owen Conglomerate and various Cambrian volcanic rocks, but also include some of Jurassic dolerite. Some of the dolerite clasts are deeply weathered *in situ*, so that only a small kernel of fresh rock is preserved within a thick carapace of yellowish clay.

A patch of similar dolerite-bearing gravel is preserved on the flank of a small ridge 250 m NNW of the main deposit, and a smaller patch of similar gravel (dolerite not noted) occurs on the west bank of the East Queen River about one kilometre further north. The latter was on a small bench about 35 m above present river level. Similar gravel occurs just outside the mapped area beside the Zeehan Highway 250 m west of the Mt Lyell Co. offices, and also along the broad ridge between the old slag dump and the Queenstown football ground. In the latter area, the dolerite-bearing gravel fills a large steep-sided channel structure cut through Pioneer Beds and volcanic rocks.

The nearest known source of Jurassic dolerite is on Mt Sedgwick, and the occurrence of perched erratics of dolerite at an elevation of 540 m

south-west of the Comstock open cut (Wade and Solomon, 1958) suggests that ice from this area may have spilled south from the Comstock Valley down the West Queen system. Although the upper reaches of this river are now deeply incised and not obviously glaciated, the occurrence of till-like gravel 35 m above river level suggests that the present gorge may be largely the result of post-glacial dissection. Alternatively, the dolerite may have been derived from the Eldon Range, and may have reached the Queen system *via* the Linda Valley and a spillover into Conglomerate Creek. The valley of Conglomerate Creek also contains morainal deposits (Corbett, 1979) and shows evidence of considerable post-glacial incision.

?CRETACEOUS LAMPROPHYRE DYKES

Narrow dykes of biotite-feldspar-phyric lamprophyre have been noted in three localities on the Lake Margaret Road. The dykes are generally deeply weathered to brownish clay. They appear to postdate the cleavage in the host rocks, and hence are probably post-Devonian. Similar dykes are common in the Mt Lyell mine area (Sutherland and Corbett, 1974; Reid, 1976).

The northernmost occurrence is in a quarry near the Yolande River, where a vertical two metre wide dyke obliquely cross-cuts slate and tuff. About 350 m further south, two dykes (0.6 m and 1.0 m wide) intrude the same sedimentary unit on a side track. These dykes show chilled margins, and one contains small inclusions of siliceous sediment. A single dyke is exposed near the eastern contact of a quartz-feldspar-chlorite porphyry body at Swan Creek. The apparent alignment and similarity of trend of the three occurrences suggest they may be part of a single continuous body. A Cretaceous age for the West Coast lamprophyres has been suggested by Sutherland and Corbett (1974).

CAMBRO-ORDOVICIAN OWEN CONGLOMERATE AND PIONEER BEDS

Siliceous conglomerate and sandstone of the Owen Formation is faulted against Mt Read Volcanics on the western flank of the Sedgwick Plateau.

A correlate of the Pioneer Beds (Wade and Solomon, 1958) rests unconformably on Tyndall Group rocks just west of the Mt Lyell mill. The Beds are subvertical to slightly overturned, and comprise some 5-10 m of white siliceous pebble-granule conglomerate and interbedded sandstone. Cross-bedding is evident in the sandstone layers, and concentrations of chromite grains (confirmed by electron probe analysis by A.V. Brown) occur in a number of beds in some cross-laminae. The Beds are overlain by deeply weathered laminated sandy shale and grey puggy clay representing leached impure limestone.

MT READ VOLCANICS - CAMBRIAN

Tyndall Group

Rocks belonging to the Tyndall Group (Corbett *et al.*, 1974) occur at three localities in the mapped area : western end of Comstock Valley; near the Mt Lyell mill; and on the western flank of the Sedgwick Plateau.

Comstock Valley

The thickest sequence is on 'Zig-Zag Hill', near the Comstock Valley; this is the type area for both formations of the group. The top of the sequence is obscured by glacial deposits in this area. The basal Comstock Tuff crops out extensively on the south face of the hill, where the beds

dip east or north-east at 55° to 85°. The sequence is faulted off on its southern side by an E-W trending fault, and reappears further east outside the mapped area. The northern boundary is probably also faulted. The formation is about 300-400 m thick, and comprises interbedded crystal tuff, crystal-lithic tuff, agglomerate, volcaniclastic conglomerate and breccia, tuffaceous sandstone and siltstone, and laminated ash.

The apparent base of the sequence comprises 10 m of fine-grained volcanic ash and siltstone showing the prominent pink and green banding typical of the formation. This unit overlies, apparently conformably, a pale coloured pumiceous rock containing plagioclase and quartz crystals and altered pumice fragments in a partly recrystallised glassy matrix (71/631, 72/116). The latter rock appears to represent an ash-flow or 'froth-flow', and has compositional similarities with the Comstock Tuff. It may be a local unit developed at the base of Comstock Tuff, but its relationship to the poorly exposed underlying rocks is not known. A fossiliferous marine limestone lens containing late Middle Cambrian fossils occurs at the base of the Tuff near the Comstock open cut (Jago *et al.*, 1972), but has not been seen in the mapped area.

The laminated ash (72/123) consists of small (0.07 mm) sericitised plagioclase grains and less common quartz crystals in a feldspar-chlorite matrix showing vague shard shapes. The pink bands show abundant secondary mosaic albite. The rock is cut by veins of mosaic feldspar, and by a cleavage outlined by strings of sericite.

The sequence above the basal unit, although incompletely exposed, appears to consist largely of pink and green banded tuff and pink to brown-weathering agglomerate, with some units of massive volcaniclastic conglomerate or breccia and some sandstone-siltstone-ash units. The prominent banding in the tuff is due to the development of abundant secondary pink mosaic albite which replaces the matrix of some primary bands, albeit in a rather irregular fashion. The green bands tend to lack secondary albite, but have chlorite flakes and grains scattered through the matrix. Some of the crystal-lithic tuff and agglomerate show development of haloes of secondary albite around small lithic clasts, and in places these may coalesce to form a crude banding. Some varieties show a charcteristic splotchy texture with irregular green chlorite splotches, generally flattened in the plane of bedding, and pink albite-rich patches.

Thin sections of the tuff (71/629, 72/118, 72/297) show a jumble of albite crystals, rare to abundant quartz crystals, rare clinopyroxene grains (usually partly altered to amphibole and chlorite), and opaque iron ore grains, in a fine-grained matrix of feldspar and chlorite which may be partially or wholly replaced by secondary mosaic albite.

The bedded nature of the tuff suggests that the majority are of ash-fall origin, although some of the finer grained, more clearly laminated units were probably deposited in shallow water. Some of the 'splotchy' tuff near the top of the sequence contains irregular fragments and rafts of laminated pink ash and shows crude grading in units a metre or so thick, suggesting they may be flows of some kind.

The volcaniclastic conglomerate-breccia units are generally massive and of the order of 5 to 20 m thick. They generally contain a mixture of rounded clasts (mostly of volcanic rock types) and angular to highly irregular clasts of shale, sandstone and tuff up to two metres long, in a tuffaceous matrix rich in feldspar and quartz crystals. The irregular clasts appear to have been ripped up during flow, and the conglomerate

units probably represent mass-flow deposits.

The contact with the overlying 'Jukes Formation' is taken as the base of a prominent unit of interbedded shale and sandstone, above which the sequence is predominantly sedimentary. The contact is offset by several small WNW to NW-trending faults near the top of 'Zig-Zag Hill'. The 'Jukes Formation' sequence comprises laminated grey siltstone, shale, tuffaceous sandstone, volcaniclastic conglomerate, and minor tuff. Conglomerate becomes increasingly abundant upwards, and is the dominant lithology in the exposed upper half of the formation. The typical conglomerate (72/295) is a green to purplish rock with abundant to sparse, rounded to sub-rounded clasts of pebble to small boulder grade set in a strongly foliated tuffaceous sericitic-chloritic matrix. Clasts are mainly of volcanic rock types, but include quartzite and shale-mudstone. Some of the sandstone beds show grading, and cross-lamination is evident in some siltstone units. Scattered units of quartz-feldspar crystal tuff and crystal-lithic tuff occur in the lower half of the formation.

A distinctive unit of purplish dense crystal-vitric ash-flow tuff crops out within the 'Jukes Formation' at 61722561* (€ti on map). In thin section (72/294) the rock consists of embayed quartz phenocrysts and corroded and rounded plagioclase phenocrysts set in a matrix of well preserved shards. The shards show moulding and compaction textures around phenocrysts. Parts of the matrix are replaced by secondary minerals, including chlorite, carbonate, mosaic feldspar and quartz, and many of the phenocrysts are rimmed by a fine-grained chlorite-feldspar-quartz aggregate. This rock has been described and figured in Corbett *et al.* (1974), and is one of the units analysed in a zircon dating project (Black, Corbett, and Green, *in press*).

Mill area

The Comstock Tuff is excellently exposed in a small area 300 m north-west of the Mt Lyell Company mill. The beds form an open south-plunging syncline with steep to moderate dips, and are truncated unconformably by the vertically dipping to overturned Pioneer Beds.

The base of the Comstock Tuff sequence is exposed in several places. In the north-eastern part of the area, a black shale-siltstone unit (5-10 m thick) at the base rests abruptly on massive andesitic agglomerate. Several rounded blocks of andesite (the largest about one metre across) occur within the shale in one place (in a small south flowing creek), and have locally folded and disrupted the bedding. Dumping of spoil in this area has recently obscured some of the contact exposures. In the north-western part of the area, a lower unit of interbedded tuffaceous sandstone, shale, and breccia has a basal fine-grained conglomerate which rests, apparently abruptly, on deeply weathered andesitic rock. Bedded fine tuff in the underlying sequence strikes obliquely towards the contact.

The lower sandstone-rich unit in the north-west part is 30-40 m thick, and includes thin beds with sole marks, flame structures, grading and cross-lamination. Volcanic quartz is abundant in many of the sandstones. Overlying this unit, along an irregular erosion surface, is a massive coarse breccia unit at least 30 m thick. The breccia contains blocks of ripped up sandstone several metres long, and irregular blocks of felsic porphyry

* The geological map of the Lake Margaret Road-East Queen River area (fig. 1) is based on the obsolete Australian National Grid (ANG) and co-ordinates in this report are therefore given in yards. All grid references lie in the 100 kiloyard grid square 38.

of similar size. Some of the latter have narrow twisted protrusions, which indicate that the blocks were molten when emplaced. Also within the breccia are abundant small, irregularly-shaped glassy volcanic fragments (resembling the fiamme of ash-flow tuffs), blocks of quartz-feldspar porphyry, feldspar porphyry, and andesite-like rock, and abundant well-rounded pebbles and granules of volcanic rocks which were clearly water worn before redeposition. The breccia appears to represent a lahar or mass-flow deposit, possibly initiated by a volcanic eruption as evidenced by the inclusion of molten blocks and fragments. Incorporation of the water-worn pebbles may have occurred when the flow crossed a beach or river deposit before coming to rest in the subaqueous (probably marine) environment of the sandstone.

Overlying the breccia is a sequence of typical banded pink and green crystal and crystal-lithic tuff with intercalated breccia and vitric ash units. Some of the breccias are mass-flow deposits, and contain blocks of banded ash, hornblende andesite, quartz-feldspar porphyry and, in one case, roundstone pebble-cobble conglomerate which, from the irregular shape of the blocks, was unconsolidated at the time of incorporation. Local erosion surfaces are apparent in the tuff sequence in places (*e.g.* Corbett *et al.*, 1974, fig. 8).

Sedgwick Plateau area

A small outcrop of pink-weathering banded tuff and agglomerate, typical of the Comstock Tuff, is exposed through scree deposits on the western flank of the Sedgwick Plateau. The location of the outcrop suggests that there may be a narrow sliver of Tyndall Group rocks along the western side of the Great Lyell Fault in this area, as is the case north of Lake Margaret.

Subdivision of pre-Tyndall Group sequences

The volcanic and volcano-sedimentary sequences lying below the Tyndall Group are extremely complex in the mapped area, and many of the stratigraphic relationships remain to be clarified. There is clearly much lateral variability in the sequences, such that correlation over distances of a few hundred metres is often difficult or impossible, and this is compounded by structural complexity and weathering and outcrop problems.

A broad subdivision into a western volcano-sedimentary sequence and a central volcanic sequence, as previously proposed for the South Queenstown area (Corbett, 1979), is also possible in this area, but the boundary between the two units is not well defined and there appears to be significant interfingering. The stratigraphic units proposed by Cox (1981) in the area immediately east of the East Queen River are only partially evident in the present mapping. A major NW-trending fault cuts the sequence in the southern part of the area, but no unequivocal correlation has been possible across the fault. Several other significant faults are probably present, but their existence has not been confirmed.

For the purposes of the present discussion, the western sequence south of the major fault is taken as extending eastward to the boundary with massive feldspar-porphyry near the ridge crest on the west bank of the East Queen River. The area of interbedded sediment and tuff south-east of No. 2 Dam is considered as part of the western sequence, the contact with the central sequence running diagonally NNW from the East Queen River. The northern boundary of this area is poorly defined, but may be formed by the continuation of the North Lyell Fault (Cox, 1981).

The western sequence north of the major fault is taken as extending eastwards to the boundary with the thick ash-flow unit at No. 3 Dam. It is thus considered to include the unit of probable ash-flows just west of Crown Hill, and the ridge top sequence immediately east of the Crown Hill andesite bodies. No boundary has yet been defined north of Swan Creek.

Western volcano-sedimentary sequence north of major fault

A sequence of interbedded shale, sandstone, and tuff, cut by several tabular intrusive bodies, is exposed along the Lake Margaret Road and on various side tracks north of the major fault. The sequence generally dips steeply east and faces east, with slight overturning in places. The sequence can be subdivided into a lower unit of crystal tuff, followed by a unit of interbedded vitric tuff, shale and sandstone, followed by a unit of vitric-crystal ash-flow type tuff, followed by an upper unit of interbedded shale, sandstone, crystal tuff, and vitric tuff.

The lower crystal tuff is exposed along the road to the lower power station, and in Whipsnake Creek. It is a massive, grey-green, granular, medium-grained rock which in thin section (71/330, 71/372) consists of a close-packed aggregate of quartz crystals (many broken, some embayed) and plagioclase crystals (mostly strongly altered to sericite) in a sparse matrix (10-15%) of fine-grained quartz, recrystallised wispy sericite, and chlorite. There are rare volcanic rock fragments and some sericite-chlorite masses which may represent altered pumice fragments. The unit appears to be an air-fall tuff, and is truncated to the east by a quartz-feldspar porphyry body.

Between the latter body and a narrower porphyry body to the east is a sequence of mostly fine-grained sericite porcellanous tuff interbedded with shale and sandstone. Two shale-rich horizons have been differentiated in the mapping. The tuff is typically pale grey to pale green or white in colour, and varies from well laminated to apparently unbedded. Tectonic foliation is generally well developed, some of the rocks being semi-schistose. They range from almost pure vitric tuff, in which only scattered small grains of quartz, plagioclase (usually altered to sericite), and muscovite occur in a variably devitrified and recrystallised glassy shard-rich matrix (*e.g.* 71/349) to vitric-crystal tuff in which the grain component is more abundant (*e.g.* 71/331, 71/574). Some examples contain rounded to lens-shaped green to white blebs up to several centimetres long, which appear to be devitrification structures or, in some cases, original pumice fragments. One example (71/342) contains well preserved pumice fragments with frayed ends, similar to fiamme. The majority of the tuffs appear to be subaqueous ash deposits.

Cross-lamination, deformed lamination, fine-scale parallel lamination, load casts, flame structures, and rare graded bedding occur in the units of interbedded grey-black shale, sandstone, and tuff (*e.g.* 71/346). Although no fossils have been found, the units are considered to be marine.

East of the dacite porphyry is a sequence of mainly vitric-crystal tuff and crystal-vitric tuff with some thin horizons of shale and vitric tuff. Some of the coarser tuff (*e.g.* 71/504) contains abundant flattened pumice fragments (altered to felted sericite-chlorite) and resembles ash-flows. Some of these contain disrupted shale fragments, indicating sub-aqueous deposition. A tuff from the western flank of Crown Hill (71/352) contains crystals of pyroxene (probably augite) as well as altered plagio-clase, and appears to be andesitic. A distinctive agglomerate-breccia (71/505), which occurs at the eastern margin of the isolated southern

projection of the Crown Hill andesite body, contains irregular fragments of pyroxene-bearing lava, as well as sediment clasts, in a shard-rich matrix, and appears to be a subaqueously deposited andesitic ash-flow.

East of the Crown Hill andesite body the sequence includes several units of pyritic black shale-siltstone (quarried for road metal) and units of coarse-grained quartz-rich crystal-lithic tuff. A chemical analysis of the black shale-slate from the road metal quarry just south of Crown Hill is given in Appendix 1. The coarse tuff units (*e.g.* 71/377) commonly contain ripped up shale clasts, and have erosional contacts with underlying shale in some cases. Large embayed quartz crystals (up to 5 mm) and cloudy plagioclase crystals are abundant in the tuff, in an uneven, recrystallised quartz-feldspar-chlorite-sericite matrix. Individual tuff units are 10-20 m thick and appear to represent large subaqueous flows. Vitric and vitric-crystal tuff also occur in the sequence, and include some in which original shard textures are well preserved (*e.g.* 71/490).

A sheared zone about four metres wide and containing abundant pyrite is exposed within a vitric-crystal tuff unit underlying a black shale on the old tramway formation west of the Lake Margaret Road.

Western volcano-sedimentary sequence south of major fault

Bedding in the sequence south of the fault strikes generally NNE and is steep to vertical. Facing is generally east, but several reversals have been noted. The sequence is transected by a large quartz-feldspar porphyry body at No. 1 Dam, similar to that which intrudes the western sequence north of the fault. The sequence is a complex mixture of vitric and crystal tuff, agglomerate, shale and sandstone.

The westernmost unit examined is a greenish, fine-grained, massive vitric-crystal tuff exposed beneath a power pylon just west of the road. In thin section (71/380) it consists of jumbled small grains of completely sericitised plagioclase and angular quartz set in an abundant matrix of very elongated shards. The shards show crude axiolitic recrystallisation (mostly to fine quartz, chlorite, and dusty opaques) and many are bent. A chemical analysis of this tuff (Appendix 1) shows a potassic rhyolite or rhyodacite composition.

Above the basal tuff is a sequence of coarse agglomerate-breccia units separated by units of shale and bedded to massive vitric-crystal tuff. Some of the agglomerate units contain large deformed rafts of sediment up to 10 m long, as well as numerous blocks of volcanic rocks, and appear to have deformed and disrupted bedding in the underlying shale in some cases. Individual units are 5-50 m thick, and may be graded from coarse agglomerate at the base to sandy-crystal tuff at the top. One of the agglomerate units contains rolled-up balls or lenses of laminated tuffaceous shale up to 200 mm long, with margins penetrated by clasts and crystals from the surrounding matrix material (71/383a). This unit also contains abundant angular clasts and wispy fragments of pale glassy lava (hyalopilitic to finely vesicular), some of which are bent around the larger clasts as though they were still plastic when deposited (*e.g.* 71/385, M147). The agglomerate represents large subaqueous flows, some of which were still hot when deposition occurred.

Above the main agglomerate sequence, and exposed along the road to No. 1 Dam, is a sequence of pale-weathering sandy tuff, tuffaceous sandstone, vitric tuff and shale, showing occasional cross-lamination, grading, and flame structures. An agglomerate unit with fragments of shale and

glassy lava occurs towards the eastern margin.

A distinctive unit comprising some 5-10 m of interbedded grey quartzose sandstone and black slate crops out beside the road 200 m west of No. 1 Dam. The sandstone beds are 30-200 mm thick, and show graded bedding, parallel lamination, and cross-lamination. In thin section (71/386) the sandstone consists predominantly of well rounded to sub-rounded quartz grains and some small rock fragments in a recrystallised chloritic matrix (about 10%). The quartz grains include polycrystalline types, possibly of Precambrian derivation, and clear quartz (probably of volcanic origin), and the rock fragments include chert and fine-grained volcanic rocks. The rock resembles some varieties of the Miners Ridge Sandstone of South Queenstown (Corbett, 1979) in the abundance of quartz, presence of polycrystalline grains, and lack of feldspar, and these factors, together with its close association with the large porphyry body, suggests it is probably an extension of that unit.

Overlying the sandstone is a coarse agglomerate-breccia unit containing large rafts of bedded sediment up to several metres long. The quartz-feldspar porphyry has an intrusive contact against this unit.

The sequence east of the porphyry body consists largely of pale-weathering vitric tuff and quartz-feldspar crystal tuff interbedded with tuffaceous sandstone and shale, but also includes a 150 m thick unit of quartz-feldspar-phyric rock which resembles the weathered porphyry in outcrop. This unit is massive for the most part, but shows clear bedding near its eastern margin. In thin section (75/715) it contains abundant quartz crystals (many broken, some embayed) and plagioclase crystals (mostly very altered), and a few probable rock fragments, in a fine-grained recrystallised matrix which probably included some glassy material. A somewhat similar porphyry-like unit, containing shale clasts, occurs in the western sequence above the Miners Ridge Sandstone at South Queenstown (Corbett, 1979, p. 17).

Bedded sequence east of No. 2 Dam

A sequence of pale-weathering, quartz-rich, sandy crystal-vitric tuff, sandstone, and shale, similar to that along the No. 1 Dam road, occurs north of the major fault and east of No. 2 Dam. Its relationship to the rock sequences to the north and north-west is not clear. Some of the sandstone beds in the north-west part of the area show large scale trough cross-bedding and erosional scours, and are clearly west facing. A massive quartz-feldspar-phyric rock, probably a crystal tuff but possibly an intrusive porphyry, occurs in the central part of the sequence. To the east of this the beds dip and face east, and appear to have a conformable, interdigitating contact with feldspar porphyry and tuff of the central sequence.

Several agglomerate units in the eastern part of the area (*e.g.* 75/717, 75/718, 75/729) contain quartz and feldspar grains and rock fragments (including quartz porphyry), as well as flattened pumice clasts which show evidence of compaction around lithic clasts or phenocrysts. These units resemble ash-flow tuffs, but their association with bedded sediments suggests they were deposited subaqueously.

Near the eastern margin of the sequence, on the west bank of the East Queen River, is a narrow unit of distinctive dark green to black agglomerate, closely associated with a sliver of andesite. In thin section (75/719, 75/720) the agglomerate consists of abundant, irregular clasts of dark, finely vesicular, microlitic, chlorite-epidote rich basaltic rock, and blocks of pinkish feldspar porphyry, in a poorly defined dusty matrix of

chlorite, feldspar, carbonate, and small rock fragments. Similar agglomerate occurs near the contact of the western and central sequences in the South Queenstown area, and has a basaltic composition (Corbett, 1979, p. 28-29).

Central volcanic sequence and undifferentiated sequences

A highly complex sequence of felsic to intermediate tuff, agglomerate, lava, intrusive rocks, and minor sediments extends north-westwards from the East Queen River near Cape Horn Mine to Lake Margaret township. Lithological similarity and structural continuity indicate correlation with the central volcanic sequence of the South Queenstown area (Corbett, 1979). Internal complexity, structural complications, and lack of marker horizons have so far precluded detailed correlation from area to area. The sequence is therefore described in terms of localities.

Lake Margaret township area

Pale green to grey vitric-crystal tuff and agglomerate is exposed in road cuttings on either side of the Yolande River and on the slopes east and west of Lake Margaret township and power station. Many of the rocks have a strong eutaxitic foliation formed by platy clasts and wisps of sericite-chlorite, interpreted as collapsed pumice fragments (fiamme). A six metre thick unit of black pyritic slate occurs within the sequence near the west abutment of the Yolande River bridge.

Thin sections of the tuff (71/324, 71/337, 71/338, 71/339) show scattered to moderately abundant plagioclase crystals (usually strongly altered to sericite-carbonate) and small quartz crystals (some samples only) in a flow-like foliated mass consisting mostly of very fine grained felted sericite (plus carbonate, chlorite, quartz, feldspar, opaques) representing the collapsed pumice fragments. Some of the fragments show the internal striping and flamed ends typical of fiamme. Many show evidence of having been compacted and compressed over phenocrysts, suggesting that the clasts were still hot when deposited. The rocks are interpreted as ash-flow tuffs.

A massive greenish-grey rock exposed along the access track up the penstock ridge contains large carbonate blebs resembling amygdales and appears to be a lava. In thin section (71/340) the rock has a porphyritic, semi-crystalline texture, with phenocrysts and glomerocrysts of plagioclase in a groundmass of plagioclase-quartz-chlorite-sericite-carbonate. Further east on this track, a similar massive greenish rock (71/341) wraps around a probable xenolith of siltstone, and consists of plagioclase phenocrysts in a chlorite-quartz-carbonate-sericite matrix in which shard shapes are apparent. This rock is probably an ash-flow tuff.

North of Swan Creek

The sequence east of the dacite porphyry body just north of Swan Creek begins with bedded fine to coarse-grained tuff, followed by a thick unit of coarse tuff with abundant small bomb-like clasts (up to 50 mm long), followed by a unit of massive, pale grey, amygdaloidal feldspar-phyric lava forming a small hill. In thin section (71/360) the lava consists of phenocrysts and glomerocrysts of altered plagioclase in a semi-granophyric groundmass of quartz, cloudy feldspar, plagioclase needles, granular chlorite, and opaque grains. Some of the amygdales are filled with coarse quartz and chlorite and some are lined with quartz.

Outcrop is poor to the east of the lava unit, but rock types noted include quartz-feldspar crystal tuff (71/361), fine-grained crystal-lithic

tuff (71/362), lithic tuff rich in feldspar porphyry fragments (71/363), and shard-rich vitric-crystal tuff (71/576).

Ridge north-east of Crown Hill

The large andesite body on the slope one kilometre east of Crown Hill is followed to the east by poorly exposed crystal tuff with feldspar and quartz and some epidotised rock fragments (71/354), followed upslope by a thick sequence of eutaxitic feldspar-phyric ash-flow like tuff and agglomerate (71/355, 71/356, 71/357). The latter sequence includes an intercalation of eight metres of bedded slate and tuff exposed in an old water race. Further upslope, near the Owen Conglomerate, is a thick sequence of grey felsophyric lava (71/358) consisting of small plagioclase phenocrysts in a partly crystalline groundmass of plagioclase, quartz, sericite, and chlorite.

Upper West Queen River area

A complex but poorly exposed sequence of tuff, agglomerate, intrusive rocks, and minor sediments occurs along the West Queen River between the small andesite body north of No. 3 Dam and the large andesite body to the north-east. On the north-east side of the small andesite body is a crescentic ridge composed of agglomerate containing blocks of hornblende andesite and other lithologies in a matrix which also contains weathered hornblende crystals (71/503). Flanking this to the east is a unit of felsophyric, eutaxitic ash-flow like tuff with some small intercalations of grey shale. An unusual breccia-agglomerate (71/510) containing clasts of quartz porphyry, feldspar porphyry, andesite, and tuff occurs east of this, and is followed by a unit of black slate in which bedding strikes E-W. The slate is intruded by a quartz-feldspar-phyric rock, showing breccia texture in places, which appears to be closely related to, and may be a marginal phase of, a deeply-weathered andesite body exposed in a large costean on the adjacent knoll. Poorly exposed slate and vitric tuff occur on the eastern side of the andesite.

South of the river, towards 'Agglomerate Hill', are poor exposures of tuff with varying proportions of crystal, vitric, and lithic components. Some of the tuff resembles ash flows (*e.g.* 71/391, 71/392). Also in this area is a thin unit of laminated white quartzite, with an exposed thickness of three metres. The quartzite shows parallel bedding and some wavy lamination suggestive of ripple marks. In thin section (71/393) the rock is a well sorted, fine-grained, partly recrystallised quartzite consisting of fused ragged quartz grains (mostly less than 0.05 mm across) fringed with oriented sericite flakes outlining two foliations at about 40° to one another. Flanking the quartzite is a schistose volcaniclastic quartzwacke (71/394), in which redeposited quartz spherulites and phenocrysts with overgrowths are abundant.

On the upper north-western flank of 'Agglomerate Hill', adjacent to the complex of intermediate rocks, is a series of agglomerates and tuffs of air-fall type containing abundant glass shards (71/395). Some of the agglomerate contains abundant small spindle-shaped clasts (*e.g.* M173), 20-150 mm long, which appear to be volcanic bombs. These rocks appear to grade into the intermediate sequence.

From No. 3 Dam to south of 'Agglomerate Hill'

A series of greenish, fiamme-bearing vitric-crystal tuffs and agglomerates is exposed on the track into No. 3 Dam and around the northern and

southern shores of the dam. The contact with the sedimentary sequence to the west is not exposed. The eutaxitic foliation in the tuff is subvertical, and subparallel to the dominant NNW trending cleavage in the area. The typical tuff (*e.g.* 71/378, 71/494, 71/495) shows strongly altered plagioclase phenocrysts in a matrix made up of 'swirling' recrystallised pumice fragments (now mainly felted sericite) and glass shards. Compaction of pumice against crystals is evident in some cases, and the rocks are interpreted as ash flows. A chemical analysis (Appendix 1) of a unit from the spillway below No. 3 Dam shows a sodi-potassic rhyolite composition. Fine-grained shard-rich vitric tuff (*e.g.* 71/496) is intercalated with the eutaxitic tuff in places.

At the eastern abutment of No. 3 Dam is a coarse agglomerate containing rounded and lens-shaped clasts up to 600 mm long of pink fine-grained lava and porphyritic lava. Some of the spindle shaped clasts resemble volcanic bombs. In thin section (71/379) the matrix between the larger clasts consists of a mixture of smaller rock fragments, altered plagioclase crystals, re-crystallised pumice fragments, and shards. Some of the pumice fragments show compaction and bending against rigid clasts, suggesting they were plastic at the time of deposition. The rock is probably an ash flow, with the proportion of clasts and possible bombs suggesting a near-source location.

Similar fiamme-bearing tuff and agglomerate, some with rafts of sediment, crop out around the shores of No. 2 Dam (*e.g.* 71/390), where they include intercalations of fine-grained vitric and vitric-crystal tuff (*e.g.*75/731) and rare small intermediate dykes (71/389).

East of the eutaxitic tuff sequence is a unit of massive pale grey to pinkish feldspar-porphyry, showing vesicular texture in places and crudely developed columnar jointing. The unit is probably a lava, and is exposed on an old water-race track on the east side of the West Queen River. In thin section (75/730) it consists of altered phenocrysts and glomero-crysts of plagioclase, and less common embayed quartz phenocrysts (some with spherulitic overgrowths), in a quartz-feldspar-sericite groundmass containing small pink spherulites, possibly of K-feldspar.

To the east of the feldspar-porphyry unit is a sequence of felsic crystal tuff, crystal-vitric tuff, and agglomerate which are poorly exposed on an old water-race track. Bedding is exposed in one place, and the rocks appear to be largely of the air-fall type.

Further east is a broad belt, about one kilometre wide, extending to the East Queen River and consisting mainly of felsic rocks, including eutaxitic tuff, agglomerate, probable lavas, bedded tuff, and minor silt-stone. The sequence abuts the 'Agglomerate Hill' intermediate sequence to the north, and appears to correspond to the 'ignimbrites(?) and minor siltstones' of Green (1971) and to Unit C of Cox (1981). The rocks strike NNW and are steeply dipping to vertical. Cox (1981) records an overturned east facing from just east of the East Queen River.

The lava-like units are massive, flow-banded or rarely brecciated, and are pale grey to pinkish felsophyric rocks which appear to form lenses or wedges (50-100 m thick) within the predominantly pyroclastic sequence. The most striking unit is a prominently flow banded rock forming a low bluff on the west bank of the East Queen River opposite the pumphouse on the Comstock Valley Road. An analysis of this rock (Appendix 1) shows a sodi-potassic rhyolite or rhyodacite (71% SiO_2) composition. An earlier analysis and description are given by Solomon (1960).

Thin sections of the lava-like units (71/621, 71/622, 71/623) show prominent phenocrysts (up to 3 mm) and glomerocrysts of plagioclase (probably albite), some with zoned rims and resorbed edges, and small, generally anhedral quartz crystals, set in a weakly to strongly foliated groundmass of fine-grained sericite, chlorite, quartz, and feldspar. The groundmass in some cases is patchy or streaky, reminiscent of the welded recrystallised pumice textures in some ash-flow type rocks, and it is possible that some of the lava-like lenses represent the densely welded and recrystallised parts of thick ash-flow units.

The pyroclastic rocks include abundant eutaxitic units containing flattened fiamme-like pumice clasts and feldspar crystals. Hand specimens include M187, M188, M250, M252, M253, M254, M256, M259, M263, M275, M276, M278. Thin sections (*e.g.* 71/583, 71/401, 71/620) generally show plagioclase phenocrysts (mostly strongly altered) in an irregular 'swirly' matrix composed largely of bent and compacted pumice fragments (now mainly fine-grained sericite with variable amounts of chlorite and quartz) with some bubble texture and shard texture preserved in a few places. The pumice fragments commonly show internal striping reflecting the original collapsed bubbles, and are wrapped around and compacted against the feldspar crystals (and rare lithic clasts) in various orientations. The rocks appear to be ash-flows.

Towards the eastern side of this belt is a sequence of bedded agglomerate, lithic-crystal tuff, and vitric-crystal tuff with intercalations of laminated tuffaceous siltstone. Bedding and cleavage are both generally subvertical and north-west trending, but at a few localities bedding trends north-east. The agglomerate (*e.g.* M264, M265, M270) typically contains abundant close-packed small volcanic fragments, up to 150 mm long, in a strongly foliated greenish chloritic matrix. Some of the units appear to be of intermediate to basic composition, and a thin unit of porphyritic intermediate lava(?) was also noted. The larger clasts vary from angular to rounded, and some have spindle shapes reminiscent of basaltic bombs.

Clast types in the agglomerate include vesicular basic-intermediate lava, pink felsophyric lava, and fine-grained green lava. Smaller clasts include some with irregular wispy shapes like fiamme. These are evident in thin section (72/117) as swirly recrystallised pumice fragments which wrap around the altered feldspar phenocrysts and lesser quartz phenocrysts. Traces of original bubble texture are evident in a few fragments. Late carbonate is widespread. Pressure shadows are well developed, and much of the foliation and flattening is evidently tectonic. However, the irregular orientations and extreme compaction of the clasts suggests that some of the flattening occurred during or soon after deposition, when the clasts were still hot. The presence of such fiamme-like clasts in what appears to be a bedded air-fall unit indicates that the presence of compacted pumice is not an exclusive criterion of ignimbrites. Sparks and Wright (1979) have recently documented welding and compaction of pumice in air-fall deposits.

'Agglomerate Hill' intermediate sequence

A thick wedge of brown-weathering intermediate breccia, agglomerate, lava and tuff occurs on 'Agglomerate Hill' (informal name). These rocks extend eastwards to the East Queen River, and correspond approximately with the 'intermediate lithic tuffs' unit of Green (1971) and with Unit F (dacitic-andesitic tuffs and lavas) of Cox (1981) on the eastern side of the river. Bedding in one place dips west at 65°. The rocks show a strong north-west trending subvertical cleavage, and this appears to correspond with some alignment and elongation of clasts along the crest of 'Agglomerate

Hill'.

Typical rock types include coarse breccia with individual clasts up to boulder size, massive porphyritic lava, agglomerate of various grain sizes, and crystal-lithic and crystal-vitric tuff, occasionally showing bedding. Many of the coarse breccias have an igneous matrix and appear to be autoclastic lavas or possibly shallow intrusive rocks. Some of these have a fine-grained, pale-weathering, apparently silicic matrix between the blocks. Fragmented textures may be clearly apparent only on weathered surfaces. The fresh rocks tend to be dark greenish-grey, with small phenocrysts of feldspar and less common pyroxene just visible. Disseminated pyrite occurs near the crest of 'Agglomerate Hill', where veins of quartz-epidote-chlorite are common. The abundance of coarse breccia associated with air-fall type pyroclastic rocks and lava suggests that the hill may represent an original volcanic centre.

A chemical analysis of a tuff from 'Agglomerate Hill' (Appendix 1) shows an andesitic composition (57.3% SiO_2), high soda (5.29% Na_2O), low potash (0.55% K_2O), and high CaO (5.57%).

In thin section, the matrix of an autoclastic lava (71/626) is porphyritic in plagioclase and pyroxene. The plagioclase phenocrysts (mostly less than 2.5 mm) tend to be corroded, zoned, and strongly altered (to epidote, clear albite and/or sericite). Pyroxene phenocrysts are less common, generally ragged, and partially altered to chlorite and actinolite. Plagioclase-pyroxene aggregates also occur. The groundmass (about 60%) is very fine-grained and dark, and consists of granular epidote, some fine-grained feldspar and pyroxene, and unresolvable material. Other lavas examined (71/627, 71/628) are similar, but more altered. Two lavas from the south-west corner of the outcrop area (71/624, 71/625) are altered feldspar porphyries with splotches of chlorite in the groundmass, but no recognisable ferromagnesian phenocrysts, and are possibly of dacitic composition.

A fine-grained tuff showing faint bedding from the north-west side of the crest of the hill (71/396) contains abundant small altered plagioclase crystals (mostly less than 1 mm) and less common small pyroxene crystals (partially altered to chlorite and actinolite), in a fine-grained felsic matrix containing abundant needles of actinolite. Much of the secondary actinolite is aligned in a foliation which is at a high angle to bedding and probably corresponds to the dominant (Devonian) cleavage in the area. A similar phenomenon is apparent in a well-bedded tuff (71/397) from the northern crest of the hill, in which lithological banding is well defined by variations in grain size and crystal content. Crystals are mostly altered plagioclase, with less common pyroxene (partially altered to chlorite and actinolite) and rare quartz grains, and are contained in a fine-grained matrix rich in epidote. The abundant actinolite needles and wisps in the matrix of this tuff are well aligned in a foliation which clearly cross-cuts the bedding. Alteration fringes and 'tails' of actinolite on some of the pyroxene grains are s-shaped and appear to have been rotated into the foliation, suggesting that some or all of the matrix actinolite may have been rotated into the foliation rather than having grown in it during the Devonian greenschist metamorphism.

An agglomerate from the crest of the hill (71/398) contains dark, coarser grained clasts in a paler, finer grained cleaved matrix. The clasts are porphyritic in plagioclase (mostly sericitised) and pyroxene (mostly partially chloritised and rimmed with actinolite) and have an abundant dark fine-grained groundmass of feathery plagioclase, chlorite, iron ore and actinolite. The matrix between the clasts contains scattered altered plagio-

clase and pyroxene crystals and fine-grained feldspar, quartz, chlorite, and actinolite. The actinolite does not show an obvious preferred orientation.

East of 'Agglomerate Hill'

A zone of intense shearing - possibly a continuation of an E-W fault from the Comstock Valley - separates the 'Agglomerate Hill' sequence from a poorly exposed series of mainly felsic pyroclastic rocks to the east. This series is overlain by the Tyndall Group further east, and is truncated by a large andesite body to the north. Most of the rocks examined were strongly cleaved and rather altered.

A low knob about 130 m east of 'Agglomerate Hill' shows cleaved grey tuff containing numerous white spherulite-like structures up to 10 mm across, as well as large lens shaped fragments of pale glassy material up to 300 mm long, in an abundant greenish fine-grained matrix. In thin section (71/399) the white spots are filled with columnar crystals of quartz and/or K-feldspar and sericite, and many are rimmed and partially filled with chlorite. The remainder of the rock consists mostly of lenses of foliated sericite surrounded by relatively coarse granular quartz packed with inclusions of sericite and chlorite. Coarser chlorite and sericite wisps define a foliation. The sericite lenses are suggestive of flattened pumice fragments. A thin section (71/400) of one of the larger clasts shows a fine, uneven grained mosaic of undulose quartz and a colourless fibrous mineral (K-feldspar?) in a background of cryptocrystalline quartz and sericite. The texture appears to be largely secondary, perhaps representing a recrystallised glassy lava fragment or bomb.

The pumice-rich rock beneath or at the base of the Comstock Tuff in this area has been previously described (see p. 4). To the north-east of this, in the area between outcropping andesite and typical Comstock Tuff, is an outcrop of unusual 'spherulitic' rock consisting of abundant round pale blebs, 2-6 mm diameter, in a dark grey, fine-grained matrix. In thin section (71/630) the blebs consist of randomly oriented clinopyroxene crystals in a base of mosaic feldspar and/or very fine granular material (feldspar, epidote, chlorite) and scattered needles of amphibole. The matrix between the blebs consists of elongate pyroxene crystals and fine amphibole flakes, either aligned in a base of granular epidote, isotropic glass and minor chlorite, or set at random in plates of albite. There is a suggestion of vitroclastic texture in parts of the slide, and the presence of scattered shale-like fragments in the outcrop suggests the rock was originally a pyroclastic. The present mineral assemblage, however, appears to be largely the result of metamorphism, possibly associated with the adjacent andesite body. The original affinities of the rock are uncertain.

Middle part of East Queen River

As mentioned on page 9, there is an apparently conformable, interfingering relationship between a western-type volcano-sedimentary sequence and central-type volcanic rocks in the middle reaches of the East Queen River. A distinctive basaltic agglomerate occurs near the main contact area, and is overlain near the river by a massive felsic tuff-agglomerate showing a splotchy pink and green colouration and patchy pyritisation. In thin section (75/721) the rock contains numerous irregular fragments, some of which are bent and have flamed-out ends, which show granophyric recrystallisation and appear to represent pumice fragments. The matrix is variably crystalline to cryptocrystalline, and contains altered plagioclase phenocrysts. There are traces of shards, and the rock appears to be an ash-flow tuff. Banding is apparent in this unit in old railway cuttings beside the

East Queen River.

Overlying the ash-flow type tuff is a sequence of bedded felsic crystal-vitric tuff and tuffaceous shale. An horizon of well developed pseudonodules indicates that the sequence faces east, although bedding is locally overturned. A thin section of one of the coarser tuffs (75/727) shows it to consist largely of pumice fragments, both flattened and unflattened, with many showing well preserved bubble textures, in a matrix of feldspar crystals, shards, minor quartz, sericite, and chlorite. Similar bedded tuff with well preserved pumice textures was noted in the lower part of the central sequence on Little Owen Spur, south of Queenstown (Corbett, 1979, p. 31-32). The upper part of this unit further north is a pale green agglomerate which in thin section (75/728) consists largely of deformed, recrystallised, felsophyric pumice fragments and a few other rock fragments in a sparse matrix of feldspar crystals and recrystallised glassy material. This rock could be an ash-flow tuff.

Overlying the bedded pyroclastic unit is a massive felsophyric rhyolite lava similar to that at the pumphouse further north on the East Queen River. According to the mapping of Cox (1981) this unit is overlain by an andesitic sequence on the east bank of the river.

Lower East Queen River area

South of the major fault, bedded tuff and sediments of the western sequence are apparently overlain by a massive felsophyric rhyolite unit with some small intercalations of tuff. Similar feldspar-porphyry occurs south of the cross-fault which truncates the large quartz-feldspar-porphyry body in the West Queen River. This massive lava-like rock shows weakly developed columnar jointing at several localities, with a faint flow foliation, sometimes indicated by elongate vesicles and perpendicular to the columns in some cases. The columns tend to be poorly developed and somewhat irregular in shape, with three to six sides, and have been partially destroyed by more penetrative sheet jointing in most cases.

Thin sections of the feldspar porphyry (75/711, 75/713, 75/716, 75/724) show scattered corroded and embayed plagioclase phenocrysts and glomerocrysts (up to 5 mm diameter) and small quartz-sericite blebs (possibly vesicles) in a fine-grained to partly granophyric groundmass of quartz-feldspar-sericite-chlorite. Small quartz spherulites occur in two samples. The phenocrysts and quartz-sericite blebs are aligned in what appears to be a primary flow foliation in 75/713, whereas 75/724 shows a strong tectonic foliation outlined by anastomosing sericite wisps. Traces of possible vitroclastic texture are evident in 75/711 and 75/713, suggesting again that some of the massive porphyry units could represent the densely welded parts of ash-flow sheets.

Overlying and interfingering with the lava-like units, and extending east of the East Queen River, is a sequence of grey-green fiamme-bearing eutaxitic vitric-crystal tuff and agglomerate which appear to be ash-flows. Some of the individual fiamme are up to 450 mm long (although usually only a centimetre or so thick), and an abundance of these produces a banded texture in some rocks, not unlike flow banding. Thin sections (75/708, 75/709, 75/710, 75/712, 75/725) show a general similarity, the rocks being composed essentially of pumice fragments (variably flattened, deformed, and recrystallised) and scattered rock fragments and quartz grains, in a shard rich, variably recrystallised matrix. A strong tectonic foliation obliterates much of the texture in 75/725.

Directly underlying the Comstock Tuff in the Mill area, and apparently discordant to the ash-flow sequence, is a thick wedge of brown-weathering intermediate (andesitic) rocks. These include agglomerate, breccia, tuff, and minor lava-like units. The rocks are generally dark green to greenish-grey in colour, and fairly massive, with few internal structures or contacts visible. A narrow unit of fine-grained vesicular material, possibly a lava flow, trends east-west through the main outcrop. Near the western end of the outcrop area, a thin unit of bedded fine-grained tuff appears to strike obliquely into the base of the Comstock Tuff.

The lava-like unit appears to be partly massive and partly autoclastic. The massive portion (75/878) shows a uniform porphyritic texture, with large (1.5 mm) to small feldspar phenocrysts and glomerocrysts (mostly altered to sericite and chlorite), scattered opaque grains, chlorite-feldspar blebs, and vesicle-like masses of quartz and quartz-chlorite, in a very fine-grained recrystallised groundmass of sericite, chlorite, feldspar, quartz, and opaques showing a secondary foliation. As in the other rocks examined from this area, there appear to be no primary ferromagnesian minerals preserved. A lava clast (150 mm long) from the autoclastic part of this flow (75/877) has a similar texture. A section from the more finely brecciated part of the flow (75/875) shows slightly darker porphyritic clasts, with phenocrysts of altered feldspar, chlorite, and opaque minerals set in an unusual matrix which is rich in bubble-like shapes and contains feldspar crystals, chlorite blebs, and vesicle-like bodies of mosaic quartz in a murky fine-grained base of sericite-quartz-feldspar.

Intrusive rocks

Andesite

Andesitic intrusions, ranging from large lens-shaped bodies several hundred metres wide and over one kilometre long to small dykes less than one metre wide, occur throughout the area, but are most abundant in the central sequence. A concentration of large bodies occurs in the Crown Hill-upper West Queen River area, while small dykes are particularly abundant in the lower East Queen River area. Some of the intrusive rocks are associated with andesitic pyroclastic rocks and may represent feeder bodies or sub-volcanic stocks associated with local vents, but others are apparently surrounded by rhyolitic-dacitic volcanic rocks without any associated andesitic eruptive rocks.

The rocks are generally porphyritic in plagioclase, hornblende and/or pyroxene, but the smaller bodies and dykes tend to be more altered and cleaved, and the primary ferromagnesian minerals are usually replaced by chlorite. All variations from pyroxene andesite with little or no hornblende, to hornblende andesite with little or no pyroxene, seem to occur. Two chemical analyses from the Crown Hill body and one from the 'horse-paddock' site just west of the mapped area on the southern end of the Lake Margaret Road are given in Appendix 1. Silica values range from 56-59.5%, soda values from 2.25-4.5% and potash values from 2.0-2.5%. Trace element discrimination diagrams using Ti, Zr, Y, and Sr show the andesites to have calc-alkaline affinities (Corbett, 1979).

Some of the bodies for which intrusive relations can be demonstrated show pronounced autoclastic brecciation, *e.g.* the Crown Hill body, suggesting that the intrusions were near-surface. Clear evidence of intrusive relations is lacking for many bodies, and some of these could be extrusive flows. Previous descriptions of some of the andesites have been given by

Corbett *et al.* (1974) and Solomon (1960).

The Crown Hill body is lens shaped and roughly strike concordant, giving the appearance of having pushed aside the enclosing beds. A complex intermixed zone of andesite and tuff, including some possible hybrid rocks, is exposed near its southern end on the Lake Margaret Road, and seems to represent a shallow intrusive contact. A small isolated extension of the body occurs to the south of this. Most of the body shows a characteristic breccia texture, which is particularly evident on weathered surfaces, in which angular blocks of dark grey porphyry (up to 400 mm diameter) are contained in a paler, finer-grained, commonly silicified or albitised matrix. This texture has been illustrated by Solomon (1960) and Corbett *et al.* (1974). A white bleached fringe of matrix material 10-20 mm thick, is commonly present around the fragments. Phenocrysts of feldspar, hornblende (up to 15 mm long) and less common pyroxene are generally visible on weathered surfaces.

Thin sections from the Crown Hill body (71/367, 71/369, 71/371, 71/506, 71/507) show the fragments to consist of albite phenocrysts and glomerocrysts (up to 3 mm, usually containing epidote and muscovite inclusions and altered to sericite and chlorite, sometimes having narrow clear rims), clinopyroxene phenocrysts (mostly pale green, probably augite, up to 1 mm, usually fresh or partially altered to chlorite, sometimes intergrown with hornblende), hornblende phenocrysts (pale green-brown, generally rimmed by and partially replaced by chlorite), and rare embayed quartz phenocrysts, in a finely crystalline groundmass of plagioclase, chlorite and, in some cases, isotropic glassy material. A well developed taxitic texture is sometimes present in the groundmass.

The matrix between the fragments in the Crown Hill body consists largely of sub-isotropic glass-like material in some samples, but in others is mostly fine-grained albite(?) or albite-quartz, with some hornblende crystals, shard-like chlorite masses, uncommon plagioclase, pyroxene and embayed quartz crystals, small quartz slivers, and secondary epidote and carbonate. Flow structure is apparent in the matrix in many cases. Invasion and partial replacement of fragments by matrix is commonly evident. Hornblende tends to be more common in the matrix material than in the fragments, where pyroxene usually predominates. The fine-grained albite appears to replace an earlier groundmass in some samples. Sample 71/506, from the southern extension of this body, contains numerous small vesicles (up to 6 mm) filled mainly with quartz and chlorite, suggesting that this part of the body may be a lava.

The small andesite body north of No. 3 Dam is poorly exposed, but appears to be mainly massive rather than brecciated. A thin section (71/402) shows a fairly typical porphyritic texture, with phenocrysts of plagioclase (heavily sericitised, often rounded, with narrow rims of clearer feldspar), clinopyroxene, hornblende (rare, heavily chloritised) and quartz (rare, usually embayed), in a groundmass of needle-like feldspar, chlorite, and isotropic material. There are also idioblastic composites of granular pyroxene, quartz, and plagioclase inside a rim of pyroxene crystals.

A smaller, poorly exposed and deeply weathered andesite body (exposed in a costean) intrudes slate in the upper part of the West Queen River. This body has what appears to be a marginal phase of quartz-rich porphyry showing breccia texture in places, and containing xenoliths of slate and tuff. A somewhat similar brecciated quartz-porphyry was noted in the contact zone of the Crown Hill body on the Lake Margaret Road.

The large body in the headwaters of the West Queen River appears to be massive at its eastern end but shows the typical breccia texture in the western part. A thin section from the matrix of the breccia (71/353) shows phenocrysts of sericitised plagioclase, fresh clinopyroxene, and rare hornblende in a variable groundmass showing primary taxitic texture in places and secondary(?) plagioclase, chlorite, and fine quartz(?) in others.

A small sill-like body of massive, fine to medium-grained, greenish andesite-like rock intrudes the western sequence on the Lake Margaret Road north of the road to No. 1 Dam. In thin section (71/382) it is essentially even-grained, consisting of interlocking plagioclase crystals (0.1-0.2 mm) and minor amphibole, with interstitial chlorite, rare quartz grains, epidote grains, and oxidised opaque minerals. A few plagioclase phenocrysts up to 1 mm are present. The feldspar is rich in chlorite inclusions, but is otherwise unaltered, and has been determined as sodic albite on extinction angle measurements. The amphibole forms ragged prismatic crystals intergrown with plagioclase and partially replaced by chlorite, and appears to be actinolite. The body is unlike the typical porphyritic andesite but may be related to a larger body of andesite which crops out to the south-west ('horse paddock' andesite, Appendix 1).

Quartz-feldspar-chlorite porphyry (dacite)

A brown-weathering porphyry forms a narrow, sub-concordant tabular body about 150 m wide and at least two kilometres long within the western sequence west of Crown Hill. The rock is poorly exposed and generally deeply weathered, but appears to be massive. Intrusive contacts are exposed at several localities. The body terminates southwards in a zone of altered rocks on the Lake Margaret Road. The rock is pinkish-brown when fresh, with scattered large quartz phenocrysts (up to 7 mm) and smaller grey-green plagioclase and ferromagnesian crystals scattered in a crystalline groundmass. A chemical analysis (Appendix 1) shows a dacite composition, with 65% SiO_2.

A thin section (71/332) did not intersect any quartz phenocrysts, but shows scattered phenocrysts and glomerocrysts of plagioclase (up to 2 mm, commonly zoned, rounded and embayed, with clear narrow rims in some cases, generally studded with small inclusions, especially chlorite needles); large mafic masses consisting mainly of sheets of fibrous chlorite (with superimposed brown alteration products) with rare remnants of pyroxene and generally some intergrown feldspar, quartz, and iron ore; lath-like plates and needles of chlorite down to groundmass size; and small quartz crystals penetrated by groundmass minerals, in a well-crystallised groundmass of interpenetrating feldspar laths, chlorite needles, opaque dust, and alteration products.

Quartz-feldspar-chlorite porphyry (rhyodacite)

A large sub-concordant quartz-feldspar porphyry body intrudes the western sequence in the lower West Queen River area, and is well exposed in the vicinity of No. 1 Dam. A complex intrusive contact, with xenoliths and apophyses, is exposed on and near the access road to this dam. The body is displaced dextrally by a cross-fault near the southern end of the West Queen gorge, and is truncated further south by a major E-W fault along the Zeehan Highway. It is probably continuous with a similar large body in the South Queenstown area (Corbett, 1979). At its northern end it is truncated by the major north-west trending fault at the southern end of No. 2 Dam. A similar porphyry body occurs in the north-west part of the mapped area on the pipeline to the lower Lake Margaret power station, but appears to terminate before reaching the major fault.

The porphyry at No. 1 Dam is a massive, pink-weathering, fairly coarse-grained rock containing 40-50% phenocrysts (mostly quartz and feldspar, some chlorite). The fresh rock is dark grey, with quartz phenocrysts up to 5 mm. A chemical analysis (Appendix 1) shows a rhyodacite composition (68.3% SiO_2) with a fairly high potash content (4.5%). Radiometric dating of this body by the U-Pb zircon method was unsuccessful (Black *et al., in press*).

Thin sections of the porphyry (71/497, 71/498) show glassy quartz phenocrysts (commonly embayed and corroded, many with pressure fringes of calcite crystals oriented parallel to a secondary foliation); generally smaller phenocrysts and glomerocrysts of plagioclase (mostly strongly zoned and rather altered, with fringes of sericite), which appears to be mainly albite; bright green mica-like flakes now composed of chlorite and opaque grains with some epidote and carbonate, but probably after biotite; scattered large opaque grains, and abundant secondary calcite as irregular patches, grains, overgrowths, and crystal replacements. The groundmass is fine-grained, poorly crystallised, and composed of feldspar, quartz, sericite and chlorite. The micaceous matrix minerals are oriented in two foliations.

The porphyry body in the north-western part of the area shows intrusive relationships in the pipeline cuttings and on the Lake Margaret Road. A chemical analysis (Appendix 1) again shows the rhyodacite composition. The porphyry contains well formed hexagonal plates of chlorite as well as quartz (to 4 mm) and feldspar phenocrysts. Thin sections (71/329, 71/348) show heavily embayed and corroded quartz phenocrysts with reaction rims; strongly zoned and altered plagioclase phenocrysts and glomerocrysts rich in inclusions; idioblastic chlorite-magnetite crystals (after biotite?), sometimes intergrown with feldspar and quartz; and patches and veinlets of mosaic feldspar-quartz-chlorite, in a fine-grained, poorly crystallised groundmass of feldspar, quartz, chlorite, and sericite.

STRUCTURAL GEOLOGY

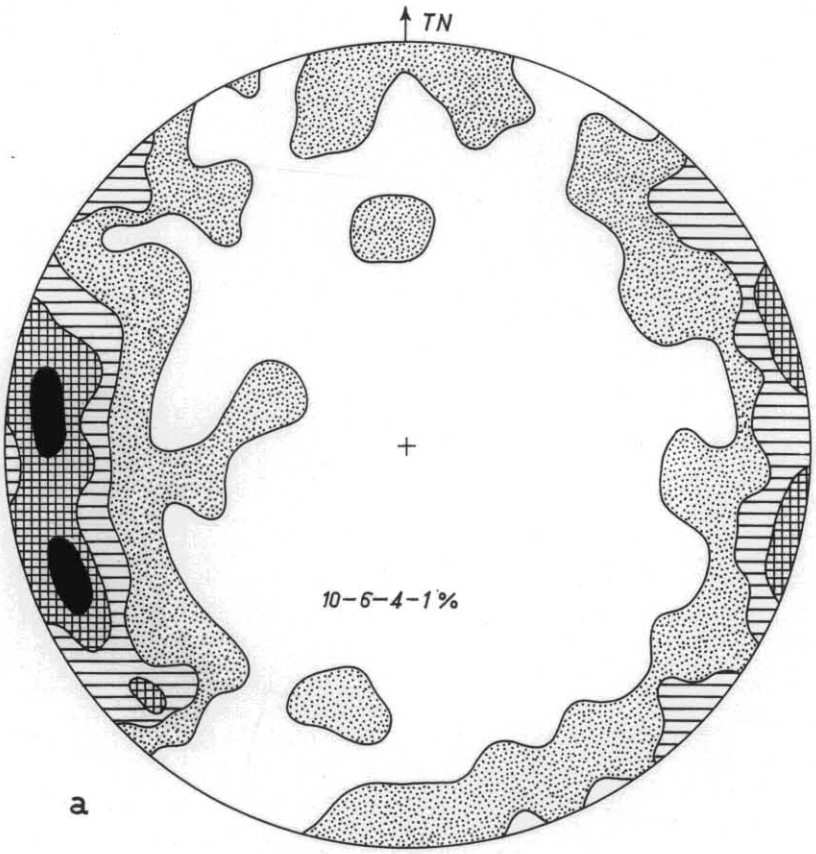
Bedding and facing

A plot of 130 poles to bedding in the mapped area is shown in Figure 3. A general N-S maximum is evident, composed of sub-maxima in the NNW and NNE directions. Smaller maxima in the NE-SW and E-W directions are also apparent. The overwhelming predominance of steep to vertical dips is apparent. Bedding trends are mainly N-S to NW-SE in the area north of the major fault, with a broad synclinal warp evident south of Crown Hill. Bedding in this area faces east. Bedding trends change markedly across the fault, with NNE to NE trends dominant on the south side. Facings in the western sequence, from which most of the bedding readings were obtained, are predominantly to the east, but some west facings on the No. 1 Dam road indicate several steep NNE-trending minor fold axial surfaces. East-west trends with south facing are present in the Tyndall Group in the Mill area.

The area east of No. 2 Dam shows north-west dips and facings in the western part, and easterly dips and facings in the eastern part, suggesting the presence of a major anticlinal structure. Cox (1981) has suggested that such an anticlinal structure coincides with the major north-west trending fault east of the East Queen River.

Folds

Megascopic fold hinges are very rarely seen in the mapped area. Most of the sequence in the northern area appears to form the eastern limb of a major N-S trending anticline with its axis located near the



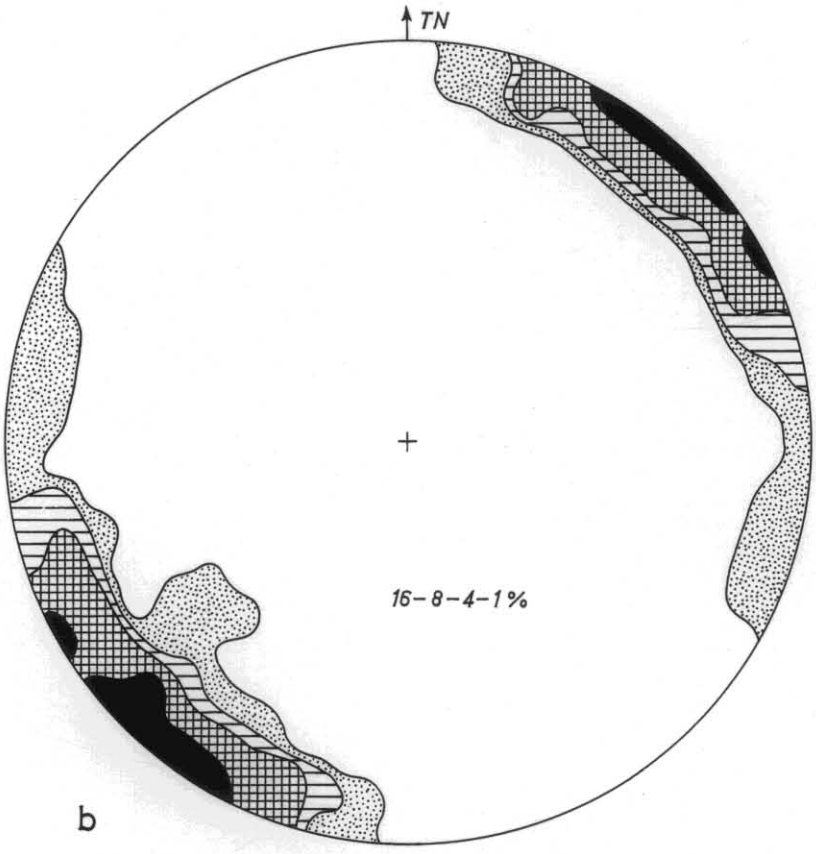


Figure 3. *Stereographic plots of: (a) 130 poles to bedding (b) 76 poles to cleavage*

5 cm

53-21

western limit of the mapped area (mapping by N.W. Sheppard, in Corbett *et al.*, 1974). No evidence of a synclinal structure has been seen, although reliable bedding readings are very sparse in the area east of Crown Hill. A probable east facing is recorded in a shale lens about 700 m west of the Owen Conglomerate contact. East facing is also evident in the Tyndall Group rocks near Comstock Valley.

A broad synclinal fold with an E-W directed axis and steep plunge is superimposed on the N-S trend south of Crown Hill. This fold may be related to the zone of E-W faulting which affects the Tyndall Group and Owen Conglomerate in the Comstock Valley.

Several minor folds trending NNE are evident as reversals in the predominant easterly dip and facing along the access road to No. 1 Dam. A steeply plunging minor fold with axial trace trending NNE was noted in siltstone and quartzose sandstone adjacent to the western boundary of the quartz-feldspar porphyry body at No. 1 Dam.

Faults

Fault traces are generally difficult to establish in the mapped area because of geological complexity and lack of marker horizons. Some minor faults evident in single outcrops are marked by quartz veins, and the abundance of quartz vein material throughout the area suggests that such faults are common.

The trace of the major north-west trending fault can be confidently mapped between the Lake Margaret Road and the East Queen River because of the truncation of a number of units and the marked change in strike across it. This fault is parallel to the dominant cleavage direction in the area. A continuation of this fault to the south-east has been mapped by Cox (1981). who indicates connection with a major fault affecting the Owen Conglomerate and Mt Owen. At Mt Owen, this fault dips steeply south-west (Corbett, 1979) and the movement sense appears to be south side up and eastwards (*i.e.* reverse sinistral). The sense of movement in the West Queen River section of the fault has not been definitely established. However, if the quartz-feldspar porphyry bodies at No. 1 Dam and the Lake Margaret pipeline area are the same unit, as seems likely, then a sinistral displacement of slightly more than two kilometres is indicated.

Two smaller WNW trending faults with sinistral displacement affect the No. 1 Dam porphyry, but its southern end is dextrally displaced by a somewhat larger fault which appears to be a splay from the major E-W fault along the Zeehan Highway.

A major E-W trending fault, with sinistral and/or south side up displacement, truncates the Tyndall Group along the southern foot of 'Zig-Zag Hill'. A direct continuation of this fault to the west is not evident, but a prominent zone of shearing in the saddle immediately east of 'Agglomerate Hill' may represent this fault (which would imply a slight change in trend or a southerly dip to the fault plane) or possibly a NNW oriented fault which displaces the E-W structure. Several minor faults of WNW to NW trend, some with dextral displacement, affect the Tyndall Group rocks on 'Zig-Zag Hill'. A larger E-W fault presumably forms the Tyndall Group-Owen Conglomerate contact immediately north of 'Zig-Zag Hill', and a continuation of the Great Lyell Fault is presumed to form the NNW trending contact between the Owen Conglomerate and volcanic rocks along the western flank of the Sedgwick Plateau.

Several ENE trending steep dextral faults affect the Pioneer Beds-Tyndall Group contact in the Mill area.

Cleavage

Detailed analysis of mesoscopic and microscopic cleavage development and relationships has not been attempted. In general the dominant cleavage only has been measured where it can be seen in outcrop. As indicated by the plot of 76 poles to cleavage over the mapped area, the dominant cleavage is close to vertical and trends generally north-west, cross-cutting the major bedding trend (fig. 3). However, there is a considerable spread of cleavage directions about this trend, with a suggestion of sub-maxima at about 115° and 155°. In addition, a significant number of readings, particularly in the western part of the area, show a N-S trend.

In a recent structural analysis of the adjacent Mt Lyell Mines area, Cox (1981) has suggested that an early phase of broad NNW trending folds with associated S_1 cleavage (roughly N-S) has been overprinted by a more prominent west to north-west trending S_2 cleavage associated with well developed folds in the Ordovician and younger strata. Locally, S_1 may have been rotated into the S_2 direction. The range of cleavage trends shown by Figure 3 for the area of this study also suggests the possibility of rotation or partial rotation of an early N-S cleavage into the later north-west trend. Some thin sections, however, clearly show two foliations.

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[26 November 1981]

APPENDIX 1

Major and trace element chemical analyses of selected rocks

Sample:	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
SiO_2	72.19	71.85	71.91	71.56	57.31	56.12	57.0	58.5	65.0	68.33	71.1
Al_2O_3	12.82	13.25	14.73	13.17	15.13	16.9	14.9	14.4	12.3	13.26	13.0
Fe_2O_3	3.78	3.75	3.49	4.85	8.27	7.76	1.1	1.8	5.34	4.08	1.1
FeO							6.1	5.3			2.3
MgO	1.78	1.60	0.97	0.83	4.63	4.49	5.4	3.4	4.05	1.15	1.3
CaO	0.22	0.22	0.33	1.26	5.57	6.40	5.7	4.3	3.72	2.91	0.28
Na_2O	0.00	0.00	2.94	2.9	5.29	2.25	2.9	4.5	3.05	2.81	3.5
K_2O	3.06	2.96	2.83	2.39	0.55	2.42	2.0	2.5	3.59	4.51	4.2
TiO_2	0.67	0.68	0.51	0.47	0.70	0.67	0.52	0.50	0.60	0.61	0.45
P_2O_5	0.25	0.28	0.30	0.33	0.46	0.61	0.33	0.28	0.65	0.34	0.07
MnO	0.12	0.12	0.13	0.31	0.23	0.02	0.12	0.26	0.20	0.15	0.05
H_2O+	5.9*	5.9*	2.0*	3.3*	2.1*	2.3*	3.4	2.7	1.6*	3.2*	2.4
H_2O-							0.22	0.22			0.33
CO_2		*Loss on ignition					0.01	0.04			0.03
SO_3							0.69	0.04			0.02
Traces							0.38	0.33			0.23
Total	100.79	100.61	100.14	101.37	100.24	99.84	100.77	99.07	100.1	101.35	100.4
					mg/l						
Ba	830	860	860	700	380	1820	2230	1500	1460	1030	1550
Co							25	24			<11
Cr							147	20			22
Cu							65	76			<4
Nb							7	6			16
Ni							48	19			16
Pb							<6	93			<6
Rb	180	170	160	110	4	140	61	63	120	210	128
Sc							17	20			9
Sr	35	35	76	72	210	750	661	696	390	86	87
V							203	256			52
Y	40	39	44	65	34	31	24	23	33	46	30
Zn							87	317			40
Zr	160	160	320	280	210	200	197	147	250	280	302

Notes to accompany Appendix 1

All analyses by Department of Mines, Launceston. C7, C8, C11 in 1978, others in 1972. Localities shown on Figure 2. All analyses previously published in Corbett (1979).

C 1 Black slate, road metal quarry beside Lake Margaret Road

C 2 Vitric tuff, beneath power pylon just west of Lake Margaret Road

C 3 Eutaxitic ash-flow type tuff, spillway below No. 3 Dam, West Queen River

C 4 Flow-banded feldspar porphyry, opposite pumphouse on East Queen River

C 5 Intermediate agglomerate, crest of 'Agglomerate Hill'

C 6 Crown Hill andesite body, old house site, southern foot of Crown Hill

C 7 Crown Hill andesite body, beneath power line, southern foot of Crown Hill

C 8 Horse-paddock andesite, beside Lake Margaret Road

C 9 Dacite porphyry, beneath power line east of Lake Margaret Road

C10 No. 1 Dam porphyry, West Queen River

C11 Quartz-feldspar porphyry, near pipeline west of Lake Margaret Road

5 cm

378 000 m E — 58 000 y E — 79 — 59 — 80 — 60 — 81 — 61 — 82 — 62

53 49 000 m N — 8 28 000 y N — 53 48 — 8 27 — 53 47 — 8 26 — 53 46 — 8 25 — 53 45 — 8 24 — 53 44 — 8 23 — 53 43 — 8 22 — 8 21 000 y N — 53 42 000 m N

Lake Margaret Power Station

YOLANDE RIVER

SEDGWICK PLATEAU

CROWN HILL

Zig Zag Hill

Agglomerate Hill

Swan Creek

Whipsnake Creek

Lake Margaret Road

ZEEHAN HIGHWAY

Comstock Road

Queen River

West Queen River

No. 3 Dam

No. 2 Dam

No. 1 Dam

CAPE HORN MINE

MT LYELL MILL

Slag Dump

Qpm — Qpmd — Qal — Qf — UD — Et — Et i

QUATERNARY

- Qal — Alluvium
- Qf — Bouldery fan deposits & scree — mostly Owen Conglomerate detritus
- Qpm — Pleistocene moraine Lake Margaret area.
- Qpmd — Pleistocene moraine with Jurassic dolerite clasts in some areas, lower East Queen River

? CRETACEOUS

- Lamprophyre dyke

LATE CAMBRIAN — EARLY ORDOVICIAN

- Owen Conglomerate, with upper Pioneer Beds correlate in Mill area

CAMBRIAN — MT READ VOLCANICS & ASSOCIATED ROCKS

TYNDALL GROUP

- Volcaniclastic conglomerate & sandstone, with minor shale, tuff & ignimbrite (Eti).
- Comstock Tuff — banded tuff, agglomerate, breccia, shale.
- Andesitic to basaltic volcanics — mainly breccias & tuffs with minor lavas & possible intrusives. Bedded in places.
- Mainly eutaxitic felsic tuff & agglomerate with flattened pumice clasts — probably mainly ash-flows.
- Feldspar porphyry — massive, flow-banded and/or columnar jointed — probably includes lava flows, densely welded parts of ash-flows, minor intrusives. Rhyolite to rhyodacite composition.
- Well-bedded to faintly bedded tuff, agglomerate minor shale.
- Interbedded vitric tuff, shale, sandstone, crystal tuff, agglomerate — dominantly marine.
- Black shale & sandstone with interbedded tuff — mappable horizon.
- Quartz-rich sandstone.
- Agglomerate & breccia, usually with some sedimentary clasts — mainly mass-flow deposits.
- Quartz-feldspar crystal tuff, including coarse-grained porphyry-like units. Bedded in places.
- UD — Undifferentiated volcanic rocks & minor sediments.

INTRUSIVE ROCKS

- Andesite-massive or brecciated plagioclase-pyroxene-hornblende porphyry.
- Dacitic quartz-feldspar-chlorite porphyry.
- Rhyodacitic quartz-feldspar-chlorite porphyry.

- Geological boundary approximate, inferred.
- Fault accurate, approximate, inferred.
- Bedding or primary layering, facing unknown, facing known, overturned.
- Flow-banding or compactional layering in volcanic rock.
- Plunge of columnar jointing in volcanic rock.
- Dominant cleavage, dipping, vertical.
- Direction of plunge of minor fold.
- Minor prospect.

Cartography by G. J. DICKENS 1981

MT READ VOLCANICS & ASSOCIATED ROCKS – LAKE MARGARET ROAD TO EAST QUEEN RIVER

GEOLOGIST — K. D. CORBETT

SCALE 1 : 15840

0 — ½ — 1 MILES

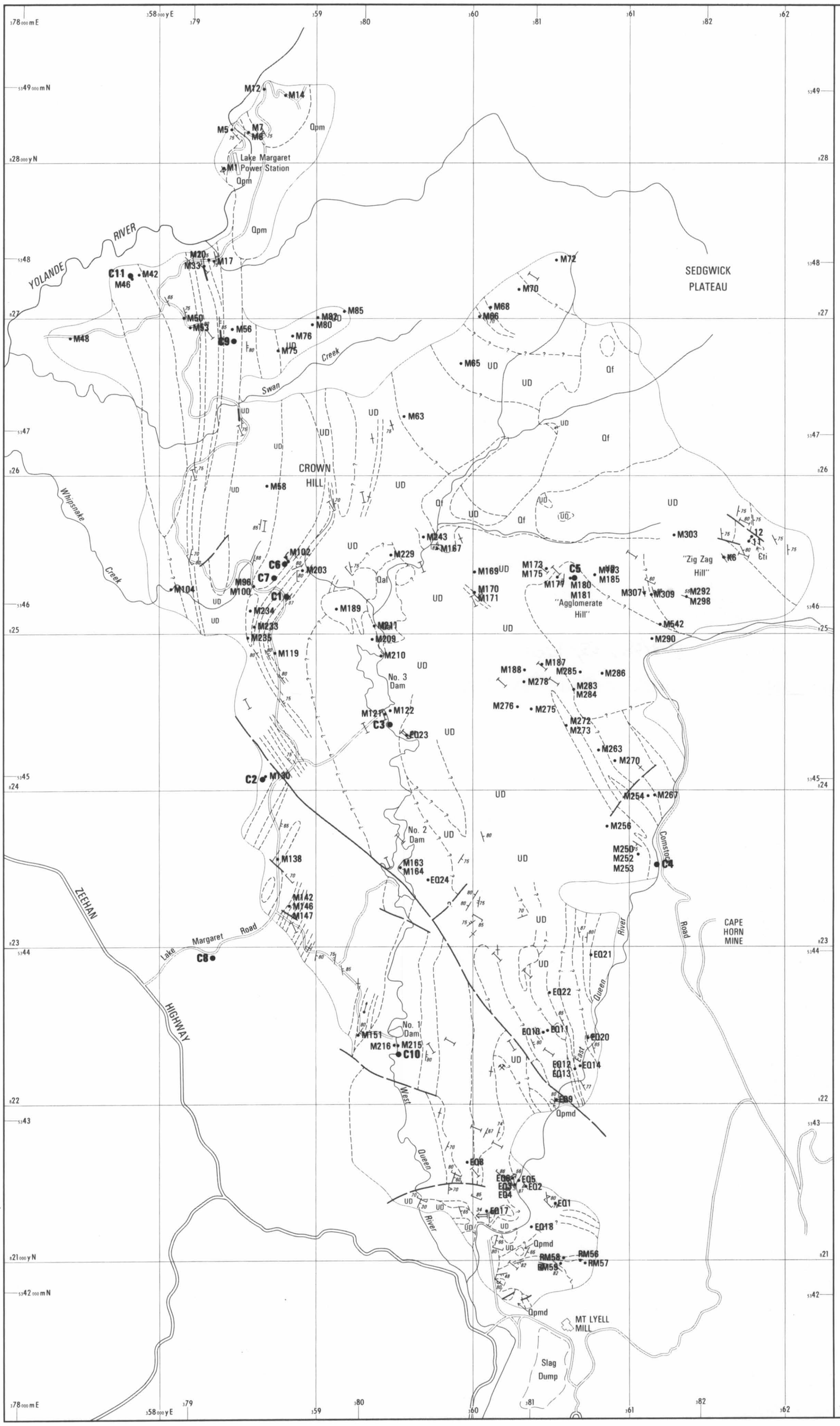
0 — ½ — 1 KILOMETRES

5 cm

TASMANIA, DEPARTMENT OF MINES

4868

5 cm



• PETROLOGICAL SAMPLES			
Hand Specimen	Thin Section	Hand Specimen	Thin Section
Comstock Tuff		M122	71/379
M542	72/116	M164	71/390
M307	71/631	EQ24	75/731
M309	72/123	M163	71/389
M292	72/118	EQ23	75/730
M298	71/629	M272	71/622
K6	72/297	M273	71/623
12	72/295	M267	71/621
11	72/294	M187	71/583
Western Sequence		M188	71/401
North of Fault		M250	
M48	71/330	M252	
M104	71/372	M253	
M53	71/349	M254	
M50	71/331	M256	71/617
M17	71/574	M263	71/620
M20	71/342	M275	
M33	71/346	M276	
M58	71/352	M278	
M233	71/505	M270	72/117
M119	71/377	Agglomerate	
M203	71/490	Hill Sequence	
Western Sequence		M285	71/626
South of fault		M286	71/627
M130	71/380	M290	71/628
M142	71/383a	M283	71/624
M146	71/385	M284	71/625
M147		M177	71/396
M151	71/386	M180	71/397
EQ8	75/715	M181	71/398
Bedded Sequence		East of	
East of No. 2 Dam		Agglomerate Hill	
EQ10	75/717	M183	71/399
EQ11	75/718	M185	71/400
EQ22	75/729	M303	71/630
EQ12	75/719	Middle East	
EQ13	75/720	Queen River	
Central Sequence		EQ14	75/721
Lake Margaret		EQ20	75/727
Township Area		EQ21	75/728
M1	71/324	Lower East	
M5	71/337	Queen River	
M7	71/338	EQ4	75/711
M8	71/339	EQ6	75/713
M12	71/340	EQ9	75/716
M14	71/341	EQ17	75/724
Swan Creek Area		EQ1	75/708
M75	71/360	EQ2	75/709
M76	71/361	EQ3	75/710
M80	71/362	EQ5	75/712
M82	71/363	EQ18	75/725
M85	71/576	RM59	75/878
North-east of		RM58	75/877
Crown Hill		RM56	75/875
M65	71/354	RM57	75/876
M66	71/355	Andesites	
M68	71/356	M96	71/367
M70	71/357	M100	71/369
M72	71/358	M102	71/371
Upper West Queen		M234	71/506
River area		M235	71/507
M229	71/503	M234	71/506
M243	71/500	M189	71/402
M167	71/391	M63	71/353
M169	71/392	M138	71/382
M170	71/393	Dacite	
M171	71/394	Porphyry	
M175	71/395	M56	71/332
M173		Rhyodacite	
No. 3 Dam to		Porphyry	
Agglomerate Hill		M215	71/497
M121	71/378	M216	71/498
M209	71/494	M42	71/329
M210	71/495	M46	71/348
M211	71/496		

● Chemical Analysis Samples

C1 Black Shale Lake Margaret Road
C2 Vitric tuff
C3 Ash-flow tuff
C4 Pumphouse rhyolite
C5 'Agglomerate Hill' tuff
C6 Crown Hill andesite
C7 Crown Hill andesite
C8 'Horse-paddock' andesite
C9 Dacite porphyry
C10 No. 1 Dam porphyry
C11 Pipeline porphyry

SAMPLE LOCALITY MAP

LAKE MARGARET ROAD TO EAST QUEEN RIVER

GEOLOGIST — K. D. CORBETT

SCALE 1 : 15840

0 ½ 1 MILES

0 ½ 1 KILOMETRES

5 cm

TASMANIA, DEPARTMENT OF MINES

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