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1982/25. Stratigraphy and correlation of the Mt Read Volcanics and associated rocks in the Mt Sedgwick-Lake Beatrice area and the Lake Dora-Lake Spicer area.

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Abstract

The Mt Read Volcanics and associated sedimentary units in the Mt Sedgwick-Lake Beatrice area and Lake Dora-Lake Spicer area are described and discussed. Underlying the Owen Conglomerate with apparent conformity in both areas is a variable thickness (0-500 m) of volcaniclastic conglomerate and sandstone, with intercalated lenses of tuff and some small quartz-feldspar porphyry bodies in some areas. The two belts of volcaniclastic conglomerate appear to be equivalent, and occupy opposing limbs of a large Devonian synclinal structure. The western belt unconformably transgresses most of the volcanic units at Mt Sedgwick, but the eastern belt interfingers with a sequence of mineralized quartz-feldspar-phyric volcanic and porphyritic rocks at Lake Dora. These volcanic rocks probably represent a large volcanic centre flanked by an apron of coarse epiclastic rocks. Similar interfingering is apparent at the western margin of an isolated arm of volcaniclastic conglomerate south-west of Lake Beatrice.

The volcaniclastic sequence is correlated with the Tyndall Group on good lithostratigraphic grounds, and the mineralized volcanic sequence at Lake Dora apparently represents the most significant mineralization known from that group. A revised interpretation of the Tyndall Group is suggested to take account of the marked diachroneity of the base, as mapped; the presence of major volcanic centres such as that at Lake Dora; and the apparent interfingering with central volcanic sequence lithologies south-west of Lake Beatrice.

The volcaniclastic sequence between Lake Dora and Lake Spicer abuts and apparently overlies the Sticht Range Beds, a basal, west-facing, 800 m-thick, sequence of sandstone, siltstone, and conglomerate of largely Precambrian derivation. However, the contact zone is marked by considerable contortion, disruption, shearing, and soft-sediment slumping and mixing of sandstone and volcanic lithologies, and may represent a Cambrian fault scarp where Sticht Range Beds slumped into a volcanic rift structure. An alternative interpretation for the volcanic and volcaniclastic sequences at Lake Dora as being basal to the Mt Read Volcanics pile cannot be ruled out, but implies that the eastern and western belts of volcaniclastic conglomerate are unrelated.

Sequences of feldspar-phyric spherulitic lavas and ignimbritic tuffs, with intercalated shales and including massive pink rhyolite with magnetite-hematite veins, occur at Mt Sedgwick and are typical of the central volcanic sequence elsewhere. An interpretation involving an island or archipelago of subaerial lavas and ignimbrites flanked by submarine deposits is suggested. A large mass of flow-banded to autobrecciated quartz-phyric lavas, with minor tuff, shale and intrusive rocks, occurs within and partly overlying the feldspar-phyric sequences at Mt Sedgwick. It probably represents an isolated quartz-phyric volcanic centre within the central volcanic sequence, but could possibly be a root volcano for the Tyndall Group.

The presence of an east-dipping correlate of the Owen Conglomerate resting directly on Precambrian basement adjacent to the west-dipping Sticht Range Beds near Lake Spicer implies considerable

tilting and erosion of the latter beds during the Cambrian.

INTRODUCTION

This report is based on geological mapping by the author in the Mt Sedgwick-Lake Beatrice area (January-February, 1977) and in the Lake Dora-Lake Spicer area (February, 1980). The mapping was part of a special project on the Cambrian Mt Read Volcanics aimed at clarifying the stratigraphy of the volcanic rocks and the stratigraphic setting of the mineralization.

Access to the Lake Dora area is gained by a rough 4-wheel drive track from the Lake Rolleston Camp, a Mt Lyell Company hut camp located some five kilometres (and one hour's drive) north of the mapped area. The Lake Rolleston Camp is accessible by 4-wheel drive road from the Zeehan Highway via either Bradshaws Road or Howards Road. The Lake Beatrice area was mapped from a tent camp on the Dante Rivulet, and the upper Mt Sedgwick area from a tent camp beside Lake Adam.

The topography of the area is dominated by a high rugged plateau with an average altitude of about 850 m, developed largely on the Owen Conglomerate but including a strip of Cambrian volcanic rocks and Precambrian quartzite in the Lake Dora area. Although the plateau primarily reflects the exhumed surface beneath the flat-lying Permo-Carboniferous sequence (a remnant of which is preserved on Mt Sedgwick, with a capping of Jurassic dolerite), it has also been extensively glaciated in the Pleistocene. It now exhibits numerous small lakes and tarns either in rock basins or dammed behind moraines. The plateau drops abruptly some 650 m to the floor of the Eldon River valley to the east, and to the Comstock Valley to the south. Lake Beatrice lies within a deep, narrow embayment in the south-east corner of the plateau, and was the site of a major outlet glacier from the Lake Spicer area.

A narrow belt of Mt Read Volcanics occurs in the Lake Dora-Lake Spicer area beneath the eastern margin of the Owen Conglomerate, but is separated from the adjacent Precambrian basement by a distinctive clastic sequence of sandstone, mudstone, and conglomerate known as the Sticht Range Beds. Small patches of a correlate of the Owen Conglomerate unconformably overlie Precambrian rocks along the eastern lip of the plateau. Near Mt Sedgwick, the Cambrian volcanic rocks are exposed in the core of a broad, gently north-plunging anticline developed in the Owen Conglomerate, and occupy the steep southern slopes of the plateau down to the fault-controlled margin of the Comstock Valley. Outcrop of the volcanic rocks is generally good in the Lake Dora-Lake Spicer area, but is largely obscured by extensive Pleistocene glacial deposits and thick forest and scrub in the area south of Mt Sedgwick.

Patchy pyrite-chalcopyrite-hematite-magnetite mineralization occurs in the volcanic rocks in the vicinity of Lake Dora, and was intensively prospected with numerous trenches, adits, and shafts late last century. Intermittent exploration has continued in the area to the present day.

QUATERNARY DEPOSITS

BOULDERY FAN DEPOSITS

The steep south-east to south-facing slopes beneath the rim of Owen Conglomerate to the south-west of Mt Sedgwick are covered by coarse bouldery gravel deposits cut by narrow stream channels which form fan-like lobes in the lower reaches. The deposits grade laterally into Pleistocene morainal deposits. They consist largely of Owen Conglomerate detritus, including very large boulders, and appear to be derived partly from reworking of morainal deposits and partly from periglacial(?) and post-glacial scree and talus.

PLEISTOCENE MORAINE DEPOSITS

Mt Sedgwick-Lake Beatrice area

Extensive deposits of bouldery till, dominated by Owen Conglomerate detritus and containing erratics up to several metres across, form a blanket around the lower slopes of Mt Sedgwick between valley-floor level (240 m) and about 540 m. 'Fingers' of this material extend up to about 780 m altitude. The deposits extend eastwards towards the Dante Rivulet, and are continuous with deposits in the Lake Beatrice valley. Large arcuate terminal moraines are present in the Comstock Valley just south-west of the mapped area, and mark termini of a large offshoot of the King Glacier which pushed up the valley (Ahmad *et al.*, 1959). The glacier from the Lake Beatrice area must have coalesced with this glacier, and most of the till which now covers the slopes west of Dante Rivulet was probably deposited by the Beatrice Glacier.

The peak area of Mt Sedgwick was also the source of several small glaciers. Morainal material containing Jurassic dolerite detritus occurs on the plateau area immediately west and south-west of the peak, and till with blocks of Permo-Carboniferous conglomerate occurs in the glaciated valleys to the south-east and south of the peak.

A small section through the glacial deposits is exposed in the head of a landslide beside a creek at CP869466 (38/66902585)*. This section shows lenses of horizontally stratified sand, gravel, and clay as well as massive bouldery material.

Lake Dora-Lake Spicer area

Extensive deposits of bouldery till occur east of Lake Spicer, and include several sinuous moraine forms with generally north-south orientation, suggestive of lateral moraines. A faint striping effect evident on the till surface immediately south-east of Lake Spicer also has a north-south orientation, suggesting that ice in this area spilled southwards into the Lake Beatrice depression. A large (lateral?) moraine blankets much of the ridge of Precambrian rocks immediately north of Marble Bluff.

Ground moraine to the east and south-east of Lake Dora shows prominent east-west striping (evident as lines of different vegetation types), suggesting that ice in this area moved eastwards to spill into the Eldon River valley.

JURASSIC DOLERITE

The peak of Mt Sedgwick is occupied by a remnant of Jurassic dolerite showing the typical columnar jointing in cliff sections. The contact with the underlying Permo-Carboniferous rocks is at an altitude of about 960 m. The contact is obscured by an apron of dolerite talus except on the more

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* Grid references prefixed by CP refer to the Australian Metric Grid. References prefixed by 38 refer to the imperial Australian National Grid used on Figure 1.

eroded southern side.

PERMO-CARBONIFEROUS BEDS

A sequence of flat-lying grey conglomerate, mixtite, and siltstone containing marine fossils crops out beneath the dolerite on the south-east side of Mt Sedgwick. The beds were not examined in detail. The basal contact is exposed in several areas, and demonstrates considerable basement relief. A narrow tongue of the deposits extends south-eastwards down a present stream valley, and clearly occupies a pre-Permian valley. The base of the sequence rises some 70 m over an adjacent ridge of Owen Conglomerate, then dips down into a smaller valley to the north. The basal mixtite immediately east of Mt Sedgwick contains boulders up to one metre diameter in an abundant grey silty matrix. Clasts are mainly of Owen Conglomerate, with some of volcanic rocks. A 600 mm clast of limestone, similar to Gordon Limestone, was noted in a large loose block of mixtite.

The thickest section of the deposits is exposed in cliffs at the head of the valley on the south side of Mt Sedgwick. Banks and Ahmad (1962) describe the section as being 63 m thick, with conglomerate, 'tillite', fossiliferous siltstone, and minor limestone as the main lithologies. They suggest correlation with the Darlington Limestone and underlying beds of the Hobart area. East-west trending striations, considered to be of glacial origin, were recorded on the basement surface in one area.

CAMBRO-ORDOVICIAN OWEN CONGLOMERATE

MT SEDGWICK AREA

The lower part of the Owen Conglomerate sequence was examined in the vicinity of Mt Sedgwick and around the rim of the plateau to the south-east and south-west of the peak. The base of the formation to the south-east is marked by a cliff-forming unit of pink to white siliceous pebble-cobble conglomerate with minor sandstone bands. This unit has an apparently gradational contact, over a few metres, with underlying volcaniclastic conglomerate. Clasts of volcanic rock types, particularly quartz-feldspar porphyry, up to boulder size, occur scattered through the lower part of the Owen Formation, and there are numerous quartzite clasts in the underlying volcaniclastic formation. Overlying the lower conglomerate unit at the eastern foot of the peak of Mt Sedgwick is a distinctive unit of red to white sandstone and minor siltstone, about 35 m thick, which is thin-bedded to laminated and contains abundant burrows and bioturbation structures. The sandstone unit appears to thicken northwards, and is overlain by white pebble-cobble conglomerate.

Near Lake Barnabas, the base of the Owen Formation is a white pebble-cobble conglomerate having an apparently sharp contact on volcaniclastic sandstone and conglomerate. A red sandstone unit, correlatable with that to the east, overlies the white conglomerate, but appears to wedge out southwards.

To the west and south-west of Mt Sedgwick, a white to pink pebble to boulder grade conglomerate unit at the base of the Owen Formation rests abruptly on a thin sequence of volcaniclastic conglomerate and sandstone. The volcaniclastic unit wedges out southwards, and massive, siliceous, white to pink, pebble to boulder conglomerate rests directly on volcanic rocks in the south-west part of the mapped area.

The isolated block of Owen Conglomerate near the valley floor on the south side of the mapped area consists predominantly of pink cross-bedded and flat-bedded sandstone with worm burrows and bioturbation structures in some beds. Thin shale bands and probable fossil fragments were noted in the sequence in the creek just east of the main outcrop area. A low ridge on the valley floor about one kilometre further east has outcropping white thin-bedded sandstone with worm burrows, and is probably also part of the Owen Formation.

LAKE DORA-LAKE SPICER AREA

The base of the Owen Conglomerate is well exposed along a low NNW-trending ridge west of Lake Dora and Lake Spicer, where the conglomerate sequence dips moderately west. Sandstone and pebbly sandstone are more abundant than conglomerate in the lower 100 m of the formation in this area. A poorly known sequence of limestone and shale occurs about 300 m above the base, and forms a broad synclinal valley two kilometres west of Lake Spicer.

The basal unit in the vicinity of Lake Spicer is a white to pink siliceous pebble conglomerate, about 5 m thick, overlain by sandstone and pebbly sandstone. Closer to Lake Dora, the base consists mainly of pink sandstone and granule conglomerate, overlain by white sandstone. The basal beds generally abruptly overlie massive volcaniclastic conglomerate, but towards Lake Dora there is overlap onto porphyritic volcanic rocks. Faint conformable bedding is developed in the immediately underlying volcaniclastic material in some localities, and in places is associated with an increase in the amount of siliceous detritus, giving the appearance of a conformable gradational contact. The bedding generally dies out downwards within a few metres, however, and the apparent gradation could be due to slight reworking of the upper surface of the volcaniclastic material during deposition of the Owen Formation.

The basal contact is obscured by talus on Walford Peak, where the basal Owen unit is apparently a white to pink pebble conglomerate about 6 m thick, overlain by a predominantly sandstone sequence. Clasts of hematite up to 180 mm long are abundant in the lower conglomerate unit. The base apparently rests directly on massive volcanic rocks in this area.

CORRELATE OF OWEN CONGLOMERATE EAST OF LAKE SPICER

An east-dipping sequence of siliceous breccia, conglomerate, and sandstone rests unconformably on the Precambrian basement along the lip of the plateau east of Lake Spicer. At the base of the sequence in many places is a purplish-red breccia-conglomerate containing blocks of the underlying quartzite and quartz-schist up to about one metre diameter in a hematite-rich sandy matrix. This material fills an isolated, 50 m wide, east-west oriented channel structure cut in Precambrian rocks on the highest point of the plateau rim east of Lake Spicer, and a larger channel structure with a white siliceous breccia at the base is preserved east of Lake Dora. Overlying the basal red breccia is a sequence of white to pale pink quartzose sandstone, pebbly sandstone, and granule-pebble conglomerate, with large-scale cross-bedding evident in many places. Maximum exposed thickness of the sequence appears to be about 200 m.

The eastern limit of the main outcrop has been mapped in one area, where the basal unconformity surface is almost flat, but elsewhere the sequence may extend some considerable distance down the rugged, bush-clad eastern slopes of the plateau.

The sequence does not appear to be a correlate of the Sticht Range Beds, the base of which consists of white, well sorted, sandy pebble conglomerate as exposed east of Lake Spicer. The breccia-conglomerate is most probably a lateral equivalent of the Owen Conglomerate preserved on the eastern limb of a broad anticlinal structure (see cross-sections, fig. 3). It is also possible that it represents a lateral equivalent of the Pioneer Beds, the uppermost part of the Owen Formation, which in the Queenstown area rest unconformably on folded beds of the underlying part of the Owen Formation and transgress westwards to rest directly on volcanic rocks (Corbett *et al.*, 1974). The Pioneer Beds are directly overlain by Gordon Limestone, and are probably of Early Ordovician age.

A possible contact with the Sticht Range Beds is poorly exposed near the crest of the ridge about 1.5 km south-east of Lake Spicer [CP902499] (38/706294). Here, an east-dipping unit of massive, pink, pebble-cobble conglomerate (with overlying pink sandstone) overlies, apparently abruptly, a thick west-dipping sequence of thin-bedded purplish siltstone and fine sandstone. The outcrop could represent an unconformity between the two sequences, but due to limits on time and availability of outcrop, it was not possible to definitely establish the stratigraphic affinity of the siltstone unit.

It is significant that no volcanic strata occur between the Owen Conglomerate correlate in this area and the underlying Precambrian basement, despite the fact that the main belt of Mt Read Volcanics must have existed only a few kilometres to the west at the time of deposition. Nor was any volcanic detritus seen in the basal units of the sequence. This would seem to indicate that the volcanic rocks were confined to a narrow belt or rift structure just off the present western margin of the Precambrian block.

In addition, the lack of any intervening Sticht Range Beds sequence beneath the conglomerate over most of the area, and the apparent structural discordance between the east-dipping conglomerate and west-dipping Sticht Range Beds (see sections, fig. 3) implies that the latter beds were tilted and eroded prior to deposition of the Owen Conglomerate correlate.

CAMBRIAN MT READ VOLCANICS AND ASSOCIATED ROCKS

VOLCANICLASTIC CONGLOMERATE SEQUENCE

General description

A distinctive sequence of massive to poorly bedded grey to purplish or brown volcaniclastic conglomerate and sandstone, with minor tuff units and intrusive porphyry bodies, directly underlies the Owen Conglomerate over much of the mapped area. It is absent to the south-west of Mt Sedgwick and also in the area to the west and north-west of Lake Dora, where the Owen Formation rests directly on volcanic rocks. Clasts in the conglomerate are generally sub-rounded to well rounded and range up to 500 mm in diameter. They include a variety of volcanic rock types, although quartz-feldspar porphyry is the predominant clast type in most areas. Scattered clasts of quartzite and quartz-schist of Precambrian derivation also occur throughout the sequence including the basal units. The sandy matrix is generally somewhat hematitic and chloritic, and is invariably rich in volcanic quartz.

Lake Dora-Lake Spicer area

The volcaniclastic sequence bifurcates around the southern end of a large volcanics-porphyry mass at Lake Dora, with one arm wedging out against the Sticht Range Beds to the east, and the other disappearing beneath Owen Conglomerate and Pleistocene moraine to the west. Maximum apparent thickness of the sequence in this area is of the order of 500-600 m, assuming no folding or repetition. However, dips and strikes are rather variable, and include easterly and south-easterly dips near Lake Spicer. Strikes and dips are discordant with the overlying Owen Conglomerate in some areas, but clear evidence of unconformity at the contact has not been seen.

The relationship to the volcanics-porphyry mass is a complex one, but is at least partly interfingering, as lenses of typical conglomerate occur within the mass in at least two localities, and lenses of typical quartz-phyric volcanic material occur within the conglomerate. The predominance of quartz-feldspar porphyry lithologies within the volcanic rocks and also as clasts in the conglomerate strongly suggests that the conglomerate has, in large part, been derived from the volcanic rocks. From the areal distribution, it would appear that the conglomerate represents an apron or fan of detrital material deposited around the margin of a mound or edifice of the volcanic rocks.

It is also clear, however, that there has been considerable intrusive activity associated with the volcanic rocks, and that some of the intrusions were later than the volcaniclastic conglomerate sequence. Isolated intrusive bodies of quartz-feldspar-chlorite porphyry, identical with those within the main volcanic mass, occur within the conglomerate in several places, and several of the contacts at the margin of the main volcanic mass (particularly at its southern end) are also intrusive. Thus the conglomerate, volcanic rocks and intrusive porphyritic rocks are closely related both temporally and spatially, and must be considered as belonging to the same general stratigraphic unit.

A massive pink tuff-like rock was sampled from within the conglomerate sequence 160 m south of Lake Dora. In thin section (LR8)* it consists mostly of close-packed small volcanic rock fragments (1-10 mm), particularly of fine-grained groundmass material and quartz-porphyry. Hematite is common as small flecks and as stylolite-like films. There are also opaque grains and flecks of chlorite. The sparse matrix is chloritic and dusty with hematite. The rock appears to be an epiclastic tuffaceous sandstone, rather than a primary tuff.

The volcaniclastic sequence thins to about 120 m exposed thickness at Lake Spicer, but appears to be much thicker in the vicinity of Lake Beatrice (as indicated by mapping of a tributary of Dante Rivulet, and air-photo interpretation of the area due west of Lake Beatrice).

Dante Rivulet area

An arm of the volcaniclastic sequence extends southwards to the edge of the Comstock Valley near the Dante Rivulet, and appears to be a continuation of the main belt from Lake Spicer. This arm has a north-south trending contact with the Sticht Range Beds, on line with a similar contact in the Lake Spicer-Lake Dora area. An intrusive quartz-feldspar porphyry body occurs along the only exposed part of the contact in a small creek west of

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* Sample localities and Department of Mines catalogue numbers are shown on Figure 2. Specimens are held in Department of Mines collection.

Dante Rivulet. Both northerly and southerly dips were noted in bedded sandy units within this arm but no clear stratigraphic or structural arrangement is evident. A few recorded strikes are discordant to the boundaries of the unit.

The conglomerate is intruded by a massive quartz-feldspar porphyry body at the south-west end of the arm. To the west the conglomerate has an undetermined relationship with a poorly-exposed sequence of strongly-cleaved quartz-feldspar-phyric volcanic rocks, although the presence of some lenses of volcaniclastic conglomerate in the latter strongly suggests an interfingering relationship as at Lake Dora.

A thin section of a sandstone unit from this arm (LB5) shows bedding marked by abundant black heavy mineral grains. Other grains include quartz, feldspar (heavily altered to sericite), and rock fragments, including fragments of quartzite as well as volcanic rock types. The strongly foliated matrix is rich in sericite, perhaps largely derived from vitric rock fragments.

Mt Sedgwick area

South-east of Mt Sedgwick the volcaniclastic sequence forms a belt about 400 m wide parallel to the base of the Owen Conglomerate. Dips and strikes are somewhat variable, although generally northerly to north-easterly. Thickness appears to be of the order of 200 m. The base of the sequence transgresses various underlying rock units, suggesting a possible unconformity, and an erosional, channelled contact on massive quartz-feldspar porphyry is exposed near the ridge crest 800 m south-east of Mt Sedgwick. A small irregular body of quartz porphyry was noted within the sequence in the lower reaches of the east flowing creek draining this area, and is described with other porphyries in the following section.

In the Lake Barnabas area, the volcaniclastic sequence rests abruptly on massive tuff, and has a thin basal conglomerate overlain by a thicker sequence of reddish, moderately siliceous sandstone. The lower conglomeratic unit thickens markedly to the north-east of this, where the total thickness is of the order of 90 m. At Lake Adam, the volcaniclastic sequence is at least 100 m thick (base not exposed), and includes a massive, purplish tuff or tuffaceous sandstone unit near the top. The sequence thins rapidly to the south-west before wedging out. It is only 5-15 m thick along the western margin of the embayment, with locally thicker sections (20-25 m) possibly representing infilled depressions. The contact with the Owen Conglomerate is abrupt but apparently conformable.

VOLCANIC ROCKS-PORPHYRY COMPLEX, LAKE DORA AREA

General description

A large mass of quartz-feldspar-phyric volcanic and intrusive rocks occurs immediately west of Lake Dora, and has a partially interfingering contact with the volcaniclastic conglomerate sequence. A large lens of tuff occurs south-west of the main mass, and isolated quartz-porphyry bodies occur in the Sticht Range Beds and in several places along the belt of volcaniclastic conglomerate south of Lake Dora.

Within the main mass, the volcanic rocks form large flat-topped outcrops which commonly have a pink to brownish surface colouration. Fresh rocks are generally greenish-grey or pink. Phenocrysts of quartz up to 5 mm diameter, and smaller crystals of pink feldspar are generally visible, and small flecks and laths of green ferromagnesian minerals are commonly apparent on fresh surfaces. Most outcrops are massive, but areas of flow-banding, brecciation, bedding and eutaxitic texture also occur. Some areas of fragmented pyroclastic rocks and volcaniclastic conglomerate were noted in the field, but mapping of boundaries between different rock types is extremely difficult. Variations in texture and composition (*e.g.* in the number and proportion of phenocrysts) occur within apparently massive bodies of porphyry.

Irregular intrusive contacts against volcaniclastic conglomerate are apparent at the southern end of the main mass, and internal intrusive boundaries have also been noted. However distinction between intrusive and extrusive porphyritic rock is difficult or impossible in the absence of clear contact relationships, and hence the true nature of much of the mass has not been determined. Small dykes of dark, fine-grained, intermediate(?) rock occur in several areas, particularly near the southern end of Maxfield Tarn.

Textures of the rocks as seen in thin section are generally strongly modified by recrystallisation and cleavage development, making it difficult or impossible to distinguish clastic from igneous textures. Beards and pressure fringes, often composed of carbonate, are common around phenocrysts, as is fragmentation and/or recrystallisation of matrix components. Phenocrysts are commonly cracked and annealed, and some quartz phenocrysts show mortar texture. The ferromagnesian minerals, which include both biotite and hornblende, have in most cases been replaced by chlorite and opaques ± carbonate ± epidote. The feldspar phenocrysts where identifiable are albite, but have mostly been altered to patchy carbonate-sericite-chlorite, and some examples show complete alteration to ghost-like blebs of felted sericite.

Groundmass constituents commonly show recrystallisation to patchy mosaic quartz, with abundant flecks of carbonate and minute grains of chlorite and sericite. Primary flow texture is evident in the groundmass of a few samples, and at least one unit shows well-developed snowflake texture similar to that seen in feldspar-phyric lavas near Mt Sedgwick. Opaque grains of magnetite type, up to phenocryst size, and specks and blebs of hematite are common. An unusual feature seen in several of the porphyritic rocks is the occurrence of numerous crystals of apatite, in some cases up to 2 mm long.

Petrology of some pyroclastic rocks

The large lens of pink volcanic rock which is directly overlain by the Owen Conglomerate south-east of Lake Dora [CP875534] (38/677333) appears to be a tuff. It shows faint compositional banding in the lower part, and has a sharp but apparently conformable contact with an underlying sandstone. Small lithic clasts of feldspar-porphyry, some showing flow-banding, are abundant in places. In a thin section of a sample from the lower part of the body (LR3), the banding is evident as alternations of crystal-rich and finer-grained vitriclastic laminae. Feldspar crystals are abundant, and range down to groundmass size. They are generally altered and some are zoned. Multiple twinning is rare. Some feldspar phenocrysts appear to have been replaced by mosaic quartz, and there are abundant patches of mosaic quartz through the matrix. There are sparse embayed quartz phenocrysts, fairly numerous opaque grains (including skeletal grains), and numerous elongate wisps and shreds of hematite. The matrix appears to have been originally glassy, and is marked by flowing wisps and shapes which wrap around phenocrysts. Some of the glassy shapes resemble compacted and welded pumice fragments. The rock is a hematitic crystal-vitric-lithic tuff, and could possibly have been an ash flow.

Another tuff was sampled near the western shore of Michael Tarn. It is a pale greenish-grey rock with quartz and feldspar crystals and small rock fragments in a sericitic glassy matrix. In thin section (LR16) the phenocrysts of quartz and altered feldspar, together with small porphyry rock fragments (including a snowflake-texture variety), are contained in a remarkable flow-like matrix of vitric clasts which wrap around and are compacted against the grains. Possible shard remnants are also preserved, and the texture appears to be partly a result of welding. This crystal-vitric-lithic tuff could also have been an ash flow.

A pinkish-grey porphyry adjacent to the above (LR15) contains numerous large embayed quartz phenocrysts and smaller quartz fragments, less abundant feldspars (which are completely altered to sericite and are deformed and wisped out along the cleavage), scattered opaque grains, and remnants of ferromagnesian phenocrysts (replaced by opaques and a sericite-like mineral), in a tectonised groundmass of pink feldspar, quartz, and mosaic quartz patches. It is uncertain whether this rock is igneous or pyroclastic.

A pale grey, strongly-foliated, sericitic tuff-like rock (LR21) occurs 100 m west of the northernmost tip of Lake Dora, and is cut by quartz veins which have been prospected by two shafts. The large embayed quartz phenocrysts show cracking, strain features and mortar texture, and are wrapped around by numerous flecks, wisps and patches of felted sericite. Many of the latter are strung out along the cleavage, and some appear to be relict feldspar crystals. The very pronounced foliation is marked by a continuous anastomosing web of sericite, which permeates the matrix and has obliterated most primary textures.

A massive pink feldspar-quartz-phyric rock from north of Lake Dora includes a 300 mm thick fragmental layer, suggesting the unit is a tuff. The porphyry in thin section (LR26) shows abundant large phenocrysts and glomerocrysts (to 4 mm across) of plagioclase, as well as smaller laths down to groundmass size. Many of the crystals show broad cracks filled with crystalline calcite oriented parallel to the tectonic cleavage, and many have pressure shadows and beards of calcite. Some are bent and have bent twin lamellae. Many are somewhat rounded by corrosion, and some are perfectly rounded. Most have abundant small spots of carbonate within them (commonly grown along crystal cleavage planes) and spots of sericite, but are otherwise apparently fresh. Extinction angle measurements indicate an albite composition. There are rare small phenocrysts of quartz showing rounding and embayments, but quartz is much more abundant as irregular mosaic blebs throughout the groundmass. Also present are fairly numerous wisps and flecks of pleochroic green chlorite up to 4 mm long and 1 mm wide, generally intergrown with granular epidote, carbonate and opaque grains, and containing inclusions of feldspar, quartz and apatite in some cases. Some of the chlorite bodies have a relict internal cleavage and are after biotite, but others are more complex and could be after composite ferromagnesian grains. Opaque grains are common, and include some which are broken and annealed with carbonate and/or chlorite, and some with included small crystals of apatite. Apatite is common as crystals up to 2 mm long, often with broad cracks annealed with calcite and/or chlorite. The groundmass-matrix consists of a basis of pinkish cryptocrystalline felsic material in which are set small grains and flecks of quartz, feldspar, carbonate and chlorite, and patches of mosaic quartz. Secondary cleavage effects are prominent. The fragmental nature of the matrix suggests the rock is silicified crystal tuff, but there are no definitive features to say that the rock is not igneous.

A fragmental rock from the eastern flank of Walford Peak is a massive pink-weathering quartz-feldspar-chlorite porphyry containing small angular rock fragments up to 30 mm long. In thin section (LR30) it contains large embayed quartz phenocrysts (to 3 mm), more abundant, mostly very altered feldspar phenocrysts, flakes and grains of chlorite-epidote (some clearly after biotite), and scattered opaque crystals, in a cryptocrystalline felsic groundmass. The single large rock fragment present is of dark-coloured quartz-porphyry in which large embayed quartz phenocrysts showing prominent mortar texture are contained in a dark groundmass rich in opaque minerals, chlorite and sericite. The rock appears to be a crystal-lithic tuff.

Petrology of some igneous porphyritic rocks

The small isolated instrusive lens WSW of Lake Dora is a pinkish porphyry with irregular intrusive contacts. Flow-banding is evident in some areas. Abundant phenocrysts and glomerocrysts of plagioclase are prominent in thin section (LD1), some of them partially to completely replaced by mosaic quartz and feldspar ± sericite. There are less abundant quartz phenocrysts, and fairly numerous opaque grains. Scattered blebs of chlorite and chlorite-quartz appear to be pseudomorphs after ferromagnesian minerals. The sub-isotropic groundmass shows an extraordinary texture of abundant rod-like reaction-rim structures, aligned in a flow pattern around phenocrysts in places.

The large pink knob overlooking the southern end of Lake Dora consists of massive, pinkish-grey, rather fine-grained rock which contains scattered tabular hornblende crystals (to 4 mm long) and abundant green chlorite flecks, but is otherwise not obviously porphyritic. In thin section (LR13) it consists mainly of snowflake-textured groundmass, the 'snowflakes' (or incipient spherulites) consisting of pink feldspar growing around nuclei of small quartz grains. The interstices consist largely of granular chlorite. The hornblende crystals are somewhat shredded, and show partial to almost complete alteration to chlorite. Irregular blebs of chlorite are also present. There are sparse small quartz phenocrysts, and some larger ghost-like plagioclase phenocrysts. The rock shows distinct similarities with the snowflake-textured feldspar-phyric lavas of the Mt Sedgwick area and the central volcanic sequence elsewhere.

A strongly foliated quartz-feldspar-chlorite porphyry (LR6) with abundant large embayed and broken quartz phenocrysts occurs immediately west of Maxfield Tarn. Feldspar phenocrysts are somewhat crushed and are mostly altered to sericite-carbonate-quartz. Pseudomorphs of ferromagnesian minerals (biotite, possibly some hornblende) consist of chlorite, carbonate and opaque minerals, and there are scattered large opaque mineral grains. The pink, glassy-looking groundmass contains abundant secondary carbonate, and is strongly modified by two cleavages.

A flow-banded pink feldspar-chlorite-quartz porphyry crops out on the western shore of a small tarn west of Maxfield Tarn. In thin section (LR4) large tabular pseudomorphs of hornblende (up to 7 mm long) consist of bands of carbonate and fibrous pleochroic chlorite, with inclusions of opaque minerals, quartz, and feldspar. The abundant feldspar phenocrysts are all completely altered to felted sericite (±carbonate). There are sparse embayed quartz phenocrysts, with prominent reaction rims, and abundant small irregular quartz grains, most of which show strong resorption by the groundmass. Large opaque grains are common, and there are numerous apatite crystals up to 0.5 mm long. The pink, rather murky groundmass includes much sub-isotropic material suggesting an originally glassy composition.

A massive pink porphyry occurs on the western side of a line of prospects along a chloritised zone at Faulds Tarn. It is a quartz-feldspar-chlorite porphyry (LR17) containing several small quartzite-like rock fragments. There are numerous embayed quartz phenocrysts, more abundant tabular plagioclase phenocrysts and smaller plagioclase crystals down to groundmass size, fairly numerous ferromagnesian pseudomorphs (now chlorite ± opaques), and scattered large opaque mineral grains, in a pink, cryptocrystalline, fairly homogeneous, sub-isotropic groundmass.

A large intrusive porphyry mass having an irregular contact against a lens of volcaniclastic conglomerate occurs 600 m west of the northern end of Lake Dora. A sample from near the eastern contact (LR22) is a deformed quartz porphyry with an unusual close-packed fragmental texture. The fragments, which are up to 5 mm across, consist mainly of quartz phenocrysts surrounded by extensive quartz overgrowths in optical continuity. The overgrowths enclose much dust and small inclusions of chlorite and feldspar. Altered plagioclase phenocrysts also occur within some fragments. The sparse matrix material between the grains is strongly foliated and recrystallised, and consists mainly of fine-grained granular chlorite and fibrous sericite.

A sample from the central part of the above body (LR25) is a quartz-feldspar-chlorite porphyry showing no evidence of fragmental texture. Quartz phenocrysts (to 4 mm) do not have overgrowths, and are mostly somewhat rounded and embayed. Some smaller angular quartz fragments appear to be broken crystals. The abundant plagioclase phenocrysts (to 3 mm) are mostly strongly altered to carbonate ± sericite, particularly along margins and fractures. Some flow alignment of feldspar laths is apparent. Ferromagnesian pseudomorphs (up to 2 mm) consist of pleochroic chlorite ± carbonate ± opaques. Scattered opaque grains (to 0.2 mm) showing partial alteration to leucoxene are present. The felsic groundmass is homogeneous, cryptocrystalline and sub-isotropic. A single rock fragment 7 mm across consists of snowflake-textured quartz porphyry.

A distinctive white-weathering fine-grained porphyry which occurs on the slopes of Walford Peak (LR29) contains scattered quartz phenocrysts and 'ghosts' of very altered feldspar phenocrysts in a uniform, very fine-grained felsic groundmass rich in small carbonate blebs.

The large porphyry mass which intrudes the Sticht Range Beds 800 m east of Lake Dora is mostly a massive pink rock showing considerable local variations in grain size and phenocryst content. A large xenolith, 300 m x 40 m in extent, of bedded sandstone-siltstone-conglomerate occurs within this body, and a smaller remnant xenolith of siliceous conglomerate is represented by a patch of rounded quartzite pebbles. The porphyry in thin section (LR10) is a strongly cleaved, altered quartz-feldspar-chlorite-phyric rock with abundant carbonate masses and a tectonically modified fragmental-looking groundmass.

A sample from the porphyry body (LB1) within the volcaniclastic conglomerate sequence 600 m WSW of Lake Beatrice has a fragmental appearance similar to that of the marginal phase of the body west of Lake Dora (LR22). The fragments consist of quartz porphyry in which the quartz phenocrysts are surrounded by dusty quartz overgrowths in optical continuity. Several other rock fragments are also present, including snowflake-textured quartz-porphyry. Sparse, completely altered feldspar phenocrysts are represented by masses of sericite-carbonate-chlorite. Brown biotite flakes and shreds up to 2.5 mm long are present, and include some bent and broken crystals and some containing small inclusions of apatite and feldspar. There are scattered apatite crystals up to 0.5 mm long, some of which are cracked and broken. Patches and blebs of chlorite and carbonate are common. The patchy sub-isotropic matrix between the fragments consists largely of a web of fine chlorite and sericite oriented along the tectonic cleavage and interspersed with small grains and patches of quartz and altered feldspar.

A quartz-feldspar-chlorite porphyry body having distinct similarities to the above porphyritic rocks occurs at the eastern end of Mt Lyell, where it appears to intrude the volcaniclastic conglomerate sequence underlying the Owen Conglomerate (Corbett, 1979, fig. 3). Thin sections shown to me by Dr P. Williams (ML12, ML17) contain phenocrysts of quartz, plagioclase and chlorite, and scattered rock fragments (including some with prominent quartz overgrowths and one of Precambrian-type quartzite), in a cryptocrystalline felsic groundmass modified by cleavage effects.

Mineralization in the Lake Dora volcanic sequence

Copper mineralization with minor silver and gold was discovered at Lake Dora late last century. Intensive prospecting was carried out mainly in the period 1896-1899 by a number of small companies (Smith, 1898). Numerous adits, shafts and trenches were excavated in this period, but no payable deposits were discovered. Sampling of the deposits in 1938 by the Mt Lyell Mining and Railway Co. Ltd showed an average copper assay of 0.24% Cu, with the highest grade being 1.8% Cu (Blake and Henderson, 1939). Intermittent prospecting has been carried out in the area until the present time, particularly by the Mt Lyell Company (*e.g.* Brophy, 1976).

Most of the mineralization occurs within zones or patches of chloritic alteration, generally associated with some schistosity development, within the volcanic rocks. The more elongated zones trend roughly NNW. Four major zones appear to be present: (1) along the western margin of Faulds Tarn; (2) near the southern end of the volcanics mass, with a possible extension into the adjacent volcaniclastic conglomerate, where pyrite and minor chalcopyrite mineralization has been prospected; (3) 600 m west of the northern end of Lake Dora, apparently within an intrusive porphyry body; (4) on the south-east flanks of Walford Peak, adjacent to the western boundary of a porphyry body (fig. 1).

Surface oxidation of the deposits extends to a depth of about 300-500 mm, and results in a prominent brown surface staining. Pyrite is by far the most abundant mineral, with less common chalcopyrite and minor sphalerite and galena. Veins and patches of quartz, hematite and magnetite are generally also present, and some surface malachite and covellite has been reported. The sulphides occur mainly as veinlets, disseminations, and schistosity coatings within the altered rocks, with some rare larger pods and masses. The association of copper mineralization with hematite-magnetite veins resembles the situation in the central volcanic sequence in the Jukes-Darwin area.

QUARTZ-PHYRIC VOLCANIC-VOLCANICLASTIC SEQUENCE WEST OF DANTE RIVULET

A poorly exposed sequence of quartz-phyric volcanic rocks, volcaniclastic conglomerate, and porphyritic rocks occurs west of the arm of volcaniclastic conglomerate near Dante Rivulet. Exposures are limited to small creek sections surrounded by moraine, and relationships are difficult to determine. The creek draining the western side of the arm [CP877462] (38/678254) has exposures of volcaniclastic sandstone and fine conglomerate in the upper part, but further downstream the rocks are strongly cleaved tuff and volcanic rocks, with porphyritic texture (in quartz and feldspar) and traces of fragmental texture in places. A prominent knob of volcaniclastic conglomerate occurs on the west bank of this creek.

The next creek west [CP873463] (38/673255) has been cleared by a recent landslide, and shows outcrop of greenish to pink volcaniclastic fine conglomerate intercalated with quartz-feldspar-phyric tuff and agglomerate. The agglomerate includes types with abundant secondary pink albite and green splotches of chlorite, closely resembling varieties of the Comstock Tuff. A probable intrusive body of quartz-feldspar porphyry cuts volcaniclastic conglomerate in the upper part of this section. At the top of the exposure, the quartz-rich volcaniclastic rocks apparently interfinger with fawn to pale green fine-grained locally feldspar-phyric volcanic rocks (vitric-crystal tuffs?) resembling those of the feldspar-phyric sequences further west. East of this creek are scattered small outcrops and creek exposures of quartz-feldspar-phyric volcanic rocks and volcaniclastic fine conglomerate, but further upslope the only outcrops noted were of fine-grained non-porphyritic volcanic rocks.

QUARTZ-FELDSPAR PORPHYRY SEQUENCE NEAR MT SEDGWICK

Quartz-feldspar porphyry, with some associated pyroclastic and sedimentary rocks, occupies much of the western half of the embayment of Cambrian rocks south of Mt Sedgwick. The porphyry varies from pink to grey or green in colour, and is generally either massive or flow-banded, with local development of autobreccia. Flow-banding is particularly prominent on the large bluff-like outcrops along the rim of the plateau. A narrow, north-south trending belt of quartz-phyric tuff, breccia, and slate occurs at the eastern margin of the main mass, and breccia containing slate fragments also occurs at the western margin. A smaller body of massive porphyry wraps around the upper part of the ridge immediately south-east of Mt Sedgwick.

The porphyry mass appears to have a conformable and gradational contact with a flanking (apparently underlying) sequence of feldspar-phyric lava, tuff and shale at its north-west margin [CP842482] (38/640276). The porphyry is displaced westwards on a cross-fault just south of this to lie directly beneath the Owen Conglomerate, but is flanked by a feldspar-phyric lava-tuff sequence, again further south. At its eastern margin, a steeply-east dipping sequence of bedded quartz-phyric pyroclastic rocks and sediments flanks the main porphyry and has an apparently conformable contact with a sequence of fine-grained sericitic volcanic rocks, with interbedded slate units, to the east. The smaller porphyry body south-east of Mt Sedgwick has an abrupt contact against an underlying slate unit at its western margin, and appears to transgress other units of the underlying sequence further east. This body may be intrusive. A small isolated intrusive body occurs on the east bank of a creek 800 m east of the main mass [CP860471] (38/659264).

In thin section, the typical pink porphyry of the main mass (LD7, LB10) shows fairly numerous quartz phenocrysts up to 6 mm diameter. Most of these show embayments, and some are cracked and broken. Plagioclase phenocrysts and glomerocrysts (to 5 mm) are abundant, and vary from euhedral to rounded and embayed. Extinction angle measurements indicate an albite composition. Sparse, mica-like flakes composed of chlorite, carbonate and iron oxides appear to be pseudomorphs after biotite. The murky pink felsic groundmass is fine-grained and consists of granular to fibrous feldspar (probably K-feldspar) with some carbonate, quartz, chlorite, sericite and iron oxides.

The north-western margin of the porphyry mass appears to be marked by a fine-grained grey variety of the porphyry (LB12) containing abundant small plagioclase phenocrysts (to 2 mm), but only scattered small quartz phenocrysts (to 1.5 mm). The groundmass shows pseudo-breccia texture in places, with abundant secondary carbonate and albite. Outcrops of this porphyry show flow-banding and irregular fragmental texture in places. There is no well-marked contact with the underlying sequence to the west. To the east, the porphyry appears to become increasingly quartz-rich and grades into normal porphyry.

The prominent spur at the western margin of the porphyry mass [CP841478] (38/639272) consists largely of autobrecciated porphyry, including varieties with abundant clasts (up to 500 mm across) of flow-banded porphyry, and varieties containing abundant siltstone or slate clasts. At the south-western margin of the porphyry is a chloritic greenish to pale pink, massive to brecciated rock in which small feldspar crystals are abundant but quartz is scarce. Although outcrop is poor, there is a suggestion of an abrupt contact with the feldspar-phyric sequence to the south-west. A similar rock is associated with dark grey slate on the walking track adjacent to the western margin of the porphyry sequence 500 m further south.

At its eastern margin, the main body of massive porphyry appears to have an abrupt contact (on the west bank of a south flowing creek) with an unusual bedded sequence of slate, sandstone, altered tuff, and quartz-phyric breccia. Units of tuffaceous breccia up to several metres thick contain abundant contorted fragments of shale and appear to be mass-flow deposits of some kind. Near the eastern margin of this sequence is a massive grey pyritic altered tuff containing scattered small rock fragments and cut by numerous quartz and chlorite veins. In thin section (LG21) this rock consists largely of a mosaic of secondary albite, with small feldspar crystals and sparse quartz grains and patches. Exposure in this general area was poor at the time of mapping, but has since been improved by exploration activity and would warrant further detailed examination. The sequence passes eastwards, apparently conformably but abruptly, into fine-grained sericitic volcanic rocks with associated slate.

FELDSPAR-PHYRIC PYROCLASTIC ROCKS AND LAVAS, MT SEDGWICK AREA

South-west of Mt Sedgwick

A sequence of feldspar-phyric lava and bedded tuff occurs adjacent to the Owen Conglomerate in the south-west corner of the mapped area. Several westerly dips have been recorded. The southernmost outcrop [CP839469] (38/63602615), immediately beneath the base of the Owen Conglomerate, is a massive purplish, fine-grained lava showing crude columnar jointing. A characteristic sandy weathering texture reflects the spherulitic nature of the groundmass. In thin section (LB27) the feldspar phenocrysts are completely altered to felted sericite, and some are deformed by the tectonic foliation. There are sparse smaller quartz phenocrysts, and numerous small quartz grains in the groundmass. The groundmass is dominated by fine-scale spherulitic texture, made up of close-packed subcircular areas (average diameter 0.35 mm) of pinkish feldspar grown around a nucleus of quartz. The structures are optically continuous and show uniform extinction. The margins of the spherulites are marked by slight concentrations of opaque dust.

Similar feldspar-quartz-phyric lava with columnar jointing (possibly the same unit displaced by faulting) occurs on the higher part of the ridge to the north-west, and is associated with flow-banded lava and bedded ash.

A sample of lava from this area (LB28) is similar to the above, except that the spherulitic texture is extremely well developed. The spherulites show clear radial and concentric structure in ordinary light, and coalesce to form composite bodies in many cases. This is the best example of spherulitic texture seen by the author in the Mt Read Volcanics.

Similar lavas, some showing flow-banding, occur with intercalated units of banded ash to the north. One 12 m thick unit of bedded vitric ash includes several ripple marked horizons and lenses of intraformational breccia.

A narrow belt of similar rocks occurs on the north side of the prominent spur of quartz-feldspar porphyry adjacent to the outlet creek from Lake Adam. Moderate to steep dips to both the west and east have been recorded, and suggest the presence of a NNE-trending anticline along the belt. The upper western part of the sequence is strongly oxidised to a purplish-red colour similar to that of the overlying volcaniclastic conglomerate, making it difficult to locate the contact with that unit in some areas. The contact with the quartz-feldspar porphyry sequence to the east is apparently conformable and gradational. Adjacent to this contact in the southern part of the area is a massive grey lava-like rock with sandy weathering texture. In thin section (LB13) it contains sparse, shadowy feldspar phenocrysts (altered to carbonate and sericite), and scattered small embayed quartz phenocrysts, in a carbonate-rich groundmass dominated by recrystallised feldspathic spherulites with chlorite-rich interstices. Similar lavas, some showing flow-banding, are prominent in the section to the west, and include varieties (*e.g.* LB6) with lenses of mosaic quartz resembling vesicles, and only scattered spherulites. Adjacent to the contact further north is a greenish-grey, fine-grained, vitric-crystal tuff (LB11), with sparse small feldspar phenocrysts (altered to carbonate) and scattered small quartz phenocrysts in a carbonate-rich sub-isotropic matrix in which shard shapes and small pumice fragments are apparent. This rock is interbedded with, and underlain by, laminated pale-coloured vitric ash or mudstone, and units of similar bedded ash and vitric tuff, up to 10 m thick, recur within the sequence up the slope to the west. Coarser vitric-lithic tuffs, some with remnant pumice fragments and shards, are also common (*e.g.* LB7). Some coarser-grained units contain lithic clasts up to 100 mm diameter, some of which are partially replaced by hematite towards the western margin of the area.

South-east of Mt Sedgwick

A sequence of generally pale-coloured, fine-grained feldspar-phyric volcanic rocks, including vitric tuff, ash-flow-like vitric-lithic and vitric-crystal tuff, lava, and banded ash deposits, together with intercalated slate and minor quartz-phyric tuff, occurs on the broad open ridge 1.5 km south-east of Mt Sedgwick [CP857474] (38/656267). The sequence includes lithologies similar to those in the massive feldspar-porphyry unit to the east,with which it has an apparently gradational contact. Most of the rocks are modified by a strong tectonic cleavage. The few bedding readings obtained show steep to vertical dips to both the east and west, and N-S to NNW-SSE strikes. Outcrop is insufficient to establish a stratigraphic succession, and no facings have been obtained.

A prominent black slate unit, two metres thick, lies along the NW-trending contact with the quartz-feldspar porphyry body at the northern end of the outcrop area. It is followed to the west by interbedded vitric tuff, lithic tuff, and slate exposed in a prominent landslide scar. A tuff from this area (LB15) shows remnants of a wispy pumice-clast texture with complete recrystallisation to a fine mosaic of quartz-feldspar-sericite-chlorite and carbonate, with some large sericite patches and irregular carbonate veins.

Several slate units interbedded with laminated chert-like vitric ash occur below the quartz-feldspar porphyry body on the eastern side of the ridge. The sequence in this area also includes tuff with small bomb-like clasts, and a thick unit of white-weathering, faintly-bedded vitric-crystal tuff with small quartz and feldspar crystals in a recrystallised matrix (LB24).

A massive, pale-coloured, feldspar-phyric rock with a knobbly surface weathering texture, possibly a lava, is exposed in a landslide scar and in several other areas on the western flank of the ridge. Closer to the western contact is a bedded vitric ash unit, and a pale feldspar-phyric tuff (LB22) which in thin section consists mostly of a fine-grained mosaic of secondary albite with wispy sericite streaks along the foliation.

Rocks exposed in the creek near the eastern side of the outcrop area appear to be mainly pumice-rich tuffs resembling ash-flows. A massive pyritised greenish vitric-lithic tuff (LB18) in the lower part of the creek consists of poorly-defined pumice-like fragments showing traces of bubble texture and recrystallisation to a fine mosaic of quartz-feldspar-sericite in which two foliations are evident. A massive, pale green, foliated vitric-lithic tuff (LB19) with feldspar phenocrysts altered to carbonate and pumice-like fragments altered to fine-grained feldspar-quartz-sericite-carbonate-chlorite, is intruded by a small quartz-feldspar porphyry body in this area. In the upper part of this creek is a massive fawn-weathering vitric tuff (LB25) showing traces of shards and of bubble structure within recrystallised pumice fragments.

MASSIVE FELDSPAR-PHYRIC RHYOLITE SOUTH-EAST OF MT SEDGWICK

The prominent pink knob of outcrop two kilometres south-east of Mt Sedgwick [CP862474] (38/662267) consists mostly of massive, fine-grained, strongly jointed rock which varies from pink to green to pale grey in colour. At the crest of the knob the rock is cut by numerous hematite-magnetite and chlorite veins, some of the former being up to one metre wide. Small feldspar phenocrysts are apparent in some areas, and some units show a faint wispy fragmental texture. The unit has a gradational contact with the sequence of vitric pyroclastic rocks and lava to the west, and an undetermined relationship (possibly gradational) with an undifferentiated sequence to the east.

A sample (LD8) from near the crest of the knob shows a faint fragmental texture marked by irregularly-oriented patches of green banded chloritic material and pink fine-grained material, reminiscent of pumice texture in some ash-flow rocks. The rock consists dominantly of a murky pink cryptocrystalline groundmass composed of fine chlorite and feldspar, with some larger chlorite blebs. Black opaque grains (magnetite?) are common. Remnant shadowy feldspar phenocrysts are partly to completely replaced by mosaic albite, or in some cases quartz. The rock is possibly an ignimbrite.

A sample from the eastern side of the unit (LB17) appears to be a lava and consists entirely of pink, fine-grained groundmass material in which fine-scale spherulitic texture is well developed. Some of the spherulities have grown around small quartz grains. Fine mosaic quartz, with some intergrown chlorite, occurs in the interstices between some spherulites, and there are scattered larger chlorite patches. The spherulitic structure is reflected in the sandy-textured weathering surface.

UNDIFFERENTIATED VOLCANIC SEQUENCE WEST OF DANTE RIVULET

Poorly exposed volcanic rocks occur between the massive feldspar-phyric rhyolite unit south-east of Mt Sedgwick and the quartz-phyric volcanic-volcaniclastic sequence west of the Dante Rivulet.

Exposures in the lower part of the creek at CP870462 (38/670254) show mainly cleaved greenish feldspar-phyric chloritic tuff and agglomerate, with occasional patches of quartz-phyric rock and possible volcaniclastic conglomerate. Massive pink rhyolite forms cliffs on the west bank of the creek in places, but the nature of the contact could not be determined. There is apparent interfingering of fine-grained feldspar-phyric lava(?) and volcaniclastic rocks in a landslide gulley halfway up this creek [CP868466] (38/66852580) and similar interfingering was noted in the uppermost exposures in the next creek to the east. In the upper part of the main western creek are tuff and agglomerate with intercalated units of quartz-feldspar porphyry. A sample from the prominent cliffs on the west bank of this creek (LB16) is a massive pinkish-grey quartz-porphyry containing abundant embayed quartz phenocrysts ranging down to groundmass size, but no apparent feldspars. Many of the quartz crystals are broken, and some are granulated. The strongly foliated groundmass consists mainly of sericite with disseminated fine quartz and patches of mosaic quartz.

Further east, on the south flank of the ridge capped with volcaniclastic conglomerate, are small outcrops of foliated, fawn-weathering greenish fine-grained rock resembling some varieties of the feldspar-phyric pyroclastic rocks-lava sequence to the west. One sample (LB2) shows a poorly defined wispy fragmental texture outlined by sericite-rich plates and irregular patches, resembling pumice fragments. There are smaller blebs of intergrown chlorite and quartz, and considerable fine quartz in the groundmass. There are scattered oxidised opaque grains but no apparent phenocrysts. Two foliations are evident. At the eastern end of this ridge are rugged outcrops of similar pink-weathering, greenish, fine-grained rock with faint wispy texture.

Several outcrops adjacent to the eastern arm of volcaniclastic conglomerate also consist of fawn-weathering fine-grained greenish rock which is non-porphyritic (*e.g.* LB3). Small outcrops of sandy-textured lava(?) and autobreccia also occur in this area, including one variety with clasts showing flow-banding. Pyrite veining is common in some outcrops in this vicinity.

UNDIFFERENTIATED VOLCANIC ROCKS WEST AND NORTH-WEST OF MT SEDGWICK

The volcaniclastic conglomerate sequence in the vicinity of Lake Barnabas is underlain by oxidised purplish volcanic rock which appears to be mainly tuff. The tuff is generally strongly foliated and sericitic, with feldspar crystals evident in places but little or no phenocrystic quartz. Bands of laminated vitric ash occur in the tuff in places, but most outcrops are apparently massive. The rocks most resemble the feldspar-phyric pyroclastic-lava sequence to the south-west of Lake Adam.

STICHT RANGE BEDS

The Sticht Range Beds (Corbett *et al.*, 1974) occupy a north-south trending belt up to 1.5 km wide extending from the Dante Rivulet through Lake Spicer and along the eastern side of Lake Dora to the Sticht Range.

The Beds comprise an interbedded sequence of white to grey siliceous pebble-cobble conglomerate, quartzose sandstone, micaceous siltstone, and dark slate, with a total thickness of 800-1000 m. The beds dip moderately to steeply west in nearly all areas, and face west. They rest unconformably on the multiply folded Precambrian basement rocks, the contact being exposed east of Lake Spicer. The complex contact against the volcaniclastic conglomerate sequence to the west is discussed in a later section. Worm tubes and bioturbation structures have been noted at several localities, indicating that the sequence is probably marine.

A conglomeratic basal unit rests directly on Precambrian platy quartzite at CP901519 (38/705316). At the base is a white, sandy, moderately well sorted pebble conglomerate containing rounded to subangular pebbles up to 20 mm diameter of quartzite and schistose quartzite in a sandy matrix. Overlying this is poorly-bedded pebble-cobble conglomerate and conglomeratic sandstone with minor thin brownish-green siltstone laminae. The conglomerates in the sequence generally are of granule-pebble to pebble-cobble grade, with rare clasts to small boulder size (300 mm). Clasts consist dominantly of Precambrian quartzite or quartz-schist, and are generally sub-rounded to well-rounded. The matrix material is predominantly quartz sand with some mica. Individual conglomerate beds may be up to several metres thick, and packets of conglomerate-sandstone beds may be up to several tens of metres thick. Slump sheets of pebbly mudstone up to several metres thick occur in the upper part of the sequence at Lake Spicer, and include varieties with rolled-up lenses and pods of sandstone.

The sandstones range from coarse-grained and conglomeratic to fine-grained micaceous varieties. Most are moderately well sorted quartz arenites in which quartz grains have either sutured boundaries or are separated by flakes of white mica, biotite, and/or chlorite. Grains of tourmaline are common. The quartz grains commonly show polycrystalline and schistose structure, and appear to be largely of Precambrian derivation (*e.g.* LR2). However, some units (*e.g.* LR20, LR9) also contain volcanic quartz (characterised by embayments, flash extinction, remnants of reaction rims, monocrystalline state) as well as feldspar and volcanic rock fragments, and appear to have been derived partly from a volcanic source (either by weathering or direct pyroclastic eruption) and partly from the Precambrian basement.

The thicker, coarser sandstone units may be poorly bedded or show medium-scale trough cross-bedding and channelling indicative of traction current deposition. No extensive development of large-scale cross-bedding has been seen in the sequence. Sedimentary structures are common in the medium to fine sandstone, and include parallel lamination, cross-lamination, ripple marks, convolute lamination, graded bedding, shale intraclasts, flute casts, load marks, flame structures, parting lineation, channelling, and water-escape structures. Some beds are clearly graded, with sharp bases (sometimes marked by conglomeratic material) and gradational tops, and others show a lower division of parallel lamination overlain by a division of convolute or cross-lamination as in Bouma bc sequences. Such beds appear to be turbidites, and those parts of the sequence where these beds are common are distinctly flysch-like in character. However, other parts of the sequence lack graded bedding, and are characterised by poorly-defined bedding planes, lensing bedding, cross-bedding, and channelling. These sections appear to be of shallow-marine type.

Alternation of sandstone-rich units and siltstone-rich units is evident in the Dante Rivulet section. One part of this section with fairly continuous exposure shows a siltstone sequence, with scattered graded sandstone beds up to 300 mm thick, overlain erosionally by a conglomeratic bed forming the base of a packet of sandstone-conglomerate beds. The latter becomes progressively interbedded with siltstone upwards, suggesting that the sequence consists of several fining-upwards units.

CONTACT BETWEEN STICHT RANGE BEDS AND VOLCANICLASTIC SEQUENCE

An unusual relationship is evident between the Sticht Range Beds and the volcaniclastic conglomerate sequence between Lake Spicer and Lake Dora. The contact is marked by a zone of disrupted and folded sandstone beds and mixtite-like units containing contorted lenses and wisps of sandstone (and other Sticht Range Beds lithologies) and also scattered lenses and patches of volcanic material. This disrupted zone (see fig. 1) is up to 70 m wide and has, at least in some places, an abrupt contact against the volcaniclastic conglomerate sequence to the west. To the east, however, the zone of disruption appears to grade through folded sandstone into the normal west-dipping sequence. The sheared appearance of some outcrops within the zone, and the presence of linear gaps in exposure, suggests there could be faults parallel to the trend of the contact in places, but these are difficult to confirm in the field.

The complex nature of the contact zone is indicated by the lithologies occurring at two localities where outcrop is reasonably good. On a knoll west of the north end of Lake Spicer [CP887521] (38/688318), the sequence from east to west includes the following units: (1) normal bedded sandstone sequence in which there are stratabound slump sheets (up to 3 m thick) consisting of contorted sandstone lenses and pods, and dispersed quartz pebbles, in a micaceous silty matrix; (2) a zone or area of tight, irregular, steeply-plunging small folds in interbedded sandstone-siltstone; (3) normally bedded zone of sandstone-siltstone; (4) highly disturbed zone of disrupted sandstone-siltstone beds, in which there is no continuous bedding but rather a jumble of irregular lumps, lenses, wisps and blocks (many retaining original bedding) in a cleaved silty matrix. Also present are scattered rounded to irregular lumps of sheared-looking pinkish quartz-phyric volcanic material (tuff?), up to two metres diameter, and elongate wispy lenses of fine-grained volcanic material up to about one metre long and a few centimetres thick. The silty matrix (LR1) shows remnants of original bedding and consists of fine mica flakes (white mica and chlorite), small quartz grains, some fine granular carbonate, and some dusty opaque minerals. It is cut by a prominent cleavage which shows some secondary mica growth along cleavage traces, suggesting it is related to the Devonian folding rather than being a primary feature related to the disruption.

The highly disturbed zone has an unexposed but apparently abrupt contact (possibly faulted) against massive volcaniclastic conglomerate to the west. The latter is strongly cleaved, but does not appear to be disrupted. A contact between the disrupted sandstone zone and the volcaniclastic conglomerate is exposed some 200 m further north, beside a small creek. The contact is sharp and fused-looking, with minor irregularities, and is sub-vertical. The exposed section of the contact (5-10 m) is broadly arcuate, with the disrupted material apparently forming a slight hump in the volcaniclastic rocks. The general trend of the contact is 015°T, whereas bedding in the adjacent volcaniclastic rocks trends 075°S80°.

About 600 m south of the southern end of Lake Dora, on the northeastern side of the outlet creek [CP884533] (38/68653310), the sequence from east to west across the contact zone includes the following lithologies: (1) sheared and disrupted sandstone-siltstone (contact with normally-bedded sandstone not exposed); (2) strongly sheared quartz-phyric volcanic material resembling tuff; (3) broad zone (30-40 m) of disrupted and mixed sandstone, siltstone, siliceous conglomerate, and volcanic material, including at least two phases of mixtite (one apparently intruding the other).

The coincidence of the disturbed zone with the contact, and the presence of sheared units within the zone, strongly suggests that the contact may represent a fault zone which was active during deposition. West-side-down sagging on the fault would have caused collapse of sections of the unconsolidated or semi-consolidated Sticht Range Beds onto and into the adjacent volcanic sequence. The isolated lumps and wisps of volcanic material within some of the mixtites probably represent pieces of substrata which were picked up and incorporated into the slumps. Although further checking is needed, it appears that the volcanic material now observable in the slumps is primary material rather than volcaniclastic conglomerate such as now abuts the zone to the west. Hence the initial slumping may have been into a quartz-phyric volcanic sequence, with further subsidence resulting in juxtaposition of volcaniclastic conglomerate against the Sticht Range Beds. The local discordance between bedding in the conglomerates and the trend of the disturbed zone suggests some late-stage movement on the zone. This model provides an explanation for many of the features occurring along this very puzzling zone, but further work is required and other explanations may be possible.

The disrupted zone thins rapidly to the south of a small cross-fault near the north-west corner of Lake Spicer. An apparently conformable contact is present between a thick siltstone unit and adjacent volcaniclastic conglomerate 200 m south of this fault.

The only other exposure of the contact observed was in a small creek 1.5 km SSW of Lake Beatrice. Here the sandstone-siltstone sequence shows disrupted bedding and is apparently intruded by a narrow, irregular body of quartz-feldspar porphyry. The porphyry is cleaved and faulted, and is followed to the west by sheared volcaniclastic conglomerate and sandstone. In this case the contact appears to have been the locus of porphyry intrusion as well as probable slumping and faulting.

INTERPRETATION AND CORRELATION OF THE CAMBRIAN UNITS

VOLCANICLASTIC CONGLOMERATE SEQUENCE AND LAKE DORA VOLCANIC SEQUENCE

As the volcaniclastic conglomerates interfinger with the volcanic sequence at Lake Dora, it is appropriate to consider the two as a single stratigraphic unit. The conglomerates appear to represent an apron of epiclastic detritus derived largely from, and deposited around, the volcanic pile at Lake Dora. However, the presence of quartzite clasts and other detritus of Precambrian derivation throughout the sequence indicates some input from that source, although it is also possible that this material has been reworked out of the Sticht Range Beds.

Several previous authors have suggested that two volcaniclastic units are present in the Lake Dora area, one lying directly beneath the Owen Conglomerate and generally referred to as "Jukes Conglomerate", and the other comprising the bulk of the sequence and referred to as "Dora Conglomerate" (*e.g.* Bradley, 1954; Brophy, 1976; M.J. Hutton, pers. comm.). The upper unit was thought to be richer in hematite and in quartzite clasts, and to be about 20 m thick. However no distinct boundary with the underlying unit was recognisable, and the distinction was not evident in the Lake Spicer area. The present author could find no clear evidence for establishing two units, and suggests that some reworking of the material adjacent to the boundary with the Owen Formation, and some concomitant increase in the proportion of quartzite clasts, has given the impression of an upper formation.

Bedding is present within the conglomerate sequence in places, particularly in sandy units, and indicates subaqueous conditions. It is not known, however, whether conditions were marine, lacustrine or fluvial. The apparent lack of mudstone and siltstone in the sequence suggests a relatively high energy environment, and argues against a deep-water situation where some deposition of pelagic mud might be expected. The tuff lens which occurs within the sequence south-west of Lake Dora shows indications of welding, suggesting that subaerial or very shallow subaqueous conditions may have prevailed at times.

Although there is a gap in the mapping at Lake Beatrice, there is almost certainly continuity between the volcaniclastic sequence to the south-east of Mt Sedgwick and that in the Lake Spicer-Lake Dora area. The units are lithologically similar, contain similar porphyry units, and occupy a similar stratigraphic position beneath the Owen Conglomerate. These two belts, one west-facing and one NE-facing, appear to represent the limbs of a broad NW-trending synclinal structure. This fold structure is also evident in the Owen Conglomerate, although complicated by some minor folds and NW-trending faults. The sequence at Mt Sedgwick appears to transgress the underlying volcanic rocks, probably along an erosional contact, and there is no evidence of the interfingering with volcanic rocks such as occurs at Lake Dora. There may, however, be interfingering of this type further to the south-east near the Dante Rivulet, where the 'arm' of volcaniclastic conglomerate is flanked to the west by a quartz-phyric volcanic sequence with intercalated volcaniclastic conglomerate. The implication of this distribution is that the base of the volcaniclastic sequence may be diachronous, with progressively younger epiclastic units lapping onto eroded volcanic rocks with increasing distance from the source volcanoes. This diachroneity is also suggested by the presence of only a thin sequence of volcaniclastic conglomerate in the vicinity of Lake Barnabas, and by the complete wedging out of the sequence south-west of Mt Sedgwick. There is also a strong suggestion that as the sequence becomes thinner, the relationship to the overlying Owen Conglomerate becomes more obviously conformable, and the volcaniclastic material, in some places at least, can be regarded as simply a locally-derived basal facies of the Owen Formation.

The volcanic sequence at Lake Dora appears to be a complex of related pyroclastic rocks, lavas, and intrusive rocks, with some intercalated lenses of epiclastic conglomerate. Some of the pyroclastic units show textures suggestive of collapsed pumice and welding, and may be ignimbrite. This would suggest a partially subaerial origin for the complex, but no really definitive features have been recognised which indicate the main depositional environment. The abundance of related intrusive rocks, some of which penetrate the surrounding apron of volcaniclastic rocks, implies proximity of the eruptives to the sub-volcanic magma chamber, and strongly suggests that the sequence represents a volcanic centre or part thereof.

Correlation of the volcaniclastic sequence, and of the related volcanic sequences, is necessarily based on lithostratigraphic considerations, as any physical continuity with defined units in other areas is obscured by younger deposits. The regionally subconformable relationship of the volcaniclastic conglomerate sequence to the Owen Conglomerate, and the distinctive lithological characteristics of the sequence, strongly suggest correlation with the upper part of the Tyndall Group. This group occurs in the adjacent Comstock Valley, and consists of a basal volcanic-epiclastic unit (Comstock Tuff) and an upper unit of volcaniclastic conglomerate and sandstone with minor intercalations of tuff ("Jukes Formation", Corbett *et al.*, 1974). The upper unit is directly overlain by the Owen Conglomerate (represented by the Pioneer Beds), as established from drill holes near the Comstock open cut (Jago *et al.*, 1972).

If the volcaniclastic conglomerate sequence in the Lake Spicer-Lake Dora area is a correlate of the Tyndall Group, then so also is the volcanic sequence at Lake Dora, with which the conglomerates interfinger. This correlation is of some consequence, because of the presence of significant mineralization in the volcanic sequence at Lake Dora. Other areas designated as Tyndall Group, or correlated with that group, have generally been barren of significant mineralization (Corbett, 1981; Reid and Meares, 1981).

A sequence comparable with the Tyndall Group occurs beneath the Owen Conglomerate at the eastern end of Mt Lyell, and comprises some 300 m of volcaniclastic conglomerate and sandstone underlain by a similar thickness of quartz-phyric tuff, agglomerate, and sandstone (Corbett, 1979). The lower unit overlies quartz-phyric volcanic rocks, including flow-banded and autobrecciated lavas, which may be equivalent to the Lake Dora volcanic sequence. A quartz-feldspar porphyry body which intrudes the sequence near the base of the volcaniclastic conglomerate is similar to other porphyritic rocks in the Dante Rivulet-Lake Dora area, as previously described. A N-S elongated fault block of volcaniclastic conglomerate occurs at the eastern limit of the Mt Lyell exposure, and may be somewhat comparable in structural setting to the 'arm' of volcaniclastic rocks near Dante Rivulet.

The eastern part of the volcanic succession in the Mt Jukes-Mt Darwin area, south of Queenstown, also compares closely with that in the Lake Dora area. The 'eastern sequence' at Jukes-Darwin (Corbett, 1976*a*, *b*, *c*; 1979; 1981) comprises interbedded quartz-phyric volcanic rocks (including lavas, pyroclastic rocks, possible intrusive rocks) and volcaniclastic conglomerate and sandstone. The sequence overlies a central belt of feldspar-phyric rhyolite intruded by the Darwin Granite, and contains blocks of granite and rhyolite in the basal units. It generally faces east, and has a conformable to unconformable relationship with the overlying Owen Conglomerate. Mineralization appears to be largely restricted to the contact with the underlying sequence.

The relationship of the quartz-phyric volcanic sequence at Lake Dora to the main central volcanic sequence, which is typically feldspar-phyric, is unknown. However, some indication of this relationship may be gained from the Dante Rivulet area, where a quartz-phyric volcanic sequence having similarities with that at Lake Dora abuts the volcaniclastic conglomerate sequence and contains intercalations of similar conglomerate. Although outcrop is limited, this sequence appears to interfinger with typical central sequence lithologies at several localities (in the area mapped as undifferentiated volcanic rocks), suggesting a gradational relationship. It could be argued, therefore, that while in some areas the basal part of the Tyndall Group has a more or less well-defined contact on the central volcanic sequence, and may be separated from it by a significant hiatus (*e.g.* Comstock open cut, South Darwin plateau), in other areas the lower part of the sequence may interdigitate with central sequence volcanic rocks. The situation may be that the base of the Tyndall Group is most clearly defined, and most obviously transgressive, where the group consists largely of epiclastic deposits, whereas in those areas where the root volcanoes and earliest deposits of the group are preserved, the relationship with the central volcanic sequence may be less clear-cut and could be interdigitating.

This less rigid interpretation of the relationship between the Tyndall Group and central volcanic sequence allows for contemporaneous eruptions in some areas, and for significant time breaks or erosional intervals between the two in other areas. It also implies that the base of the Tyndall Group, as mapped, is likely to be strongly diachronous, in the same way that the base of the volcaniclastic conglomerate sequence is diachronous. A diagrammatic outline of the possible relationships is shown in Figure 5.

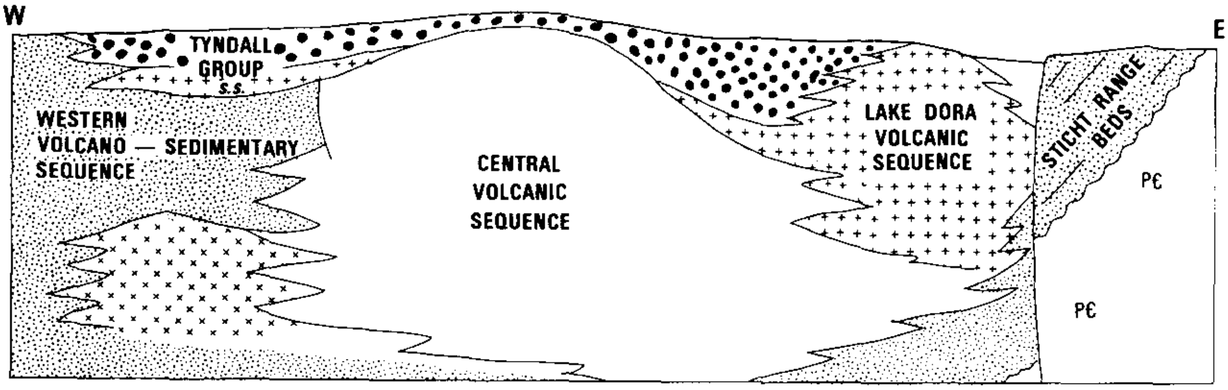

Figure 5. *Diagrammatic cross-section showing possible relationship of Tydall Group to Lake Dora volcanic sequence and other volcanic units.*

Alternative interpretation for Lake Dora sequence

An alternative interpretation for the volcanic and volcaniclastic sequences at Lake Dora has been suggested by M.J. Hutton of the Mt Lyell Company (pers. comm., 1982), namely that the sequences represent the stratigraphic base of the volcanic belt and are essentially unrelated to the Tyndall Group. There appear to be two main arguments favouring this interpretation. The first is that the volcaniclastic sequence apparently faces west (*i.e.* it appears to be dipping under the main volcanic belt, in contrast to the situation at Jukes-Darwin), and overlies a basal sedimentary unit represented by the Sticht Range Beds, which also faces west. The west facing of the volcaniclastic sequence is to be expected, however, if it represents the eastern limb of the large syncline evident in the Owen Conglomerate, as previously discussed. The unconformable or disconformable relationship with the main central volcanic belt is clearly evident beneath the western limb of the syncline, but beneath the eastern limb is the enigmatic contact with the Sticht Range Beds. From the evidence available, this contact possibly represents a Cambrian fault scarp rather than a normal stratigraphic contact, and there could be a significant time break between the two units.

The second argument for a pre-Tyndall age for the Lake Dora volcanic and volcaniclastic sequences concerns the presence within a somewhat similar sequence in the Mt Selina-Anthony River area (7-10 km north of Lake Dora) of small granitic bodies thought to be related to the Murchison Granite. The author is not familiar with the sequence in this area, which apparently includes a variety of volcanic rock types (many of them quartz-phyric) as well as a thick unit of volcaniclastic conglomerate at Mt Selina (Mt Lyell Company geologists, pers. comm.). The latter unit directly underlies the Owen Conglomerate north of the Anthony River. A gradational contact between the volcanics and the underlying Sticht Range Beds near the Anthony River is reported by McKibben (1971).

By analogy with the Mt Darwin situation, the sequence intruded by granite at Mt Selina might be expected to be equivalent to the central volcanic belt, and thus older than the Tyndall Group. This assumes, however, that the Murchison and Darwin Granites are of the same age (radiometric data are insufficiently precise to resolve this), and that the sequence at Mt Selina is equivalent to that at Lake Dora. Further work is clearly necessary before this important problem can be resolved.

QUARTZ-FELDSPAR PORPHYRY SEQUENCE NEAR MT SEDGWICK

This complex consists largely of massive to flow-banded porphyry with some autobreccia horizons, suggesting a pile of lava flows with possibly some shallow intrusive rocks. At several areas, mainly around the margins, there are intercalations of bedded tuff, sandstone, and shale, indicating that the complex was at least partly extrusive into a subaqueous environment. The presence of mass-flow-type beds containing shale clasts at the eastern margin indicates sufficient water depth to allow for slumping and redeposition.

The sequence overlies the feldspar-phyric lava and pyroclastic rocks south-west of Lake Adam along an apparently conformable and gradational contact. An apparently conformable contact is also present with similar rocks at the eastern margin of the main mass, although the time relationship could not be determined in this area. To the north the sequence appears to be directly, and probably disconformably, overlain by the volcaniclastic conglomerate sequence. The semi-isolated lens to the north-east of the main mass has an abrupt and possibly discordant contact with underlying units, and may be intrusive.

The discrete nature of the unit, and the presence of a thick pile of rhyolitic lavas and possible intrusive rocks, strongly suggests that the complex represents a single, quartz-phyric volcanic centre. The conformable and gradational relationship with the adjacent sequences indicates that it could represent a local quartz-phyric phase of the dominantly feldspar-phyric central sequence. On the other hand, if the eastern margin stratigraphically overlies the adjacent sequence, as does the western margin, then the unit may be stratigraphically younger than the bulk of the central sequence, and could represent a root volcano of the Tyndall Group.

FELDSPAR-PHYRIC PYROCLASTIC ROCKS AND LAVAS SOUTH-WEST AND SOUTH-EAST OF MT SEDGWICK

The sequence of interbedded spherulitic lava, tuff, and laminated ash deposits south-west of Mt Sedgwick includes units with well-defined bedding and ripple marks indicating subaqueous deposition. The spherulitic lavas are closely comparable with similar lavas from the central volcanic sequence in the Mt Jukes and King River gorge areas, where columnar jointing has also been observed (Corbett, 1976*b*, *c*; 1979).

The sequence to the south-east of Mt Sedgwick includes several black slate units and units of bedded ash, indicating that the depositional environment was at least partly subaqueous. Coarser vitric tuff containing pumice fragments and resembling ignimbrite is prominent towards the eastern part of the area adjacent to the massive 'rhyolite' unit, suggesting that this part of the sequence may be subaerial.

MASSIVE FELDSPAR-PHYRIC RHYOLITE SOUTH-EAST OF MT SEDGWICK

Although this unit was examined in only a few localities, it appears to consist largely of spherulitic lava and ignimbritic vitric-lithic tuff. No intercalated sediments were seen. The sequence possibly represents the subaerial part of a volcanic island or archipelago which was flanked by submarine sequences such as those containing slate and laminated ash to the west.

The unit is closely comparable with the massive, pink-weathering feldspar-phyric rhyolite of the central volcanic sequence in the Jukes-Darwin area, even to the presence of prominent hematite-magnetite veins (Solomon, 1960; Corbett, 1979).

STICHT RANGE BEDS

The Sticht Range Beds rest directly and unconformably on Precambrian basement, and have been largely derived from the Precambrian terrain. The presence of trace fossils and bioturbation suggest that the sequence is at least partly marine, and the sedimentary structures indicate a variety of shallow water and possibly deeper marine (turbidite) environments. The presence of only minor volcanic detritus in some sandstone units, and the apparent lack of any significant primary volcanogenic deposits, is somewhat surprising considering that the main volcanic belt lies only a few kilometres away to the west. This would suggest that the sequence was deposited either prior to the main volcanic activity or during a significant hiatus in volcanism. The latter seems less likely as there is no trace of any earlier volcanic units beneath the Sticht Range Beds.

If the sequence represents an essentially pre-volcanic deposit, then it is perhaps unexpected that it is overlain directly by the volcaniclastic conglomerate sequence which appears to post-date the bulk of the volcanism. As previously described, however, the contact between these two units is marked by a disturbed zone within which there is considerable slumping and deformation, and may represent an active fault scarp boundary. The initial volcanic sequence with which the Sticht Range Beds interdigitated (partly by slumping) may be buried beneath the volcaniclastic conglomerate sequence, as indicated in Figure 5.

An essentially pre-volcanic age for the Sticht Range Beds has been previously suggested by the author (Corbett, 1979), when it was argued that the Beds represent the eastern margin of a broad marine basin (essentially the Dundas Trough) within which the main volcanic belt formed. The deposits of this early marine basin to the west of the volcanic belt are represented by the lower parts of the western volcano-sedimentary sequence (Corbett, 1979). At South Queenstown this includes a major unit of Precambrian-derived quartz-wacke sandstone, the Miners Ridge Sandstone, which has many features in common with the Sticht Range Beds.

PRECAMBRIAN ROCKS

The Precambrian basement rocks consist mainly of strongly indurated, multiply-folded and crenulated white quartzite, schistose quartzite, and quartz-phengite schist, with minor phyllite, dolomite, and red sandstone. At Marble Bluff, platy quartzite and quartz-schist which occur on the crest and steep southern slopes are apparently underlain by a major unit of grey-black phyllite and slate exposed in a creek draining the western side of the Bluff.

East of Lake Spicer, an unusual horizon of well-bedded red sandstone underlies the Owen Conglomerate correlate and shows sub-vertical bedding and areas of complex folding and refolding. Elsewhere in this area, the rocks are predominantly white quartzite, platy quartzite, and quartz-schist.

North-east of Lake Dora, small outcrops of east-dipping, laminated creamy-coloured dolomite occur in a swampy area east of a breccia which appears to mark the base of the Sticht Range Beds.

STRUCTURAL GEOLOGY

Structures in Owen Conglomerate

The presence of west-dipping Owen Conglomerate west of Lake Spicer, and of east-dipping remnants of Owen Conglomerate along the rim of the plateau east of Lake Spicer, suggests the existence of a broad, deeply eroded anticlinal structure with its axial trace trending roughly NNW. This structure is either not reflected in the older Sticht Range Beds, which for the most part dip fairly uniformly west across the inferred core area of the anticline, or is indicated only by some apparent shallowing of dips and some irregular strike directions near the outcrop limit east of Lake Spicer. Significant tilting and erosion of the Sticht Range Beds prior to deposition of the Owen Conglomerate is indicated.

Between Lake Spicer and Mt Sedgwick, the Owen Conglomerate apparently forms a broad complex synclinal structure with several superimposed minor folds and a number of NW-trending cross-faults. The deepest of the minor folds is a NW-trending syncline occupied by limestone two kilometres west of Lake Spicer.

A broad anticlinal fold in the Owen Conglomerate at Mt Sedgwick has an axial trace trending NNW (approximately 325°T) and a gentle northerly plunge. Dips on the western limb are low to moderate (mostly 30°-40°), but those on the eastern limb are affected by faulting adjacent to the axial surface, and range up to 85°E. A series of minor faults affects the base of the Owen Formation in the axial region. Possibly the largest of these is a NNW-trending structure on the north-eastern side of Mt Sedgwick which shows east-side down movement and causes over-steepening of bedding. Several smaller faults of NNW trend on the western side of Mt Sedgwick are intersected by a partly later series of E-W trending structures. A series of small NE-trending faults are responsible for stepwise dextral displacement of a sandstone unit in the Owen Formation south-east of Mt Sedgwick. Several minor NW-trending folds were noted in this sandstone unit, with fold axes plunging 45° towards 335°T.

Structures in Cambrian rocks

The large-scale synclinal structure in the Owen Conglomerate between Lake Spicer and Mt Segwick is apparently reflected in the volcaniclastic conglomerate unit, but is not apparent in the older volcanic units. Similarly, the anticline at Mt Sedgwick is not apparent in the underlying volcanic units apart from the volcaniclastic conglomerate. Recorded dips in the volcanic units in the Mt Sedgwick area are generally steep to sub-vertical, with predominantly N-S strikes. An anticlinal strucutre trending NNE is suggested by bedding readings in the area south-west of Lake Adam. A dominant cleavage in the volcanic rocks in the Mt Sedgwick area trends NNW to NW, and generally dips steeply south-west. This cleavage appears to be parallel to the axial plane of a minor NW-plunging fold noted in the undifferentiated volcanic sequence at the south-east end of Lake Barnabas. A second cleavage was noted in some thin sections of the volcanic rocks.

The dominant cleavage in the Lake Dora-Lake Spicer area also has a NW to NNW trend, with a sub-vertical to steep south-west dip. A similar cleavage was noted in the Owen Conglomerate, and in the Sticht Range Beds. Evidence of a second cleavage was noted in some thin sections of the volcanic rocks. A major NW-trending fault truncates the Sticht Range Beds east of Lake Dora, and appears to dextrally offset the contact with the Precambrian by a distance of about two kilometres. The possible Cambrian fault forming the contact between the Sticht Range Beds and the volcaniclastic conglomerate sequence may merge with this fault at the northern end of Lake Dora.

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[15 July 1982]

5 cm


TASMANIA DEPARTMENT OF MINES
MT READ VOLCANICS AND ASSOCIATED ROCKS IN THE MT SEDGWICK-LAKE BEATRICE AND LAKE DORA-LAKE SPICER AREAS
GEOLOGY BY K. D. CORBETT
1982
0
0 5
1 MILE
0
0 5
1 KILOMETRE
SCALE 1 : 15840
5 cm
QUATERNARY
Qt
Talus and scree deposits.
Qf
Bouldery fan deposits with stream channels — partly reworked moraine and scree.
Qpm
Pleistocene bouldery moraine deposits.
JURASSIC
Jdl
Dolerite.
PERMO-CARBONIFEROUS
P
Conglomerate, mixtite, siltstone; some fossiliferous horizons.
LATE CAMBRIAN - EARLY ORDOVICIAN
Owen Conglomerate — siliceous sandstone and conglomerate, mostly pebble-cobble grade. Prominent sandstone unit indicated near Mt. Sedgwick.
Red breccia-conglomerate with associated sandstone and pebble conglomerate in area east of Lake Spicer. Correlate of Owen Conglomerate.
CAMBRIAN MT READ VOLCANICS AND ASSOCIATED ROCKS
Volcaniclastic conglomerate and sandstone, generally massive to poorly bedded. Clasts of quartz-feldspar porphyry usually abundant. Minor tuff horizons and intrusions of porphyry. Correlate of Tyndall Group.
Mainly quartz-feldspar-phyric volcanic rocks and associated intrusive bodies (Cpi) with intercalations of volcaniclastic conglomerate, inclusions of slate (black), and xenoliths of sandstone and conglomerate. Some internal boundaries shown. Prominently flow- banded in some areas. Locally chloritized and mineralized.
Mainly feldspar-phyric pyroclastics and lavas, generally pale-coloured and fine grained. Banding and columnar jointing in places. Minor shale horizons.
Massive pink fine-grained feldspar-phyric rhyolite, commonly spherulitic. Large haematite-magnetite veins in places.
UD
Undifferentiated volcanic rocks — includes feldspar- phyric and quartz-phyric types
Sticht Range Beds — interbedded grey quartzose sandstone, micaceous siltstone, granule-pebble conglomerate. Rare trace fossils and bioturbation. Some graded bedding and cross-bedding.
PRECAMBRIAN
P€
Quartzite, quartz-mica schist, black phyllite (P€p), minor dolomite (P€d) and red sandstone (P€ss).
Geological boundary approximate, inferred.
Fault approximate
Dip of bedding or lithological layering, facing unknown, facing known.
Flow banding in volcanic rock.
Plunge of columnar jointing in volcanic rock.
Dominant cleavage in Cambrian — Ordovician rocks — dipping, vertical.
Foliation in Precambrian rock.
Plunge of minor fold.
Prospect.
4-wheel drive road.
Track.
WALFORDS PEAK
LAKE DORA
FAULDS TARN
MICHAEL TARN
LAKE
LAKE SPICER
Disrupted zone along contact
LAKE BARNABAS
LAKE ADAM
MT. SEDGWICK
LAKE BEATRICE
MARBLE BLUFF
KING RIVER
Dante Rivulet
384 000 mE
364 000 yE
390 000 mE
371 000 yE
836 000 yN
5356 000 mN
5346 000 mN
825 000 yN
Cartography by P. B. Nankivell

Figure 1

5 cm

TASMANIA DEPARTMENT OF MINES

MT READ VOLCANICS AND ASSOCIATED ROCKS IN THE MT SEDGWICK-LAKE BEATRICE AND LAKE DORA-LAKE SPICER AREAS

GEOLOGY BY K. D. CORBETT
1982

0 0.5 1 MILE
0 0.5 1 KILOMETRE

SCALE 1 : 15840

5 cm

SAMPLE LOCALITIES AND LOCATIONS OF CROSS-SECTIONS

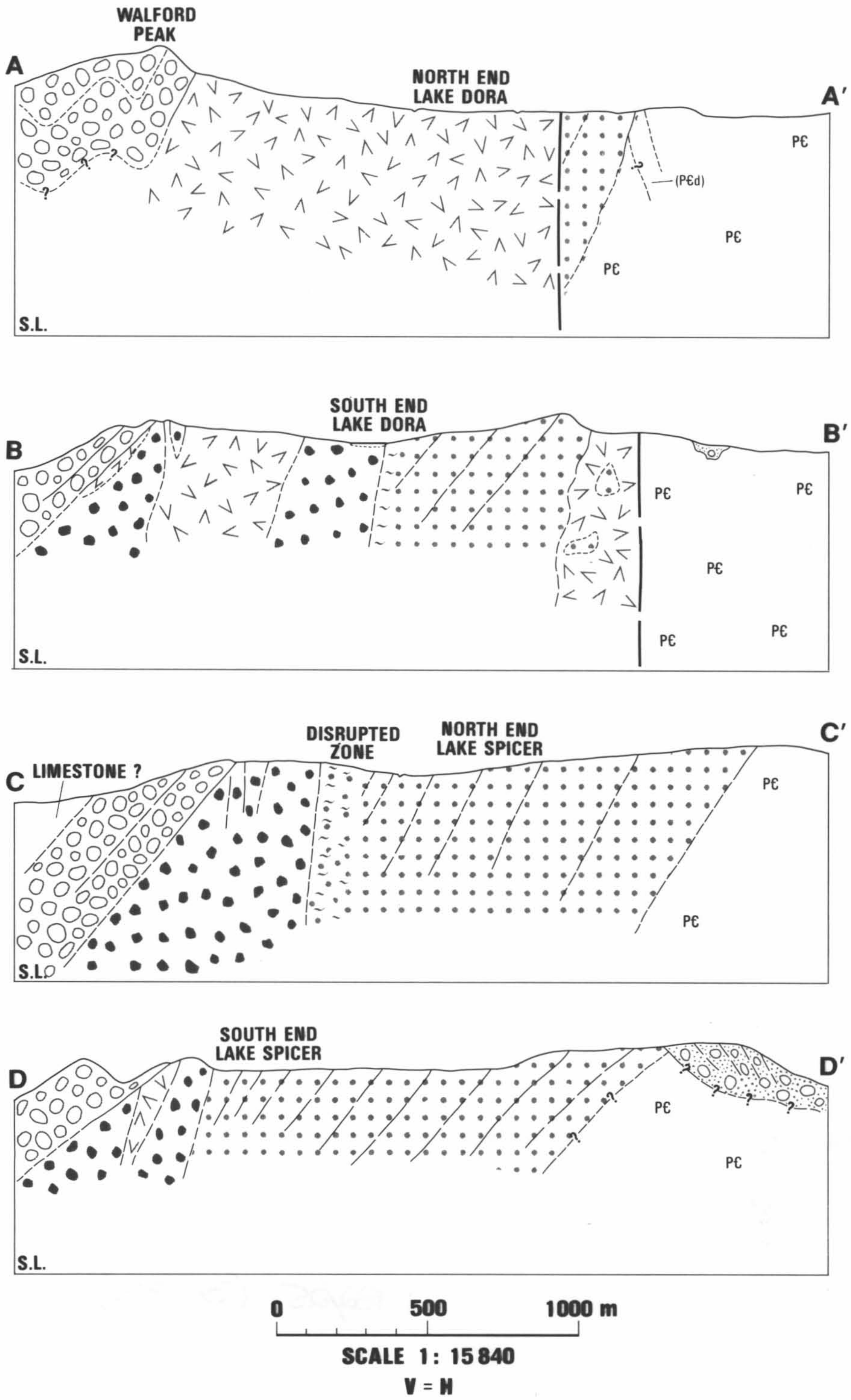
PETROLOGICAL SAMPLES

Field No. and No. referred to in text	Mines Department Catalogue No.	Field No. and No. referred to in text	Mines Department Catalogue No.
LB1	77/502	LD1	73/366
LB2	77/503	LD7	73/368
LB3	77/504	LD8	73/369
LB5	77/506	LR1	81/100
LB6	77/507	LR2	81/101
LB7	77/508	LR3	81/102
LB10	77/511	LR4	81/103
LB11	77/512	LR6	81/104
LB12	77/513	LR8	81/105
LB13	77/514	LR9	81/106
LB15	77/516	LR10	81/107
LB16	77/517	LR13	81/108
LB17	77/518	LR15	81/109
LB18	77/519	LR16	81/110
LB19	77/520	LR17	81/111
LB21	77/522	LR20	81/112
LB22	77/523	LR21	81/113
LB24	77/525	LR22	81/114
LB25	77/526	LR25	81/115
LB27	77/528	LR26	81/116
LB28	77/529	LR29	81/117
		LR30	81/118

Geological boundary approximate, inferred.
Fault approximate
Dip of bedding or lithological layering, facing unknown, facing known.
Flow banding in volcanic rock.
Plunge of columnar jointing in volcanic rock.
Dominant cleavage in Cambrian — Ordovician rocks — dipping, vertical.
Foliation in Precambrian rock.
Plunge of minor fold.
Prospect.
4-wheel drive road.
Track.

Cartography by P. B. Nankivell

Figure 2



BEDROCK CROSS-SECTIONS LAKE DORA — LAKE SPICER AREA

Legend as for Figure 1

See Figure 2 for location of cross-sections.

Figure 3

BEDROCK CROSS-SECTION ACROSS SOUTH FACE OF SEDGWICK PLATEAU

Legend as for Figure 1 See Figure 2 for location of section.

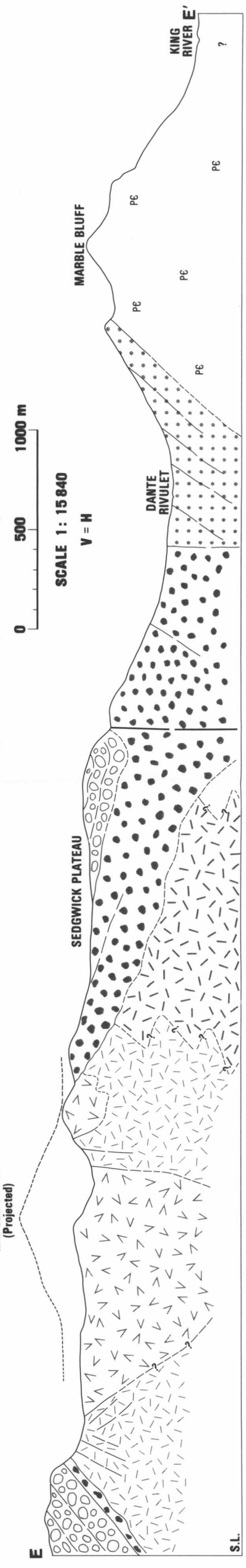


Figure 4

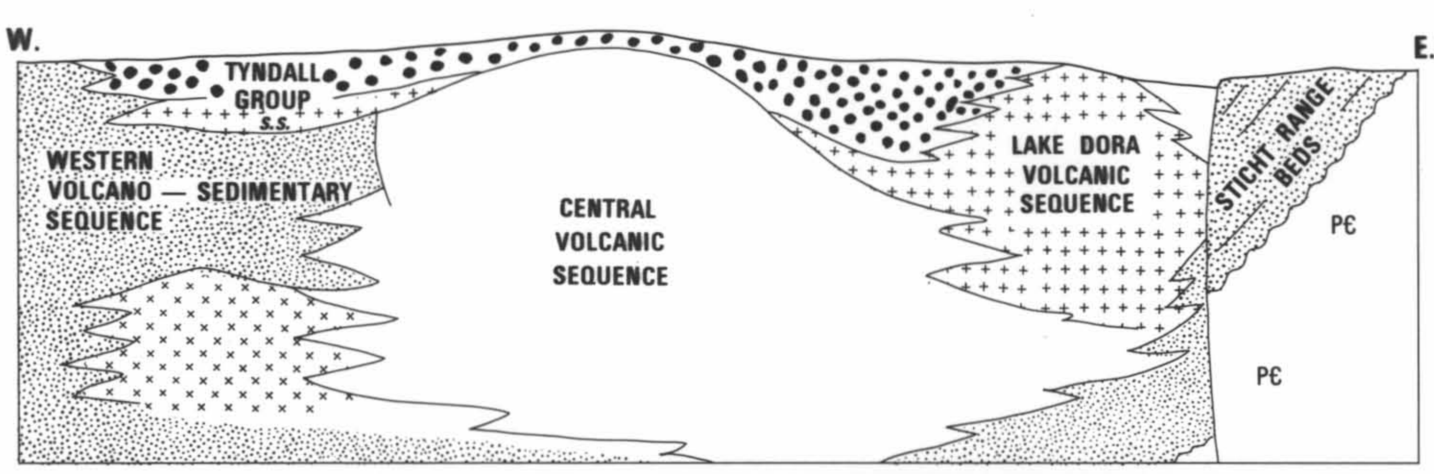


Figure 5 DIAGRAMMATIC CROSS-SECTION SHOWING POSSIBLE RELATIONSHIP OF TYNDALL GROUP TO LAKE DORA VOLCANIC SEQUENCE AND OTHER VOLCANIC UNITS