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PROGRESS REPORT DUNDAS TROUGH-MT. READ VOLCANIC BELT REGIONAL PROGRAMME.

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A.S.Joyce, E.W.Batchelor, E.H.Skey.

SUMMARY

The programme was designed to begin the examination of the geology of the Mt Read Volcanic Belt. Work commenced in our licence areas in order to ascertain the regional setting of prospects under examination. The general problem of ground acquisition also requires a regional comprehension, so the project also intended to gain an understanding of those geological features relevant to prospecting in the belt.

A series of detailed traverses, concentrated in the Rosebery-Que River area, but also extending south to Queenstown, were completed. Photo interpretation, rock geochemistry and mine visits contributed important data.

The volcanics are calc-alkaline but include sodic rhyolites. Dominantly subaerial volcanism is indicated, at least from Lyell to the Que River (50Km),by pumiceous volcanics and a general lack of interbedded sediments or reworked tuffs.

Black pyritic shales and other sediments are interpreted to occupy tightly folded synclinoria which were once elongate bays or straits between volcanic promontories; the latter now occur in broad anticlinoria. Volcanism appears to have waned while the sediments were depositing, so they may have accumulated metals.

The distribution of chemical types and lithological variants indicates a swarm of small volcanoes in the area mapped (Rosebery-Que River). Andesitic to dacitic volcanics occur to the east, with dacitic to rhyolitic types on the west of the belt. Mineralisation is associated with both types.

Both vein type and volcanogenic massive sulphide type mineralisation occur in the region, but the volcanogenic type is the most attractive target. Favourable geological environments appear to involve proximity to volcanic vents, alteration (variously albitisation, sericitisation, silicification and shearing), decadent stages of volcanic stratigraphy and, usually, proximity

to the west of the Murchison Highway, and the Pinnacles-Chester area held by Comstaff.

Future work should include mapping to test the validity of regional interpretations made, especially those related to the existence of volcanic centres. Extension of the programme throughout the belt is desirable to provide a basis for future ground acquisition.

A wide range of geophysical and geochemical prospecting techniques should be tested on the virgin mineralisation at anomaly 8 before it is significantly disturbed.

HISTORY

A history of the mining activities in western Tasmania is given by Blainey (1954). Base metal mining has been in progress since late last century and is current at Queenstown (Mt Lyell), Rosebery, Tullah (Farrell) and Williamsford (Hercules), but incorrect concepts of ore genesis and very difficult terrain are considered responsible for a lack of significant discoveries since the intensive prospecting days of the last century.

Organised exploration on a regional scale was first applied by Rio Tinto in the late 1950's. Their dominantly geophysical approach was concentrated south of Rosebery. A large number of anomalies were examined without success. Subsequent work by BHP shrank to interest in asbestos in some ultramafics and a JV with Inco on acid volcanics south of Lyell. Long tenure by BHP has restricted the volume of data publicly available on the Mt Read volcanics south of Queenstown.

Most land is now held by operators (EZ, Mt Lyell, Consolidated Gold Fields, Aberfoyle and Pickands Mather), and Comstaff. Active exploration in the last 5 years has attempted mainly to extend knowledge outwards from mines, so that large tracts of country still remain untested.

Exploration by Comstaff has relied heavily on stream sediment geochemistry (covering 200 sq. miles) and they feel that close sample spacings (500 ft) are required.

EM has been generally decried as a useful technique, but CEPL has been able to proceed rapidly to drilling by determination of geochemically anomalous soils adjacent to ground EM anomalies located initially by airborne EM.

The style of regional geology and the unexplored nature of the volcanic belt (including Abex property) justifies continued

LOCATION

The Mt Read Volcanic Belt occupies the eastern margin of the Dundas Trough and extends for 200Km from Elliot Bay on the south-western Tasmanian coast to Deloraine in the northern central part of Tasmania. Attention has been concentrated on that part of the belt between Que River and Queenstown.

This area is served by the Emu Bay Railway, opened in 1900, and the Murchison Highway completed in 1964. The railway now terminates halfway between Zeehan and Rosebery (roughly 30Km apart), whilst the road services Queenstown from the major Tasmanian port of Burnie 100Km to the north.

Rugged mountains up to 3,500ft are dissected by steep valleys and gorges and are mantled with very dense forest of myrtle, sassafras, eucalypt, and native pines. There is an active timber and pulp industry. Examination of the topography and distribution of rivers and major access north of Rosebery reveals several centres of radial drainage.

Road building is difficult even in flat ground, and $10,000 per mile may be a reasonable cost to develop a gravel surface.

Operating mines use Hydro-Electric Commission power and the Commission is currently embarking on a major power scheme in the Mackintosh, Murchison and Pieman rivers north of Rosebery.

OBJECTIVES

A programme was required to clarify the regional setting of specific targets in the Mackintosh property and to develop hypotheses to guide future exploration and ground acquisition in the Mt Read Volcanic Belt.

This programme intended to determine:-

(i) the environment of the volcanism (especially whether it was subaerial or submarine)
(ii) the chemical character of the volcanics
(iii) the distribution and type of associated sediments
(iv) the stratigraphy of the volcanics and sediments
(v) the regional structure
(vi) the distribution and style of mineralisation
(vii) the nature of any alteration in the vicinity of mineralisation.

EXPLORATION AND DEVELOPMENT

Research

During 1973, a thorough study of literature was made in Hobart libraries in order to produce 1" to 1 mile geological compilations.

A large volume of detailed data exists, including geology, geochemistry and geophysics, which could not be compiled at this scale.

Geological Mapping

Work has been confined to the part of the volcanic belt between the Que River and Queenstown.

North of Rosebery, a series of traverses at approximately 4Km separation coupled with preliminary photo interpretation, have been compiled at 1:50,000 scale (Plate DT32). Original data was recorded at about 1:25,000 scale on 1973 CEPL aerial photographs and transferred to 1:25,000 base maps.

Three traverses in the Queenstown area serve for comparison with the Rosebery-Que River district to the north.

Mapping was concentrated on artificial exposures along communication routes. These offered exposures of rocks which might n normally be deeply weathered and hence not amenable to recognition or collection for analysis.

Five hundred and three samples were collected, of which 105 were sectioned. Collection was arbitrary enough to avoid bias towards unusual rocks or resistent outcrops.

At the termination of the mapping programme, a brief aerial inspection of the area north of Rosebery was undertaken to examine possible volcanic centres, trace a sediment boundary and check access problems in an area of interest.

All readily accessible traverses have been completed between Que River and Rosebery. Further mapping should check specific hypotheses or be related to prospects. Additional traversing is possible between Rosebery and Queenstown. Mapping at Mackintosh E East has been limited to assessment of prospects.

The Romulus Pup area lying between the two parts of the Mackintosh property requires reconnaissance mapping, to assess the possible significance of a stream geochemical anomaly. The area is subject to an EL application (Mayday Creek) by CEPL.

Geochemical Work

(i) to provide a group of well documented samples as a control set for hand specimen identification.

(ii) to provide quantitative assessment of the compositional range of rocks in the area.

(iii) to assess any regular distribution of chemistry along or across the belt.

(iv) to compare the chemistry of rocks in the vicinity of mineralisation with those elsewhere in the pile. (Specimens were collected near mineralisation at Queenstown, Rosebery, Williamsford, Pinnacles and anomaly 8, Mackintosh West.)

(v) to check for sodic rhyolites which Sakrison (1970,71) regards as having significance in prospecting.

It was originally intended to analyse only SiO_2, Na_2O, K_2O and CaO, but full silicate analyses were available for a minimal cost increase and offered information on the parentage of altered rocks.

Preliminary classification was made on the basis of SiO_2 content: basic $< 52\%$ SiO_2, intermediate 52-65% SiO_2, acid $> 65\%$ SiO_2.

The ratio (R) $CaO / CaO + Na_2O + K_2O$ was used to distinguish rhyolite, rhyodacite, dacite and andesite:-

rhyolite: 65% SiO_2, $1/3 > R$

rhyodacite: 65% SiO_2, $1/3 < R < 2/3$

dacite: 65% SiO_2, $R > 2/3$

andesite: 52-65% SiO_2, $R > 2/3$

Refined classification was made on the basis of catanorms (AMDEL programme). Firstly, extensively altered or non-igneous rocks were screened out on the following bases:

(i) quartz contents in excess of 40% are incompatible with unaltered igneous rock and indicate silicification or the operation of sedimentary processes.

(ii) total feldspar content must exceed 50% in intermediate or acid igneous rocks, and 40% in basaltic rocks.

(iii) more than 5% corundum indicates extensive sericitisation.

(iv) improbable mineral assemblages, inconsistent with igneous processes.

Rocks which survived this screening were classified on the following criteria:

rhyolite $>10\%$ quartz, either $\frac{Or}{Or + Ab + An} > 2/3$ or plag. comp. less calcic than An_{10}

andesite	$< 10\%$ quartz,	$1/3 > \frac{Or}{Or + Ab + An}$	and plag. comp. less calcic than An_{50}
trachyandesite	$< 10\%$ quartz,	$1/3 < \frac{Or}{Or + Ab + An} < 2/3$,	and plag. comp. less calcic than An_{50}
trachyte	$< 10\%$ quartz,	$\frac{Or}{Or + Ab + An} > 2/3$,	and plag. comp. less calcic than An_{50}
basalt	$< 10\%$ quartz,	N/A	and plag. comp. more calcic than An_{50}

The samples interpreted on this basis as showing essentially original compositions, are composed of:-

7 sodic rhyolites
7 rhyodacites
11 dacites
4 andesites
1 trachyandesite
2 trachytes
1 basalt

Their range of composition and the full range shown by both altered and unaltered rocks in the belt is illustrated on Fig. 1. The suite is calc-alkaline.

In order to investigate whether the sodic character of the rhyolites is a "primary" feature or a product of albitisation, the 33 rocks regarded as showing unaltered bulk compositions were plotted on a Harker variation diagram (Fig. 2); such a diagram generally shows linear or curvilinear patterns for comagmatic rock compositions (the pattern for Fe_2O_3 is shown for comparison). The diagram suggests that 7 of the rocks are unusually rich in Na_2O relative to the general variation trend, consistent with albitisation, but only one of these specimens is a rhyolite. Therefore the sodic character of the rhyolites is interpreted as an original magmatic feature, quite separate from extensive albitisation which has been imposed on many rocks in the belt. Petrographic examination of the 7 rhyolites originally interpreted as unaltered in terms of their normative composition confirms that apparently primary albite grains are present but that specimen 141042 recognised as albitised on the Harker diagram does indeed contain fine grained aggregates of untwinned albite, consistent with albitisation. Sakrison (1970) commented that a sodic (alternatively referred to as low potassic) character is an indication of primitive oceanic magmas.

The interpretation that some of the volcanics may show either a primary (related to magma generation) or a secondary (related to albitisation - perhaps by sea water) sodic character,

lites can be used at detailed scale in base metal prospecting, the existence of extensive sodic rhyolites in the northern half of the Mt Read volcanics indicates that it is equally as favourable for mineralisation as the southern half (if the criterion of sodic character has some real basis and can be extrapolated outside the Canadian Archaean belts).

Examination of thin sections and norms of the 55 substantially altered rocks suggests that 5 have been albitised. 13 altered rhyolites are considered to have a "primary" sodic character. A scan of the Or:Ab:An ratios of these 55 rocks suggests that a total of 24 have been albitised (including the 5 above). This makes a total of 31 albitised rocks including the seven initially considered unaltered.

Thirty-five specimens show more than 5% normative corundum, consistent with substantial sericitisation.

Thirty-eight specimens show excessive normative quartz, mainly due to silicification, but in 5 cases, a partly or wholly sedimentary character is responsible (samples 141592, 141593, 141842, 141255, 141264).

Table 1 lists altered rocks recognised on the basis of normative data. The majority of altered rocks are from mineralised areas. Notable exceptions are:-

141072 (Murchison Highway near Sterling Valley)
141003 (near confluence of Mackintosh and Murchison Rivers)
141014 (Tullah Tramway near Farm Creek)
141040 (at Bulgobac)
141041 (at Bulgobac)
141046 (at Bulgobac)

In terms of inferred parental chemistry, the following generalisations can be made about the rocks occurring near mineralisation.

Lyell: mixed suite of rhyolites, andesites, trachytes and basalts.
Rosebery-Williamsford: sodic rhyolites prominent.
Chester and Pinnacles: sodic rhyolites very prominent.
Anomaly 8: andesites prominent.

Regional compositional variations are apparent. The southern half of the mapped zone (Queenstown area) contains basic rocks and trachytes in addition to andesites and rhyolites, in contrast to the andesitic to rhyolitic compositions encountered to the north (Rosebery-Que River). Rock compositions cluster in a fashion which, when related to other mapping data, suggests discrete volcanic centres each having erupted magma of restricted

apparent distribution of compositions is shown on Plate DT24.

Field attempts at compositional identification have been justified by the analytical data. Comparison of identification by the three geologists involved, with the preliminary analytical data, showed in excess of 70% agreement. Agreement between geologists was even better (85%) since specimens which were mis-identified, tended to be consistently mis-identified. The control set of specimens was used to correct field identifications. All 503 specimens were re-examined by all three geologists.

(b) Trace Element Analyses

No trace element analyses have been made of rock types within the belt except in obviously mineralised locations used for soil orientation studies. The interpretations placed on pyritic black shale beds in some areas indicate that analyses should be made to check whether they have accumulated significant quantities of base metals; sampling is in progress. Studies elsewhere indicate that the matrices of agglomerates should also be analysed, especially for zinc, in order to recognise mineralised vents (> 100ppm Zn is regarded as significant by Sakrison, 1970).

Orientation samples of soils and stream sediments were collected in the course of this project in order to aid in evaluating anomaly 8, Mackintosh West, and to accumulate expertise for future exploration in the belt. Details will be given in the Mackintosh report. The finest fractions of stream sediments show the best contrast and maximum dispersion train; zinc shows the longest dispersion train, lead decays rapidly, and copper is less useful (probably because of low pH). The chemistry of both A and C horizon soils does reflect bedrock but the C horizon samples generally show the best contrast and least displacement and can be collected fairly easily. Spurious enrichment, especially of lead, can be encountered in organic-rich swamp soils.

GEOLOGY

Regional Setting

The Cambrian Mt Read Volcanic Belt is an arcuate feature about 200Km long and up to 20 Km wide, extending from Elliot Bay in south-western Tasmania to Deloraine in the north east (Fig.5) and occupying the eastern margin of the Dundas Trough. The central and western trough is comprised of Upper Proterozoic (?) to Upper

abberan movement (mid-Silurian to mid-Devonian). The northern part is overlain by Tertiary basalt and many parts are obscured by Quaternary fluvioglacial deposits derived mainly from Ordovician Owen Conglomerate.

Several Jurassic dolerite plugs are recorded on the published Mackintosh 1 mile sheet. These should be examined closely since it is possible that some might be Cambrian diorite or dolerite intrusions occupying vent regions.

The origin of the Dundas Trough and the associated Mt. Read Volcanic Belt is a subject of dispute (Fig.3). Campana and King (1963) proposed a rift valley model, whilst Solomon and Griffiths (1972) suggested a subduction zone. Corbett et. al. (1972) objected to the subduction zone theory.

Rock Types

Descriptions of 105 individual rock samples are included in the appendix. The following summarises the general types encountered together with the interpretations that are placed on their origin. The classification used is presented in tabular form on the map legend.

Agglomerates consist of rounded volcanic fragments, coarser than 32mm in intermediate diameter, set in a subordinate matrix of fine rock and crystal fragments and, sometimes, shards or pumice. The coarse fragments are frequently lighter coloured than the matrix material suggesting that they may be more acid but, on the other hand, the darker colour of the matrix may simply reflect more epidote and chlorite formed by recrystallisation of glassy or finely fragmented material; the matter ought to be resolved by chemical analysis. Most agglomerates are not conspicuously polymict although there is some variety in the texture and/or composition displayed. Layered tuff fragments are present in some agglomerates despite their rarity as outcropping primary rock types. Sedimentary fragments are rarely seen. The margins of most large fragments are preserved sharply but in several locations (e.g. anomaly 8 and the Murchison Highway near Mt Block) the margins are blurred as though some recrystallisation or replacement has occurred.

Pumice agglomerates consist of large wispy fragments of generally filamentous pumice set in a matrix of finer pumice; some fragments are flattened but others are essentially uncompressed.

Volcanic breccias are analagous to agglomerates but contain conspicuously angular fragments. Few examples were en-

(>32 mm) is between 5 and 50%. The matrix material of these rocks is pumice or volcanic rock fragments so that they are gradational with lithic tuffs.

Coarse fragmental volcanic rocks can originate by:-

1. brecciation during intrusion or extrusion of solidifying magma.

2. explosive brecciation during the eruption of a volcano.

3. brecciation by gravity slumping after initial solidification of magma or deposition of ash.

The agglomerates, and subordinate breccias, encountered in this project appear to represent subaerially deposited (and therefore unsorted), largely solid fragments of explosively erupted volcanic rock. The rounded nature of most fragments is probably a result of abrasion in the volcanic conduit during fluidised transport and is not a product of aerial rounding of molten splashes. The pumice agglomerates, in contrast, probably represent a foaming eruption of highly gas charged and largely molten magma spilling out of a volcanic conduit.

Lithic tuffs consist dominantly of rounded, but unsorted, volcanic rock fragments, with a range of grainsize between 4 and 32 mm (generally about 10mm), set in a fine grained matrix. Most of the larger fragments appear to have been rounded whilst solid but some examples are encountered where the particles are drop-shaped as though rounded by aerial flight whilst molten. Devitrified shards, as well as fine crystal and rock fragments, are seen in the matrix of some specimens. Pumice tuffs are analagous rocks in which the coarsest fragments are wispy, filamentous pumice set in a matrix rich in shards. Both the lithic tuffs and pumice tuffs rarely show any sorting, grading or banding on outcrop scale which could be interpreted as bedding which must be produced by settling in air or water; outcrops are characteristically quite massive, although weak foliations variously interpretable as tectonic or primary can be seen in some outcrops.

The lithic tuffs are interpreted as ashflow deposits formed by glowing avalanche processes in which fluidised magma or even brecciated solid rock foams over the lip of a volcanic conduit and spills violently down the slopes. The pumice tuffs would represent a glowing avalanche of vesiculating molten magma whilst the lithic tuffs would represent a glowing avalanche of partly solidified magma. Apart from the lack of mesoscopic bedding, the abundance of pumice throughout the area suggests that

cases, quartz set in a fragmental matrix of crystals &/or shards. In many cases, the coarse crystals are subhedral, though often magmatically corroded, and the field decision that the rock is a tuff, rather than a porphyritic flow, may rest on the discovery of a few rock fragments mixed with the crystals. In general the rocks are quite massive and devoid of recognisable bedding.

The origin of crystal tuffs is enigmatic since few processes can be envisaged to permit separation of phenocrysts from their host magma during eruption. Sorting during settling through air or water might achieve a separation of crystals from larger rock fragments but mesoscopic bedding should be conspicuous in this situation. On the other hand, Branch (pers. comm.) has observed crystal tuff in North Queensland which is quite gradational with ashflow tuff (the matrix material contains minor well developed glass shards) and similar rocks have been recorded in the Taupo volcanics. The discovery of inverted chemical differentiation patterns in some New Zealand ashflows led Ewart and Stipp (1968) to postulate that ashflow eruptions can record progressive emptying of a magma chamber which has previously commenced fractionation by crystal settling; thus, crystal tuffs may represent fluidised eruption of a crystal mush collected by gravity settling in the base of a subvolcanic magma chamber. Therefore, the presence of poorly bedded crystal tuffs in an area suggests that a "quiet" period of crystallisation has preceded their eruption by an ash flow mechanism.

Vitric tuffs are rare in the Mt Read volcanics. They consist dominantly of glass shards, now devitrified. They could originate by settling through air or water, or by ashflow mechanisms but are certainly not reworked. Devitrification and tectonic deformation inhibit recognition of welding which would characterise most ashflow material.

Many rocks are transitional between lithic, crystal and vitric tuffs confirming an overlap in their origins.

Some slump breccias composed of fragmental volcanic material and shale occur just above the base of the Que River Beds. These are interpreted as submarine slumps or lahar-type deposits. West of the Que River bridge and on the road to anomaly 8 fragments of massive sulphide are mixed with the other fragments.

A few "porphyries" and massive structureless volcanics are encountered in which no fragmental features can be seen. These

recognisable lava flows. One of the few examples is a flow-banded rhyodacite within the Mount Lyell leases. No pillow lavas have been recorded. Branch (1971) states that "in acid lavas flow-banding is generally ubiquitous" so that this observation taken together with the plainly fragmental nature of most outcrops within the Mt Read volcanics makes it unlikely that we have wrongly estimated the scarcity of lavas. It seems that particularly gaseous ashflow or explosive eruptions must have characterised the belt.

In prefixing compositional names to the textural varieties described above, attention was paid to the types of phenocrysts, and the colour and hardness of the rock. Control was provided by 88 analysed samples.

Reworked tuffs consisting of partly rounded and sorted crystal and lithic debris are encountered in a few locations, sometimes but not always, in association with shale or immature sandstones. These rocks are important in establishing aqueous environments essential for ore formation since the bulk of the volcanics encountered are interpreted as subaerial deposits.

Black shale is conspicuous in the Que River Beds and the Farrell Slates. It is frequently finely laminated and contains sulphide rich bands. The persistent fine laminations are consistent with deposition in deep water, but the abrupt transition from underlying pumice tuff, interpreted as a subaerial deposit, to laminated black shale interbedded with tuffs and reworked tuffs suggests that it can represent a fairly shallow environment. Most of the shale has probably been deposited in bays or straits between volcanic chains during a submergent, decadent stage. A thin shale unit occurs in volcanic rocks overlying the Rosebery mineralisation.

Greywackes and sandstones occur immediately to the west of the volcanic belt and as facies variants within the Que River Beds and Farrell Slates. They contain crystal fragments derived from the volcanics but also grains of muscovite and microcline which must have originated from Precambrian basement. Whilst the rocks are immature in mineralogy, they are fairly well sorted and commonly show cross-bedding, features which are consistent with shallow water deposition in an area of rapid erosion rather than deep water deposition by slumping (as generally implied by use of the term greywacke).

pyroclastic vent-type eruptive centres. Individual volcanoes are interpreted to be 5-10 Km diameter at their present level of exposure. The intermingling of the products from adjacent centres makes it unlikely that a classical column can be deciphered. Fig. 6 shows the geology of Ruapehu, Ngauruhoe and Tongariro volcanoes (Taupo Volcanic Zone, N.Z.) and is indicative of the complexity of shapes, distribution and angles of rest which the products of volcanism may assume.

Despite weathering, fluvioglacial cover, thick vegetation and structural deformation, the recognition of depositional environments and local chronology is possible.

The abundance of unsorted pumiceous tuffs and the scarcity of interbedded sediments indicate that most of the volcanism was subaerial. However, submergence to produce shallow marine or bay conditions towards the end of the volcanic cycle is indicated by interbedded shales, sandstones and volcanics such as the Que River Beds and the Farrell Slates. Comparison can be made between the hypothetical cross sections proposed to illustrate stages in the formation of the Mt Read Volcanic Belt (Plate DT28) and the volcanogenic model proposed by Hutchinson (1973) for generation of massive sulphide deposits (Fig. 7).

The various opinions on the age of the Mt Read volcanics and their relationship to the sediments are available from the papers referred to in the first section of the bibliography. Carbonaceous shales of the Que River Beds in the northern part of the volcanic belt contain agnostid trilobites of upper Middle Cambrian age (Gee et al., 1970) and limestone recovered from drill core at Lyell Comstock near Queenstown contains trilobites and other fossils of late Middle Cambrian or early Upper Middle Cambrian age (Jago et al., 1972). The Comstock fossils occur interbedded with volcanic rocks but unconformably overlie most of the volcanics in the Queenstown area. The Que River fossils also occur interbedded with minor volcanic rocks but this investigation indicates that they mark the uppermost part of the volcanic sequence in that region. Thus, it is likely that the bulk of the Mt Read volcanics are older than upper Middle Cambrian, a view shared by Corbett et al., (1974).

It is thought that the volcanics investigated north of Rosebery do not belong to the Comstock Tuffs which form part of the Tyndall Group. Despite the fact that the Comstock Tuffs are known to extend at least 27 Km north from Lynchford, CEPL mapping and discussion with Lyell geologists indicates that these tuffs are small in volume. They are conspicuously different from

presumably marks a pause in volcanism. Additional interpretation would be possible if the angular relationships across the unconformity were known; for instance, small or non-existent angular discordance would indicate only limited erosion and thus date the mineralisation as upper Middle or lower Upper Cambrian.

Corbett et al (1974) have proposed a stratigraphic-palaeogeographic model to explain the relationships between constituents of the Mt Read Volcanic Belt and the Dundas Trough (Fig.4) in the Queenstown area. Their description of the volcanics is as follows:-

"(i) a central and partly older 'core' consisting predominantly of rhyolite flows and rhyolitic porphyries, with probably the oldest rocks represented by the bodies of massive, pink Darwin-type rhyolite ('Darwin Keratophyre'); (ii) a flanking unit consisting predominantly of pyroclastics (ash falls, ash flows, agglomerates) with intercalated sediments, minor lavas and rhyolitic and andesitic intrusives, which is best developed on the western side of the belt ('Queenstown Pyroclastics' in this paper); and (iii) the Tyndall Group of rocks, which appear to be unconformable or disconformable on all previous units, but which constitute only a small proportion of the total volcanic pile. There is some evidence to suggest that the andesitic intrusives, which appear to be restricted to the Queenstown-Tyndall area, could be genetically related to the Tyndall Group pyroclastics.

The rhyolitic core appears to plunge towards Mt Lyell from both the south and north, with the Lyell area itself largely buried under pyroclastics. The Mt Lyell mineralisation (pyrite, Cu-sulphides) appears to occur near the inter-fingering boundary between the rhyolites and the pyroclastics, or possibly in the upper part of the rhyolite pile....., while the zinc-lead-silver mineralisation of Rosebery and Hercules occurs within the shale horizons in the continuation of the Queenstown Pyroclastic Belt. The Darwin-type rhyolites, in the centre of the rhyolite core, carry haematite-magnetite-(barite) veins and minor sulphides, with copper mineralisation associated with chloritised zones in the Jukes-Darwin area."

Alteration

Recognition of hydrothermally or pneumatolytically altered zones is hindered by widespread recrystallisation of the originally finely fragmented and often glassy matrices of the pyroclastic rocks to mineral assemblages consistent with lower

have been altered to sericitic and chloritic schists varying in texture and composition according to the original composition of the rocks and the intensity of alteration. These altered rocks have been known as the "Lyell Schists" for some time (Solomon & Elms, 1965). Outside the mineralised zones, the rocks show their original pyroclastic textures much more readily.

Similar alteration is conspicuous in an extensive mineralised zone extending between the Williamsford and Rosebery Pb-Zn deposits where the pyroclastic rocks have been sericitised, chloritised, kaolinised, albitised, silicified and sheared to produce the'Rosebery Schists'. Again, rocks away from the mineralised zone reveal only minor metamorphic foliation and greenschist facies minerals developed in the matrix material of plainly recognisable pyroclastic rocks. An even more striking feature is that within the Rosebery Mine and on the access road to Mt Read, the altered rocks can be observed to be confined stratigraphically below largely unaltered pyroclastic rocks including prominent tuff agglomerate.

The interpretation we place on the Rosebery Schists is that they may represent a large tract of rocks altered by fumarolic activity and sporadically mineralised during a quiescent volcanic period. Extensive kaolinisation and sericitisation would have rendered the rocks very responsive to the subsequent structural and mineralogical adjustments imposed by the Tabberabberan orogeny. The "massive pyroclastics" overlying the "schists" probably represent a resumption of active volcanicity and, not having been subjected to appreciable fumarolic alteration, these rocks have not responded as readily to subsequent metamorphism. The outcrop extent of the Rosebery schists is large, but quite comparable to the extent of present day fumarolic fields.

Sericitisation is conspicuous in the host rocks exposed by trenching in the Pinnacles Pb-Zn prospect. It is probable that some form of alteration is displayed in the nearby Thomas Tunnel since the walls are composed of very rotten amorphous volcanic material even though it penetrates well below depths at which local experience indicates coherent identifiable rock should be encountered. Dump material includes fresh sericitic host rock essentially identical to that seen in the Pinnacles trench.

Rocks sericitised and silicified to a sufficient extent to largely obliterate their original textures, have been recorded in outcrop and pits within anomaly 8.

Albitised pyroclastic rocks have been noted between the Pinnacles and Chester Pyrite Mine (abandoned), several miles

Structure

In addition to CEPL mapping, a selection of reliable information was gleaned from government mapping and other sources.

In the area of immediate interest between Williamsford and Que River, the volcanics are exposed in three major anticlinoria plunging north, the easternmost one resting on Precambrian basement and the two western ones occurring on unknown, but possibly oceanic, basement. The intervening synclinoria are occupied by the Que River Beds and Farrell Slates which mapping indicates are stratigraphic equivalents younger than the volcanics. Folding within the volcanics appears to be of an open simple style, whereas folding in the Que River Beds and Farrell Slates is of a tightly appressed and sometimes overturned style. The main mass of sediments west of the Mt Read volcanics also exhibits tight, frequently overturned folding, with the axial planes dipping west. (Plate DT29).

Major faults are considered to bound the main mass of the volcanics in the Tullah area. The western margin is apparently faulted from Pinnacles south to Rosebery, while the eastern margin is complicated by linear strike faulting in the Mackintosh valley north east of Tullah, possibly an extension of the Henty Fault. Drilling near Pinnacles is claimed to have demonstrated that the western fault dips east at 20^{o}.

Faulting on the eastern side of the belt prohibits westward extrapolation of the base of the volcanics from the only known outcrops occurring in the Mackintosh East property, so the interpretation of the thickness of the volcanics becomes subjective.

Mineralisation

Relevant references on mineralisation in the Mt Read Volcanics are listed in the bibliography. Massive volcanogenic sulphide deposits of lead, zinc, copper and iron within altered pyroclastic rocks characterise the operating mines at Rosebery, Hercules and Lyell. The Farrell Mine shows a similar range of mineralogy to the volcanogenic mineralisation, suggesting a related origin, but consists essentially of galena veins in black slate. Minor mineralisation, some of which has been exploited previously for silver and lead, is scattered throughout the belt and appears to represent both vein and massive volcanogenic types.

FINANCE

Expenditures Periods 1/74 to 8/74 inclusive.

CODE:		
	1400 Geology	19,866
	1700 Survey	402
	2600 Geochemistry	2,186
	6100 Tenure	911
	2000 Geophysics	2,160
		$25,525

Redissection

Accommodation	672
Communications	398
Transport	3,611
Salaries	12,299
Administration Charges	3,250
Geochemistry	478
Geophysics	115
Geological Items	1,110
Contractors	3,079
Tenure	134
Equipment	379
	$25,525

CONCLUSIONS

1. Between the Que River and Williamsford the volcanism is dominantly subaerial, consisting of ashflow type deposits erupted from local vents. Subaerial volcanism is also significant near Queenstown but interbedded sediments are conspicuous.

2. The volcanics are calc-alkaline and include basalts, trachytes, andesites, trachyandesites, dacites, rhyodacites and rhyolites. Acid rocks are the most common. The southern half of the belt contains the basalts and trachytes; north of Rosebery, the westernedge of the belt contains abundant sodic rhyolite, whereas the eastern portion is dacitic to andestic.

3. Two belts of sediment designated the Que River Beds and the Farrell Slates are considered to be equivalents. Both are rich in black shales but contain interbedded tuffaceous beds and immature sandstones.

Reworked tuffs occur in a few locations without any associated shale or sandstone and are important as indicators of local subaqueous environment.

4. The Que River Beds and Farrell Slates with their interbedded tuffs overlie most of the volcanics and mark a waning stage of volcanism. The combination of black shales and waning volcanism favours metal sulphide accumulation.

5. The distribution of volcanic lithologies and gross structures indicate the presence of volcanoes about 5-10 Km in diameter, at their present levels of exposure, occupying the cores of anticlinoria. Synclinoria are occupied by the Que River Beds and Farrell Slates. The volcanic pile is probably 3,000 to 3,500 metres thick in the Que River-Rosebery region.

6. The Rosebery, Williamsford and Lyell mineralisation is of the massive volcanogenic sulphide style but the Farrell mineralisation is a vein type of uncertain age (similarities in both gangue and ore mineralogy suggest it may be remobilised volcanogenic material).

Most reported mineral occurrences appear scattered and of vein type, especially those in the Stirling Valley, but their distribution may become more significant when the strat-

in shear zones. Probably the alteration is related to surface fumarolic activity weakening the rocks and rendering them responsive to later deformation and recrystallisation.

8. The programme has confirmed that the Mackintosh-Hatfield properties are comprised of volcanics and sediments with potential for base metal occurrences.

9. Mapping at Mackintosh East (EL 2/70) indicates that a thin veneer of volcanics is lain on the pre-Cambrian Tyennan geanticline. These volcanics could be regarded as basal and therefore unlikely to contain mineralisation, which is characteristically associated with the decadent volcanic phase.

It is possible that Cambrian sediments equivalent to the Que River Beds occur under or adjacent to Ordovician cover at Mackintosh East, constituting a more prospective stratigraphic level, but this possibility is completely untested.

RECOMMENDATIONS

Volcanogenic massive sulphide deposits, similar to Rosebery, offer the best targets. Vein type mineralisation, similar to Farrell, may occur in the region but these deposits are less predictable in setting and smaller in size, making them unattractive targets.

Present models for the generation of volcanogenic massive sulphide deposits stress deposition of fumarolic exhalations in subaqueous environments. Thus emphasis must be placed on:-

(i) Stratigraphy

It is important to identify decadent phases of volcanism when fumarolic activity is most likely to be developed and preserved. These stages are marked by increased deposition of sedimentary rocks or by unconformities.

(ii) Volcanic Vents

These need to be identified because fumarolic activity is generally thought to be most intense in their immediate vicinity.

They can be identified variously by:-

concentric distribution of agglomerates
vent breccias
intrusive plugs or magma chambers

(iii) Fumarolic Activity

Ancient fumarolic activity may be expressed as:

sheared and recrystallised rocks

chemical sediments

enrichment in elements or minerals released by fumaroles

(iv) Subaqueous Environments

Deposition of at least some mud, sand or reworked tuff is to be expected in a subaqueous volcanic environment.

Plates DT32, DT30 and DT24 indicate with varying degrees of licence our present understanding of these features and it is recommended that the general interpretations be tested by selected traverses and photo interpretation. Tenure interest should be concentrated on these areas depicted on Plate DT24 as having the most favourable combination of stratigraphy, proximity to vents, alteration and subaqueous depositional environment.

As demonstrated by successful drilling at anomaly 8, Mackintosh West, airborne EM and stream sediment geochemistry together with geological mapping, are suitable reconnaissance techniques. Soil geochemistry based on C-horizon sampling and ground EM are practical and offer good definition of drilling targets. Geochemistry is essential to confirm EM targets since there is a possibility of large barren pyrite bodies similar to the Chester deposit. A-horizon soil geochemistry does reflect bedrock but is not recommended because of lower contrast, more diffuse dispersion patterns, and spurious enrichment by organic processes in some soils.

Areas which have attracted special interest during this project and deserve investigation are:-

(a) Pinnacles-Thomas Tunnel: Known Pb-Zn mineralisation in volcanics is not being actively explored. Comstaff are current licence holders.

(b) Along the Murchison Highway, south of the Que River, black shales are interbedded with volcanics. Pyrite is known and a strong airborne EM anomaly occurs at the very ends of Paringa's 1972 survey lines. Comstaff control adjacent ground.

(c) Romulus Pup area: A Paringa stream sediment anomaly is recorded. Mackintosh 1 mile geology map indicates Cambrian volcanics. CEPL has applied for an exploration licence.

The mineralisation at anomaly 8 should be used before it is excessively disturbed to conduct comprehensive orientation studies of geophysical and geochemical techniques

required for sediment sampling. Evaluation should be made of Applied, Induced and Self Potential and magnetic surveys as techniques for drilling target delineation. Silver in soils and mercury in soil gas (using long term collectors implanted in auger holes during dry weather) or bedrock should be investigated for efficiency in delineating drilling targets.

The content of zinc and other metals in agglomerate matrices should be investigated as a guide to mineralised volcanic vents.

The copper, lead and zinc content of any black shales or limestones should be investigated to detect any significant enrichment.

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ATTACHMENTS

A. Text Figures

1. Na_2O, K_2O, SiO_2 and Al_2O_3 Histograms.

2. Harker Diagram of Na_2O and Fe_2O_3 vs. SiO_2 for 'unaltered' rocks.

3. Various models postulated for the origin of the Dundas Trough (Corbett, Jago, Banks, 1972).

4. Stratigraphic-palaeogeographic Model of the Dundas Trough (in the Queenstown area) (Corbett et al. 1974 in press).

5. Palaeozoic Elements of Western Tasmania (Corbett, 1969)

Hutchison, Econ. Geol. Vol.68 1973)

B. Table 1. Summary of interpretation of Catanorms.

C. Plates

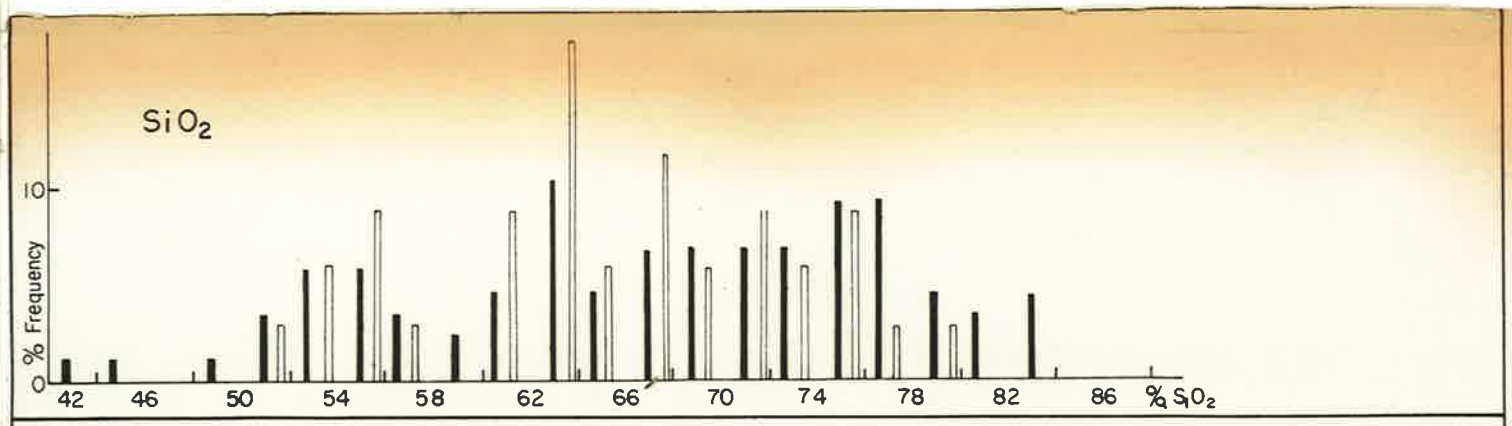
DT28	1:10,000 Diagrammatic Cross Sections
DT32	1:50,000 Fact Geology, CEPL mapping
DT37	1:50,000 Fact Geology, CEPL mapping
DT30	1:50,000 Interpretive Geology
DT29	1:50,000 Geological Cross Sections in the Que River-Bulgebac and Queenstown area.
DT24	1:100,000 Speculative Conceptual Map
DT26	1:100,000 Dundas Trough Summary Map

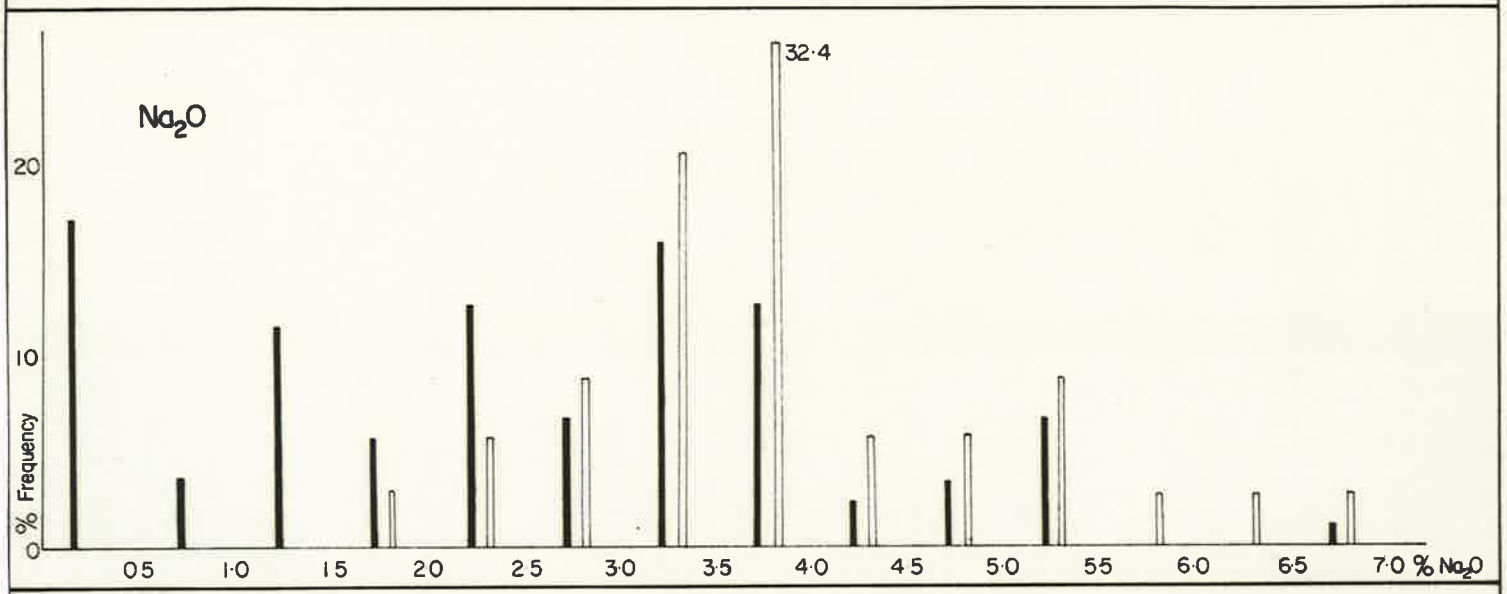
D. Appendix. Descriptions of thin sections, with chemical and normative data, (by A.S.Joyce).

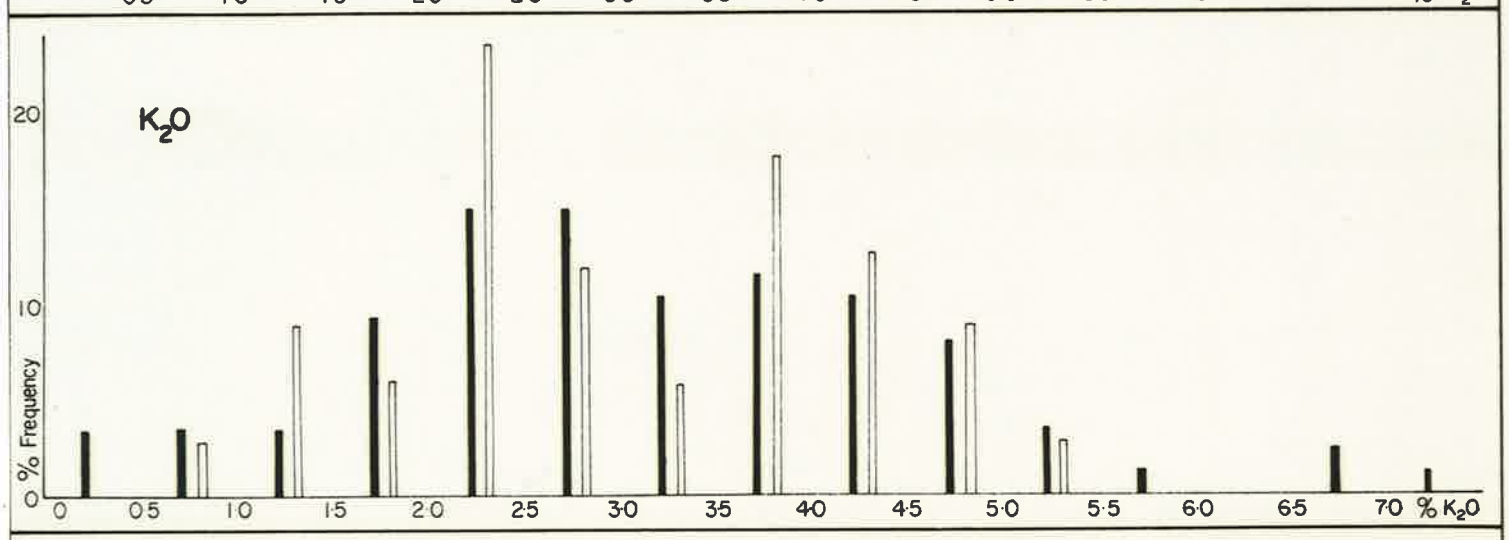
E.W.Batchelor

A.S.Joyce

E.H.Skey







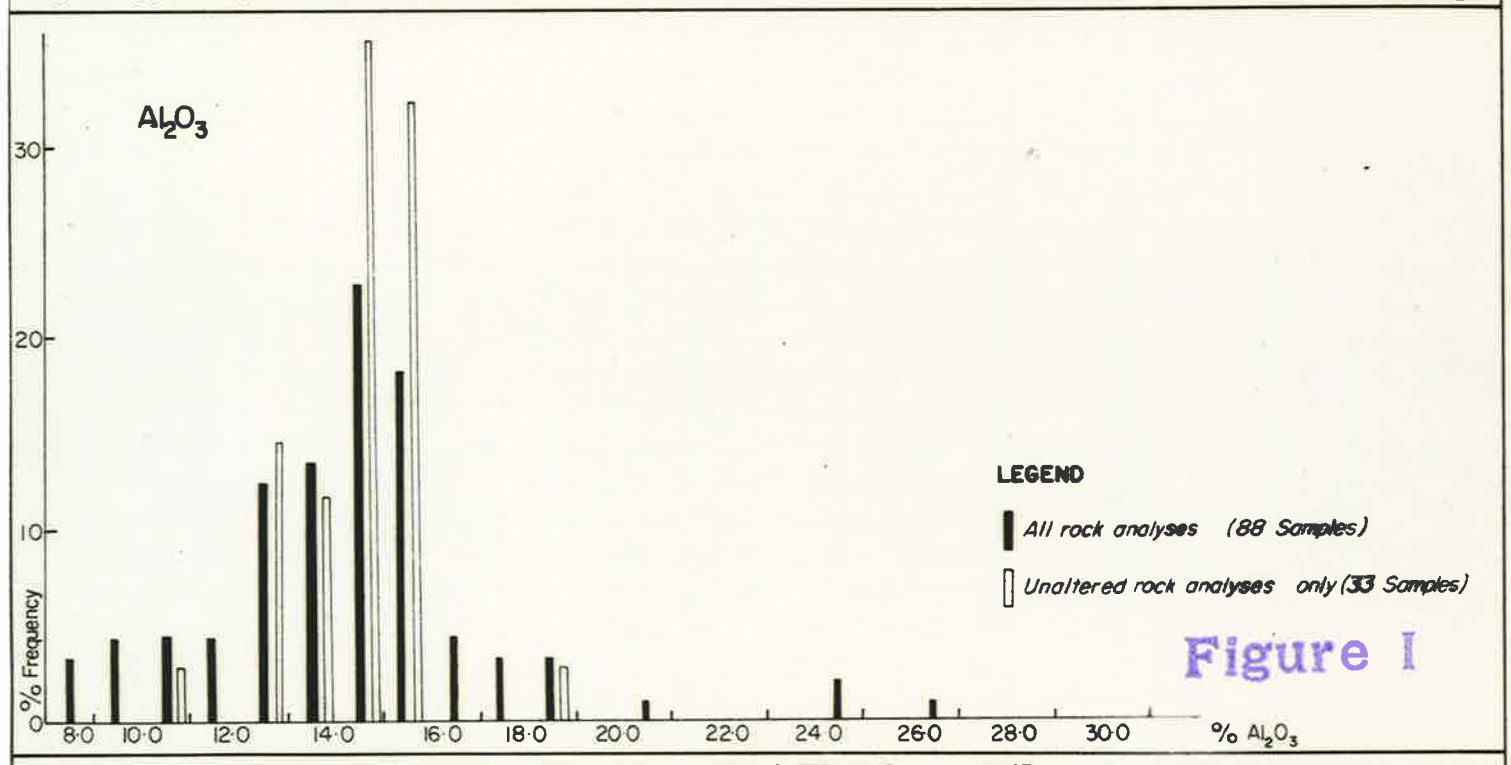
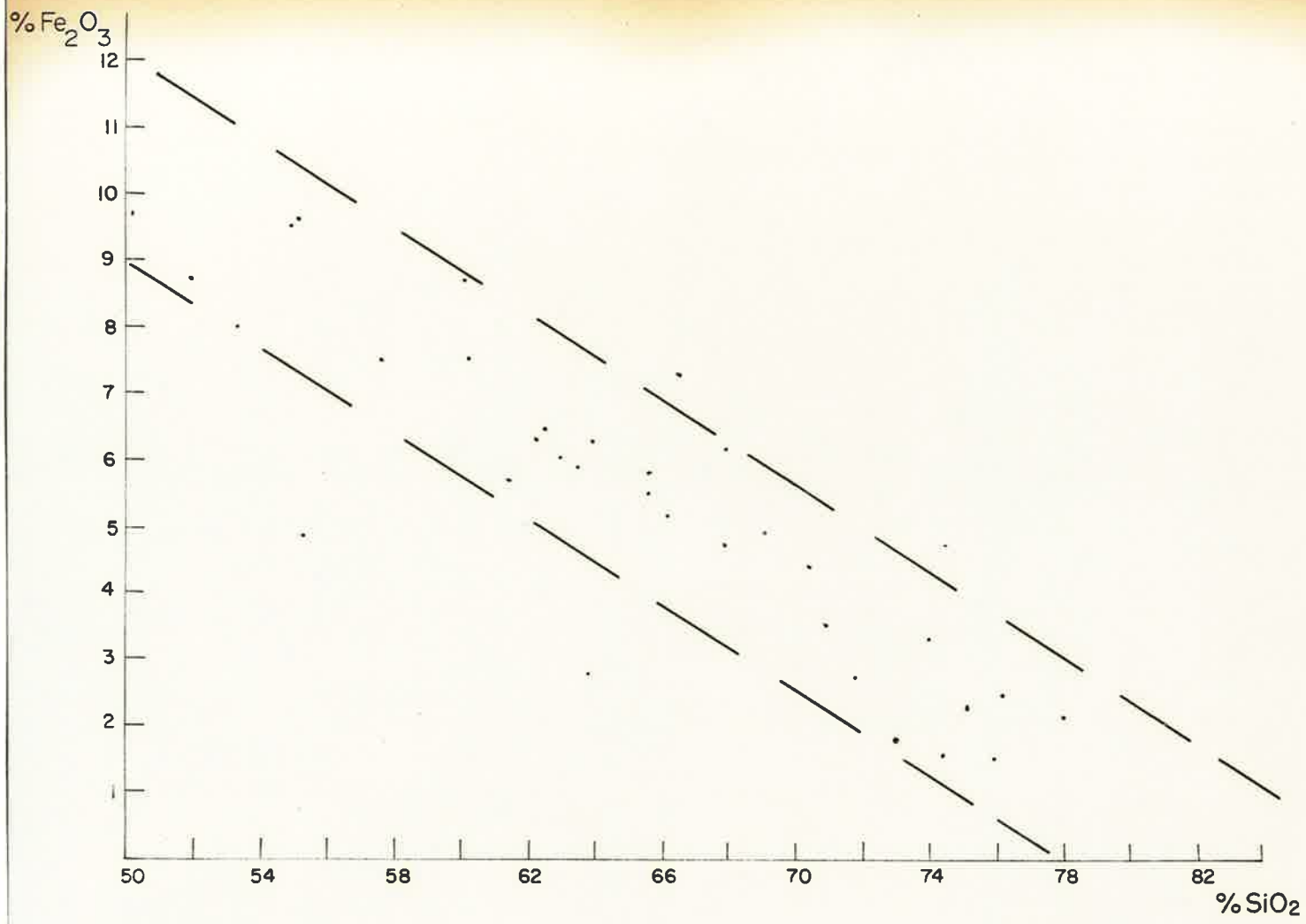


Figure I

COMINCO EXPLORATION PTY. LTD

DRAWN BY:	TRACED BY: LML	NORTH WEST TASMANIA DUNDAS TROUGH PROJECT SiO_2, Na_2O, K_2O, Al_2O_3, Histograms	
CHECKED BY:	Revised by / Date		
Location code: K55/6/44	Scale:	Date: APRIL 1974	Plate: D.T.25



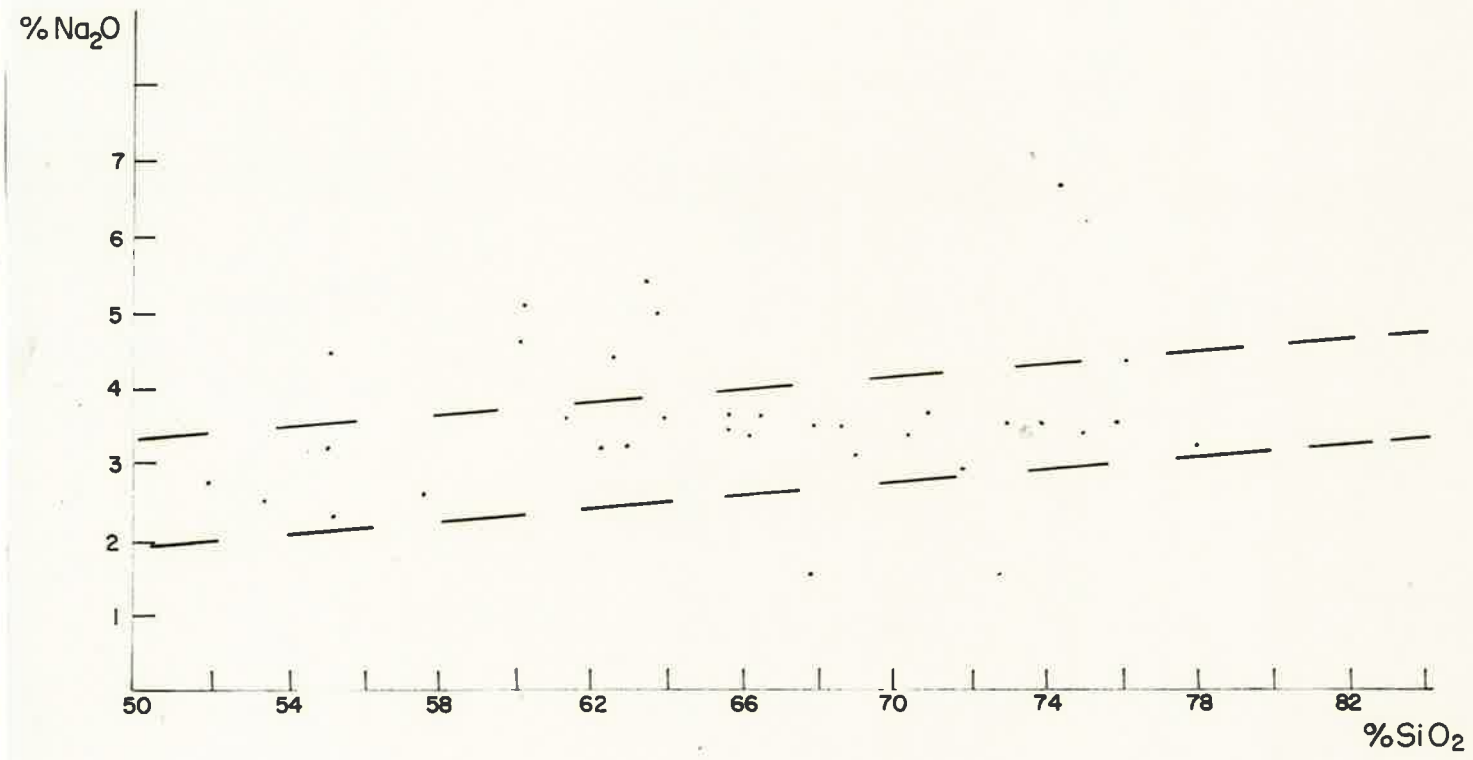


Figure 2

COMINCO EXPLORATION PTY. LTD.

DRAWN BY:	TRACED BY:		NORTH WEST TASMANIA
CHECKED BY:	REVISED BY	DATE	DUNDAS TROUGH PROJECT
REVISED BY / DATE			Harker variation diagrams for the specimens classified as "unaltered" on the basis of their norms
Location code:	Scale:	Date: APRIL 1974	Plate: D.T. 33

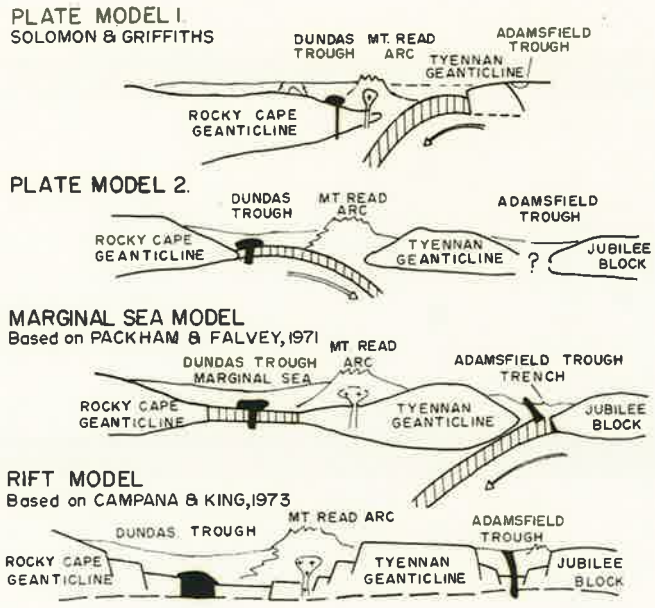


FIGURE 3 (Corbett, Jago, Banks, 1972).

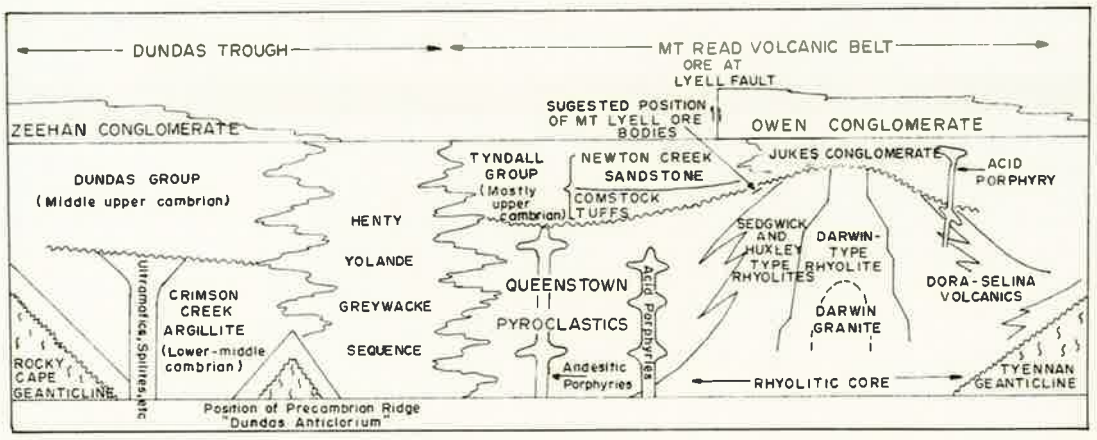


FIGURE 4 (Corbett et al 1974, in press).

Figure 3 and 4

COMINCO EXPLORATION PTY. LTD.

DRAWN BY:	TRACED BY: P.F.	NORTH WEST TASMANIA	
CHECKED BY:	REVISED BY / DATE	DUNDAS TROUGH PROJECT	
REVISED BY / DATE		FIGURE 3 and FIGURE 4	
Location code: K55/6/44	Scale:	Date: APRIL 1974	Plate: DT 27

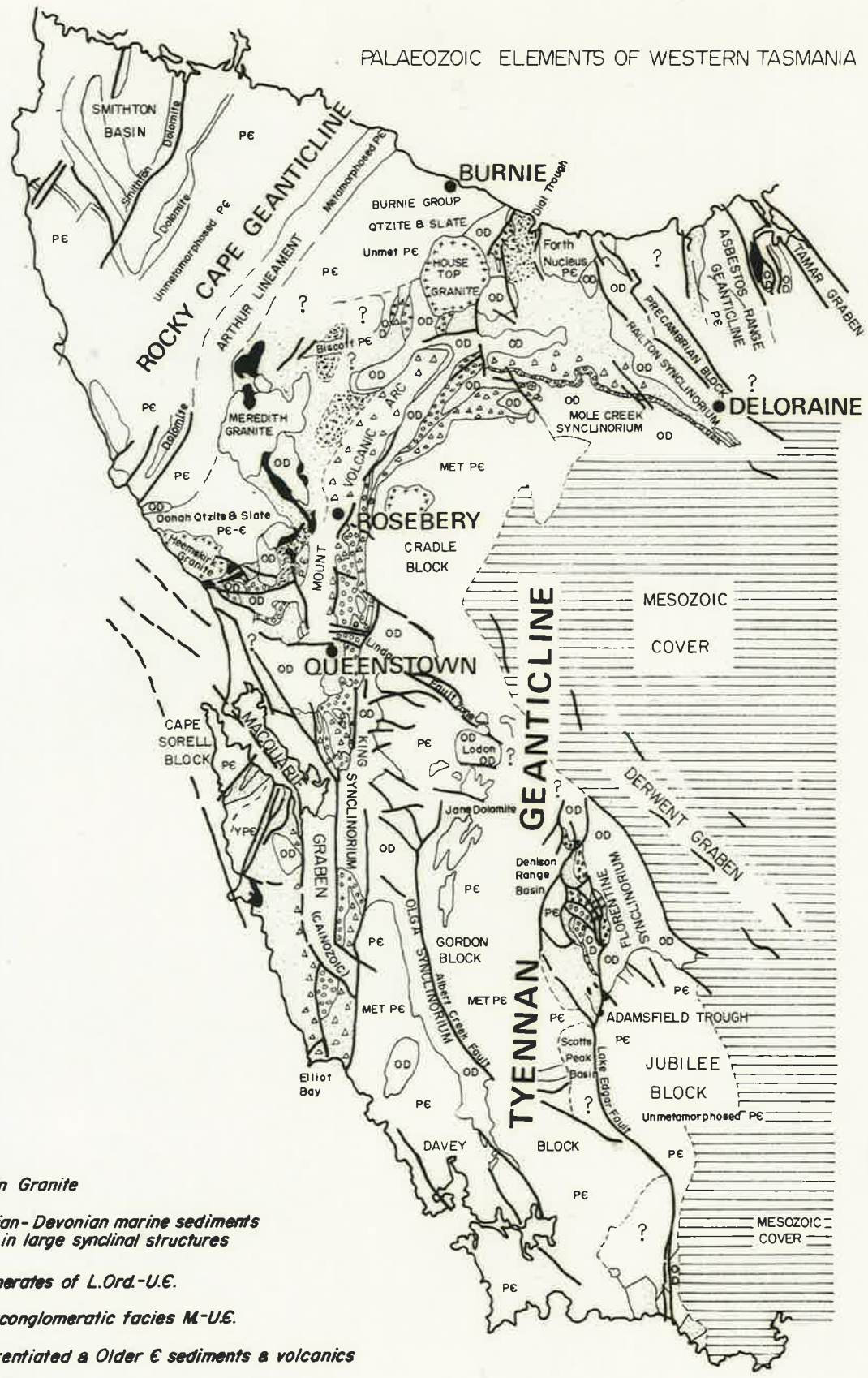


Figure 5

COMINCO EXPLORATION PTY. LTD.

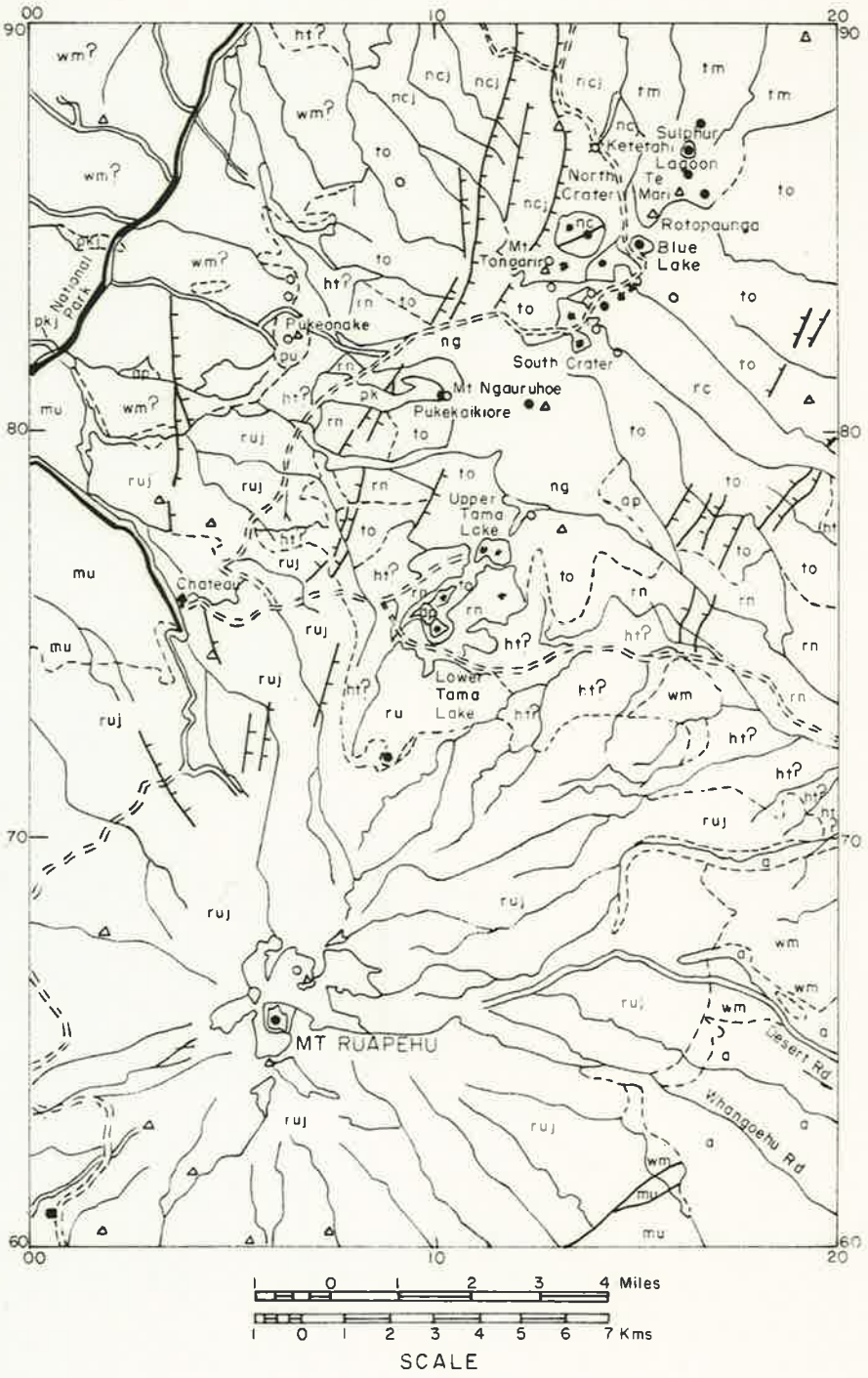
DRAWN BY:	TRACED BY:	
CHECKED BY:	REVISED BY	DATE
REVISED BY / DATE		

Palaeozoic Elements of Western Tasmania

(Compiled Corbett 1969 from various sources)

FIG. 5.

Location code:	Scale: See Scale Above	Date: APRIL 1974	Plate: D.T. 31



ap	Andesitic and pumice alluvium Young lahars from Ruapehu
a	Ruapehu Andesite Andesite ash from 1945 eruption
ng	Ngauruhoe Andesite Plagioclase - pyroxene andesite flows
tm	Te Mari Andesite Olivine - andesite flows
rc	Red Crater Andesite Olivine andesite flows
pk	Pukekaikiore Andesite Olivine andesite flows
nc	North Crater Andesite Plagioclase - pyroxene andesite flows
ru	Ruapehu Andesite Plagioclase - pyroxene andesite flows
mu	Murimotu Lahars Andesite breccias, lahar mounds
ht	Hautapu Lahars Andesite breccias of lahar origin
wm	Waimarino Lahars Andesite breccias, - Ruapehu ring plain
ncj	North Crater Andesite Pyroxene andesite flows
pu	Pukeonake Andesite Olivine andesite lapilli and block beds
pkj	Pukekaikiore Andesite Olivine andesite flows
ruj	Ruapehu Andesite Plagioclase andesites and plagioclase - pyroxene andesites
rn	Rangipo Lahars Andesite breccias, pyroclastics, and till - Tongariro ring plain
to	Tongariro Andesite Plagioclase and hornblende andesites

Active fault
Downthrow shown by bar

Geological contact
Dashed where indefinite

Explosion - collapse crater

Dormant or extinct vent

Active volcanic vent
(post glacial eruption)

Hot Springs

Excursion route

Road

Track

Trigonometric Station

Hotel

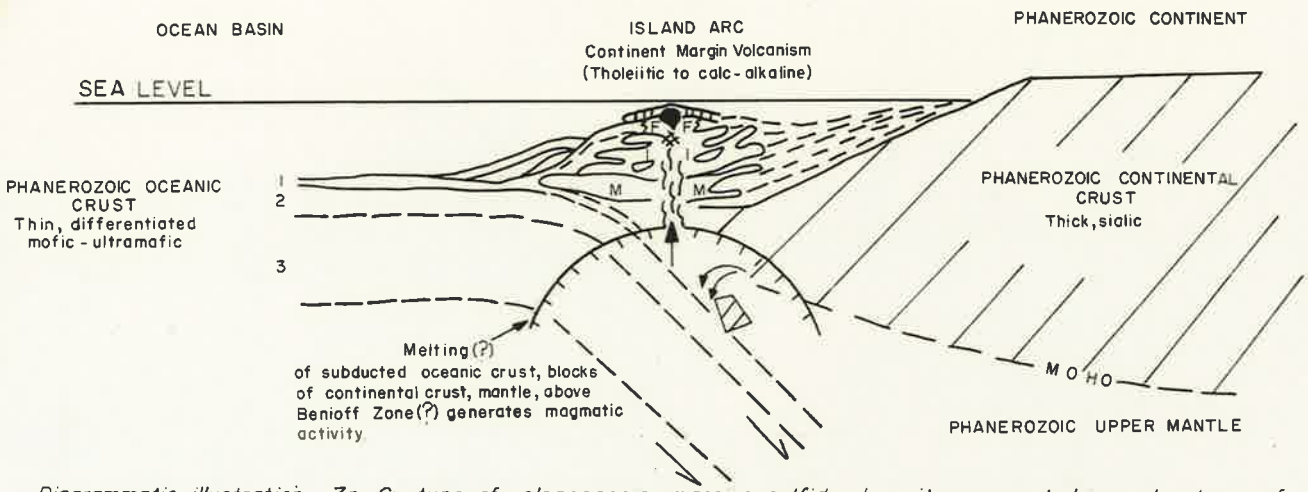
Hut

Note Geological map of the National Park volcanoes showing the main eruptive centres, volcanic formations, colluvial deposits and fault pattern. Based on mapping by G W Grindley and W.H Mathews

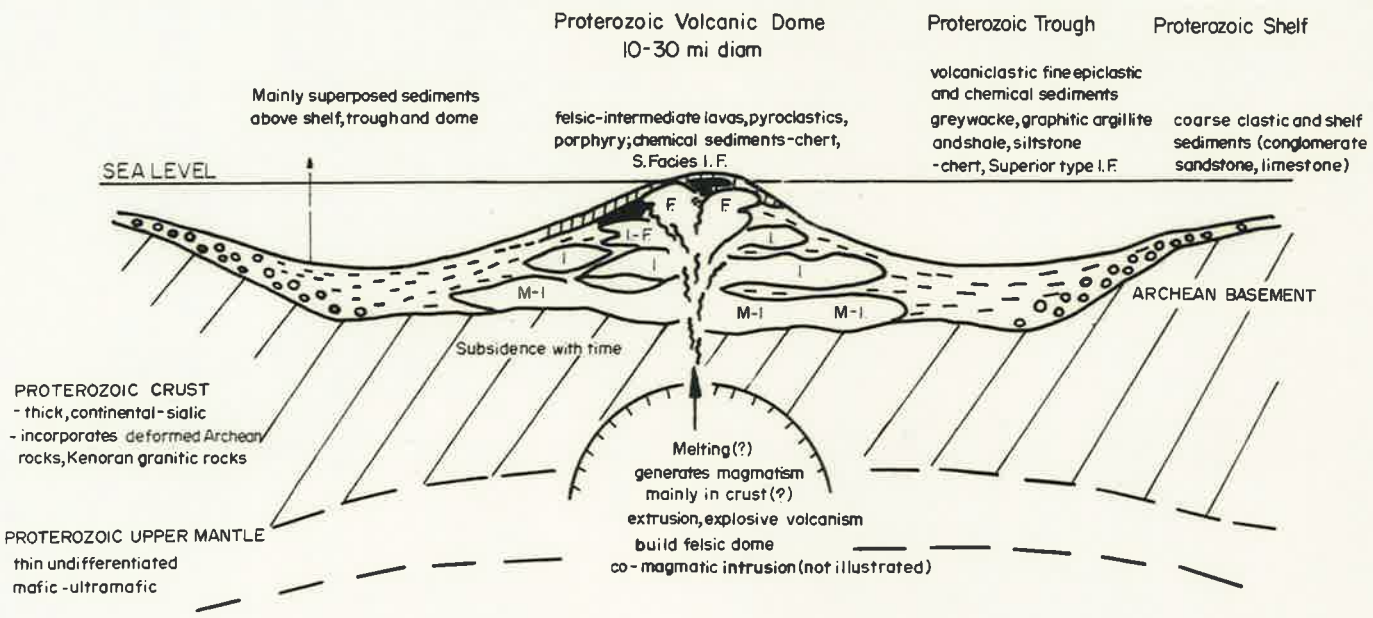
Figure 6

COMINCO EXPLORATION PTY. LTD.

Drawn by	Traced by: P.F.	REVISED BY	DATE
Checked by			
REVISED BY / DATE			
	DUNDAS TROUGH PROJECT		
	FIGURE 6		
Location code:	Scale	Date: April 1974	Plate: DT 34



Diagrammatic illustration: Zn-Cu type of volcanogenic massive sulfide deposit regenerated in early stage of Phanerozoic continent margin mobile belt.



Diagrammatic illustration Pb-Zn-Cu-Ag type of volcanogenic massive sulphide deposit in Proterozoic tectonic setting From Hutchinson, Econ Geol. Dec. 1973

- *Iron Formation - sulphide facies*
- *Pb-Zn-Cu-Ag body*
- *sediments - fine epiclastic, volcaniclastic, chemical*
- *sediments - coarse clastic*
- F — *felsic volcanics - endogenous dome*
- I — *intermediate volcanics*
- M — *mafic volcanics*
- 1 — *oceanic layer - deep sea sediments*
- 2 — *oceanic layer - basalt*
- 3 — *oceanic layer - mafic-ultramatic intrusions.*

Figure 7

COMINCO EXPLORATION PTY. LTD.

DRAWN BY:	TRACED BY		DUNDAS PROJECT FIG. 7		
CHECKED BY:	Revised by	Date			
Revised by / Date					
Location code:			Scale: See Scale Above	Date: APRIL 1974	Plate: D.T. 35

		(Na_2O/SiO_2)
141055	Sodic rhyolite	
141060	Sodic rhyolite	
141061	Andesite	
141063	Sodic rhyolite	
141064	Andesite	Albitised
141065	Dacite	
141066	Rhyodacite	
141068	Dacite	
141034	Dacite	
141031	Basalt	
141042	Sodic rhyolite	Albitised
141043	Sodic rhyolite	
141048	Rhyodacite	
141080	Rhyodacite	
141109	Rhyodacite	
141104	Trachyandesite	
96039	Dacite	Albitised
141004	Rhyodacite	
141005	Dacite	
141006	Sodic rhyolite	
141008	Dacite	
141009	Rhyodacite/dacite	
141010	Dacite	Albitised
141011	Dacite	
141012	Dacite	
141013	Sodic rhyolite	
141159	Andesite	
145060	Andesite	
95877	Dacite	
141587	Trachyte	Albitised
141844	Dacite	Albitised
141250	Rhyodacite	
145062	Trachyte	Albitised

B. Altered volcanics (based on norm interp.)

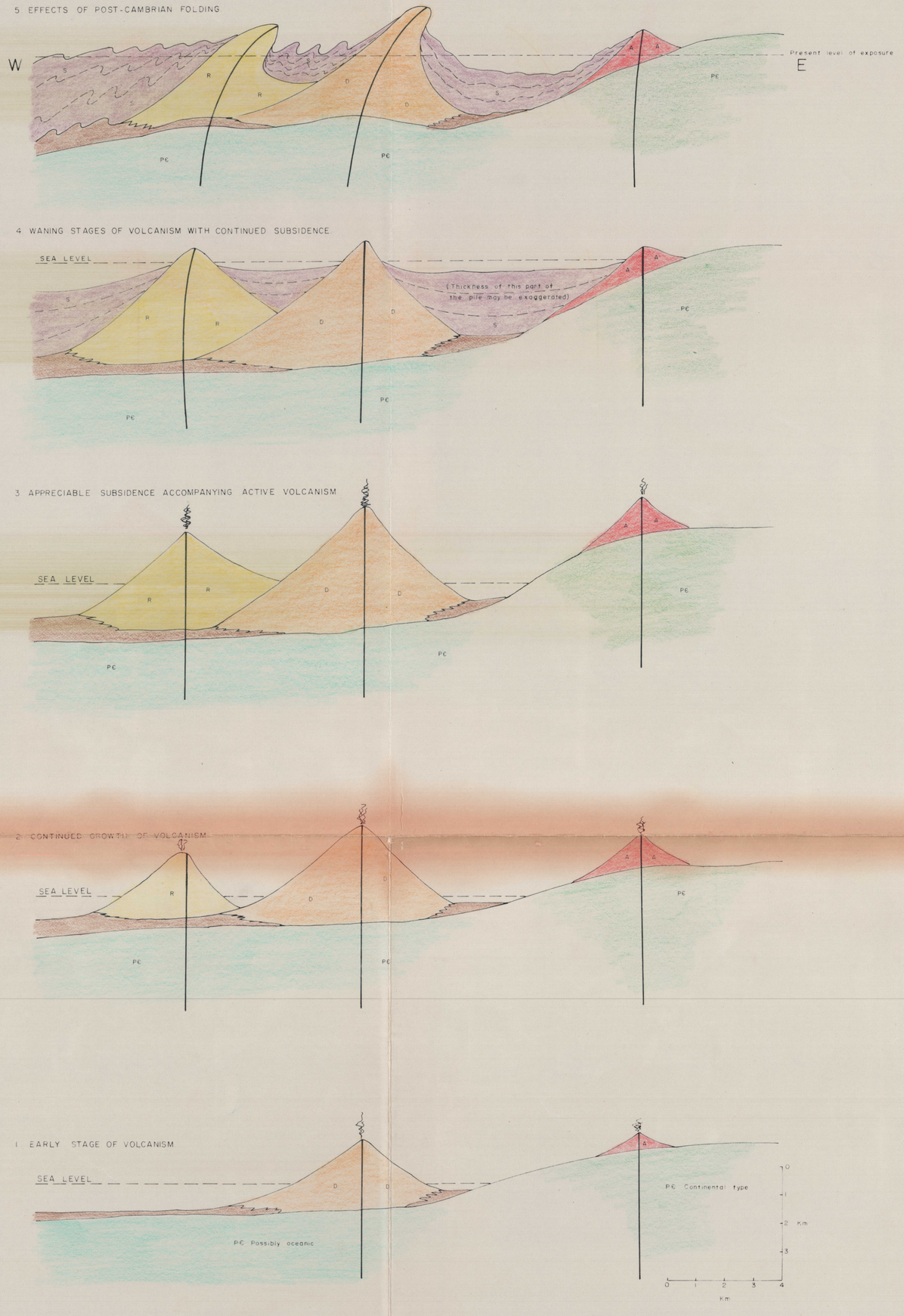
Number	Interp. orig. comp.	Type of Alteration		
		silicified	sericitised	albitised
141051	Rhyolite	-	x	S
141052	Andesite	-	x	-
141054	Andesite	-	x	x
141056	Rhyolite	x	-	S
141058	Rhyolite	-	x	S

141041	Rhyolite	x	-	-
141046	Rhyolite	x	-	-
141079	Rhyolite	-	x	S
96035	Basalt or andesite	some form of alkali addition.		
141003	Dacite	-	x	-
141014	Rhyolite	x	x	S
141082	Rhyolite	x	x	-
141083	Rhyolite	-	x	-
141084	Rhyolite	x	x	-
141086	Rhyolite	x	x	-
141088	Rhyolite	x	-	x
141089	Rhyolite	x	x	S
141099	Rhyolite	x	x	-
141122	Mixed shale and volcanic?	-	x	-
141160	Basalt	x	-	-
95886	Rhyolite	x	x	-
95887	Dacite	x	x	-
141586	Rhyolite	-	x	x
141589	Dacite	x	x	-
141590	Basalt	x	x	-
141591	Basalt	x	x	-
99211	Dacite	-	x	-
141254	Mixed volcanic and chert (+barytes)?	-	x	-
141257	Andesite or dacite	x	x	-
141270	Rhyolite	-	x	-
145061	Rhyolite	x	x	S
145064	Rhyolite	x	x	S
145067	Dacite	x	x	S
145069	Basalt	x	x	-
141779	Rhyolite	x	-	S
141781	Basalt	x	-	-
141785	Basalt	see Appendix text		
141787	Dacite	-	x	x
141788	Rhyolite	x	-	S
99150	Andesite	x	x	-
99153	Rhyolite	x	x	-
99155	Rhyolite	x	x	S
99156	Rhyolite	x	x	S
99157	Rhyolite	x	x	S
99159	Andesite	x	x	-
99162	Andesite	x	x	-
99163	Basalt	x	x	-

S - "Primary" sodic character interpreted from albite character.
Other alteration as shown.

141592	reworked volcanic
141593	reworked volcanic
141842	sandstone
141255	chert
141264	chert

Hypothetical Sections Across the Volcanic Belt Just North of Bulgobac (Approx. to Scale)



- Ocean sediments
- S — Sedimentary rocks equivalent to and/or younger than the Que River beds and Farrel slates
- R — Volcanic rocks including prominent sodic rhyolites
- D — Volcanic rocks of dacitic to andesitic composition
- A — Volcanic rocks of uncertain acid or intermediate composition
- PC — Basement possibly of oceanic type
- PC — Basement of continental type

COMINCO EXPLORATION PTY. LTD.			
DRAWN BY A.S.J.	TRACED BY P.F.	DIAGRAMATIC CROSS SECTIONS	
CHECKED BY S.H.S.	REVISED BY / DATE	EVOLUTION OF MT. READ VOLCANICS	
REVISED BY / DATE		DUNDAS PROJECT	
Location code K 55/6	Scale 1:100,000	Date April 1974	Plate DT 28

EL 15/73

EL 2/70

EL 2/70

EL 4/73

TULLAH

Mt. Pearse

Hatfield River

Que River

Murchison Highway

Bulgobac Ck.

Mt. Charter

Mt. Block

MACKINTOSH RIVER

Farm Ck.

Pieman River

Mt. Farrell

Southwell Ck.

Mt. Romulus

White Hawk Ck.

River Leven

Lake Lea

River Lea

Mayday Mt

Mt Cripps

Mayday Ck.

Belvoir Ck.

Pencil Pine Ck.

Back Peak

Mt Remus

Devils Ravine

Schist Ck.

Fury River

Barn Bluff

Mt Inglis

Lake Will

High Tor

Bald Hill

Sophia River

Victoria Peak

Sophia Peak

Mt Murchison

James Ck.

Bluff River

Chalmers Ck.

Corrina River

Achilles River

Wallace River

Mt. Nereus

Dome Hill

Anthony Ck.

MURCHISON RIVER

White Cliff Hills

Red Hills

Lake Selina

Lake Westwood

Lake Julia

Newton Peak

Lake Rolleston

Mt Tyndall

A

B

C

D

E

F

41° 30'

41° 35'

41° 40'

41° 45'

41° 50'

41° 55'

41° 0'

41° 5'

145° 35'

145° 40'

145° 45'

145° 50'

145° 55'

SCALE 1:50,000

1 0 1 2 3 4 miles

1 0 1 2 3 4 5 6 Kilometres

TN MN 11°E

TASMANIA

- Major road
- Secondary road
- Track
- Railway line
- Abandon railway or tramway
- Power transmission line
- Trig station
- Lake
- River and creek
- National Park boundary
- Mine
- Quarry
- AEM Anomalies
- Geochemical anomaly, Paringa soil grid

- Q — Quarternary: Unconsolidated glacial and fluvial deposits
- Tb — Tertiary: Basalt flows
- O-S — Ordovician and Silurian: Undivided
- Ev — Cambrian Volcanics: Acid to intermediate pyroclastics and flows
- Es — Cambrian Sediments: Sandstone, shale, greywacke and slate, minor volcanics
- Eu — Cambrian Undivided: Volcanics and sediments
- Fold axis position defined
- Fold axis position undefined
- Geological contacts
- Tenure boundary

COMINCO EXPLORATION PTY. LTD.

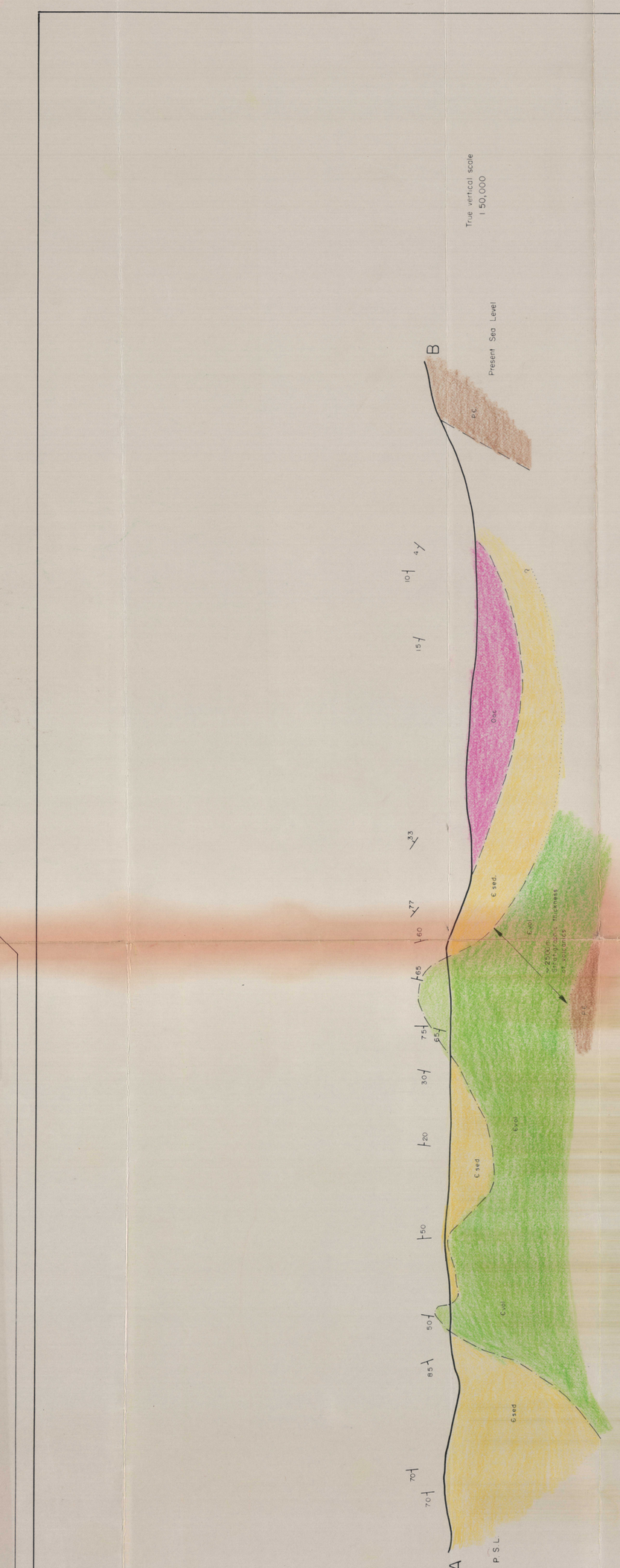
INTERPRETIVE REGIONAL GEOLOGICAL MAP

DUNDAS TROUGH REGIONAL PROGRAMME

Drawn by E.H.S & A.S.J. | Traced by P.F.

Checked by E.H.S | REVISED BY | DATE | REVISED BY | DATE

Location code K 55/6 | Scale 1:50000 | Date April 1974 | Plate DT 30



(Solomon, M.T. Elms, R.G., Copper Ore Deposits of Mt Lyell, Geol of Aust Ore Deposits, Vol 1, 1965)

Dev — Shale

Sil — Sandstone, undivided

Ord — Gordon limestone

Dmc — Owen conglomerate

Dmj — Jukes conglomerate

Cam — Farrel slate, Que River slate and Dundas group sediments

Cxed — Mt. Read volcanics

Schist, phyllite, etc.

Dip

Dip, overturned

Geological contact

Fault

Note: See plate DT 30 for location of sections

COMINCO EXPLORATION PTY. LTD.			
DRAWN BY EWB ASJ	TRACED BY PF	GEOLOGICAL CROSS SECTIONS	
CHECKED BY EHS	REVISED BY / DATE	MT READ VOLCANICS	
REVISED BY / DATE		DUNDAS PROJECT	
Location code K 55/6	Scale 1:50,000	Date April 1974	Plate DT 29

SCALE 1:100,000

2 1 0 2 4 6 8 miles

2 1 0 2 4 6 8 10 12 Kilometres

- Major road
- Secondary road
- Track
- Railway line
- Abandon railway or tramway
- Power transmission line
- Trig station
- Lake
- River and creek
- Township
- National Park boundary
- Mine / Sulphide Occurrence
- Quarry

- Generalised arcuate fracture patterns (photo interpretation)
- Gross sediment / volcanic contact. Sediment shaded
- Agglomerate, breccia or tuff-agglomerate occurrences
- Reworked tuff occurences
- Post and preCambrian rocks
- Altered volcanics

COMINCO EXPLORATION PTY. LTD.

DUNDAS TROUGH REGIONAL PROGRAMME

SPECULATIVE - CONCEPTUAL MAP OF THE WILLIAMSFORD - QUE RIVER AREA, MT READ VOLCANICS BELT

Drawn by: A.S.J, E.W.B	Traced by	
Checked by: EHS		
Location code K55/		
Scale 1:100,000	Date January 1974	Plate D.T. 24

COMINCO EXPLORATION PTY. LTD.

Dundas Trough Regional Programme

C.E.P.L. Fact Mapping

Location code K55/6 | Drawn by E.H.S.A.S.J.E.W.B. | Checked by E.H.S. | Traced by I.M. | Scale 1:50,000 | Date APRIL 1974 | Plate 12

EL. 15/73

EL. 2/70

EL. 4/73

Mt Pearse

Hatfield River

Que River

Bulldog

Mt. Charter

Mt. Block

Mt Cripps

Mayday Mt

Mt Romulus

Mt Remus

Mt Farrell

Mt Murchison

Mt Tyndall

Mt Inglis

Mt Nereus

Barn Bluff

Dome Hill

High Tor

Bald Hill

Victoria Peak

Sophia Peak

Red Hills

Newton Peak

White Cliff Hills

Back Peak

Pencil Pine

Pearces Copper Reward

Proposed Lake

New North Farrell

TULLAH

HEC Village

HEC Camp

Pieman River

Form Ck

Mackintosh River

Southwell Ck

Mayday Ck

Belvoir Ck

Devils Ravine

Schist Ck

Fury River

White Hawk Ck

Sophia River

Stripe Ck

Anthony Ck

MURCHISON RIVER

Lake Selina

Lake Westwood

Lake Julia

Lake Rolleston

Lake Will

James Ck

Bluff River

Chalmers Ck

Ganning River

Achilles River

Wallace River

Paringa Grid

No 1 Recce lines

No 4 Recce loop

No 8 Grid area

No 9

No 10

No 11/N

No 11/S

No 12

No 13

CRADLE MOUNT - LAKE ST CLAIR NATIONAL PARK

41°30' 41°35' 41°40' 41°45' 41°50' 41°55'

145°35' 145°40' 145°45' 145°50' 145°55'

T.N. M.N. 12°13'

TASMANIA

SCALE 1:50,000

0 1 2 3 4 miles

0 1 2 3 4 5 6 Kilometres

- Geochemical anomaly, Paringa soil grid
- Tenure boundaries
- Major road
- Secondary road
- Track
- Railway line
- Abandoned railway or tramway
- Power transmission line
- Trig station
- Lake
- River and creek
- National Park boundary
- Mine
- Quarry
- Bedding facing shown
- Bedding facing not known
- Cleavage
- Foliation uncertain

FIELD MAPPING LEGEND

VOLCANICS

Fragment Size	Rock Composition	Fragment - Type	Descriptive/Genetic Name
<4mm	Rhyolite (R), Rhyodacite (RD), Dacite (D), Andesite (A), Diorite (Di), Granodiorite (GDi), Dolerite (Do), Basalt (B)	ash, dust etc	Tuff (t)
>4mm - <32mm (>20mm fragments, add prefix coarse-c)		lithic (l), pumice (p) (>5% l or p component)	Tuff (t)
vitric fragments, glass shards vis with hand lens		vitric (v)	
(if >4mm add prefix coarse-c)		feldspar (fd), quartz (q) crystal (x) (>5% crystal component)	
All fragments >4mm, 5-50% fragments >32mm		Rounded fragments define agglomerate and tuff agglomerate, angular fragments define breccia and tuff breccia. No need for prefix 'l', but add 'p' if fragments are pumiceous	Tuff Agglomerate (ta) Tuff-Breccia (tb)
All fragments >4mm 50% fragments >32mm (Add prefix coarse (c) if fragments >10cms)			Agglomerate (a) Breccia (b)
No visible fragments			Pumice (p)
Uniform groundmass with phenos		specify phenos, fd, q, etc.	Porphyry (por)
			Massive structureless volcanic (indicate with composition name above)

INTRUSIONS

	As above in Volcanics		dyke, sill

SEDIMENTS

Reworked Tuff (rwt)
Sandstone (ss)
Siltstone (sts)
Shale (sh)
Chert (ch)
Conglomerate (co)
Greywacke (gy)

CAMBRIAN

- Tertiary basalt, Devonian, Silurian and Ordovician sediments
- Comstock Tuffs - "Younger" Volcanics
- Rhyolite to Dacite composition: Massive flows, dykes
- Rhyolite to Dacite composition: agglomerates, breccias
- Rhyolite to Dacite composition: crystal dominated tuffs, vitric tuffs
- Rhyolite to Dacite composition: fragment dominated tuffs, fine tuffs
- Andesitic composition: flows, dykes
- Andesitic composition: crystal dominated tuffs
- Andesitic composition: fragment dominated tuffs
- Basaltic composition: flows, dykes, fragmentals
- Shales dominant
- Sandstone dominant
- Chert
- Pre Cambrian schists and quartzites (including quartz-sericite schists)

		(Na_2O/SiO_2)
141055	Sodic rhyolite	
141060	Sodic rhyolite	
141061	Andesite	
141063	Sodic rhyolite	
141064	Andesite	Albitised
141065	Dacite	
141066	Rhyodacite	
141068	Dacite	
141034	Dacite	
141031	Basalt	
141042	Sodic rhyolite	Albitised
141043	Sodic rhyolite	
141048	Rhyodacite	
141080	Rhyodacite	
141109	Rhyodacite	
141104	Trachyandesite	
96039	Dacite	Albitised
141004	Rhyodacite	
141005	Dacite	
141006	Sodic rhyolite	
141008	Dacite	
141009	Rhyodacite/dacite	
141010	Dacite	Albitised
141011	Dacite	
141012	Dacite	
141013	Sodic rhyolite	
141159	Andesite	
145060	Andesite	
95877	Dacite	
141587	Trachyte	Albitised
141844	Dacite	Albitised
141250	Rhyodacite	
145062	Trachyte	Albitised

B. Altered volcanics (based on norm interp.)

Number	Interp. orig. comp.	Type of Alteration		
		silicified	sericitised	albitised
141051	Rhyolite	-	x	S
141052	Andesite	-	x	-
141054	Andesite	-	x	x
141056	Rhyolite	x	-	S
141058	Rhyolite	-	x	S

141041	Rhyolite	x	-	-
141046	Rhyolite	x	-	-
141079	Rhyolite	-	x	S
96035	Basalt or andesite	some form of alkali addition.		
141003	Dacite	-	x	-
141014	Rhyolite	x	x	S
141082	Rhyolite	x	x	-
141083	Rhyolite	-	x	-
141084	Rhyolite	x	x	-
141086	Rhyolite	x	x	-
141088	Rhyolite	x	-	x
141089	Rhyolite	x	x	S
141099	Rhyolite	x	x	-
141122	Mixed shale and volcanic?	-	x	-
141160	Basalt	x	-	-
95886	Rhyolite	x	x	-
95887	Dacite	x	x	-
141586	Rhyolite	-	x	x
141589	Dacite	x	x	-
141590	Basalt	x	x	-
141591	Basalt	x	x	-
99211	Dacite	-	x	-
141254	Mixed volcanic and chert (+barytes)?	-	x	-
141257	Andesite or dacite	x	x	-
141270	Rhyolite	-	x	-
145061	Rhyolite	x	x	S
145064	Rhyolite	x	x	S
145067	Dacite	x	x	S
145069	Basalt	x	x	-
141779	Rhyolite	x	-	S
141781	Basalt	x	-	-
141785	Basalt	see Appendix text		
141787	Dacite	-	x	x
141788	Rhyolite	x	-	S
99150	Andesite	x	x	-
99153	Rhyolite	x	x	-
99155	Rhyolite	x	x	S
99156	Rhyolite	x	x	S
99157	Rhyolite	x	x	S
99159	Andesite	x	x	-
99162	Andesite	x	x	-
99163	Basalt	x	x	-

S - "Primary" sodic character interpreted from albite character.
Other alteration as shown.

141592	reworked volcanic
141593	reworked volcanic
141842	sandstone
141255	chert
141264	chert

APPENDIX

Descriptions of thin sections and comments on analyses and catanorms. Underlining in catanorms indicates anomalous composition.

Compiled by A.S.Joyce

GENERAL LOCATION: Murchison Highway between Rosebery and Tullah.

141051 Sericite schist of rhyolitic affinities

Analyses		Catanorms	
SiO_2	70.20	Calcite	.00
TiO_2	.39	Apatite	.09
Al_2O_3	14.50	Pyrite	.00
Tot. Fe	3.20	Ilmenite	.56
MnO	.04	Orthoclase	39.47
MgO	2.20	Albite	14.77
CaO	.05	Anorthite	-.01
Na_2O	1.60	Corundum	5.43
K_2O	6.50	Magnetite	.00
P_2O_5	.04	Hematite	.00
L.O.I.	1.81	Diopside	.00
		Hypersthene	10.84
TOTAL	100.53	Quartz	28.86
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00

Norm. Plag. An_0

The rock is a sericite schist containing relict phenocrysts of K-feldspar rounded into augen shapes by shearing. The grains now consist of microcline but were probably volcanic crystal fragments of orthoclase or sanidine originally (shearing generally causes inversion to microcline). In addition to sericite, the groundmass contains fine-grained biotite and untwinned feldspar and quartz.

Chemically the rock has rhyolitic affinities but its normative corundum content indicates minor metasomatic sericitisation. The amount of modal sericite exceeds the amount implied by normative corundum, so some of it must be a result of isochemical recrystallisation. The negligible CaO content implies the rock may have been albitised but this is not certain and there is no petrographic evidence. Iron and magnesium are more abundant than would be expected in a rhyolite suggesting metasomatic addition.

The conclusion that the rock has rhyolitic affinities rather than representing a silicified intermediate rock is supported especially by its low TiO_2 content and by the presence of remnant phenocrysts of potassic feldspar instead of plagioclase grains.

141052 **Sericite schist of andesitic affinities**

Analyses		Catanorms	
SiO_2	53.80	Calcite	.00
TiO_2	.91	Apatite	.44
Al_2O_3	24.00	Pyrite	.00
Tot. Fe	3.70	Ilmenite	1.32
MnO	.26	Orthoclase	44.44
MgO	2.30	Albite	20.64
CaO	.19	Anorthite	-.38
Na_2O	2.20	Corundum	14.52
K_2O	7.20	Magnetite	.00
P_2O_5	.20	Hematite	.00
L.O.I.	5.19	Diopside	.00
		Hypersthene	11.72
TOTAL	99.95	Quartz	7.30
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

The rock is a sericite schist containing stringers of chlorite and albite. There are numerous clusters of chlorite intergrown with opaque grains in a fashion suggesting pseudomorphs after pre-existing ferromagnesian minerals such as hornblende or pyroxene. Several cubic grains of ?fluorite are present.

Chemically the rock has andesitic similarities in its content of SiO_2, TiO_2, Fe and MgO. Its normative corundum and orthoclase indicate extensive metasomatic sericitisation and its lack of anorthite indicates albitisation.

141054 **Albitised sericitised andesitic lithic feldspar crystal tuff.**

Analyses		Catanorms	
SiO_2	56.30	Calcite	.00
TiO_2	1.90	Apatite	1.00
Al_2O_3	17.10	Pyrite	.00
Tot. Fe	9.40	Ilmenite	2.74
MnO	.11	Orthoclase	11.62
MgO	3.30	Albite	47.41
CaO	.77	Anorthite	3.84
Na_2O	5.10	Corundum	7.19
K_2O	1.90	Magnetite	.00
P_2O_5	.46	Hematite	.00
L.O.I.	3.80	Diopside	.00
		Hypersthene	21.95
TOTAL	100.14	Quartz	7.26
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00

Norm. plag. An_2

The rock consists of a few recrystallised plagioclase phenocrysts set in a groundmass of plagioclase, chlorite, sericite and opaque grains which is partly recrystallised but has a distinctly trachytic texture in places. With care the boundaries of lithic fragments can be recognised, consistent with hand specimen textures indicating that the rock is a lithic feldspar crystal tuff.

Chemically the rock shows andesitic, or even basaltic, affinities. Its norm shows metasomatic sericitisation and albitisation.

141055 (photo micrograph) Sodic rhyolite lithic tuff

Analyses	
SiO_2	72.90
TiO_2	.24
Al_2O_3	14.30
Tot. Fe	1.80
MnO	.00
MgO	.33
CaO	.02
Na_2O	3.50
K_2O	4.60
P_2O_5	.00
L.O.I.	1.96
TOTAL	99.65

Catanorms	
Calcite	.00
Apatite	.00
Pyrite	.00
Ilmenite	.35
Orthoclase	28.05
Albite	32.44
Anorthite	.10
Corundum	3.98
Magnetite	.00
Hematite	.00
Diopside	.00
Hypersthene	3.47
Quartz	31.62
Olivine	.00
Nepheline	.00
TOTALS	100.00

Norm. plag. An_0

In hand specimen, the rock displays conspicuous lithic fragments, some of which have droplet shapes consistent with solidification in flight. In thin section the boundaries are much less conspicuous and the whole rock show extensive recrystallisation to a mosaic of quartz and feldspar. Conspicuous sericite forms arcuate aggregates resembling perlitic cracks and/or vesicle walls so the original fragments were probably glassy and/or vesicular. There is minor secondary biotite and iron-titanium oxides. Sparse phenocrysts of feldspar are preserved partly recrystallised to albite and microcline.

Chemically the rock is a rhyolite containing more normative albite than orthoclase. There are no indications of appreciable metasomatic alteration.

141056 (photo micrograph) **Altered coarse rhyolite pumice tuff**

Analyses		Catanorms	
SiO_2	78.20	Calcite	.00
TiO_2	.27	Apatite	.02
Al_2O_3	12.10	Pyrite	.00
Tot. Fe	1.60	Ilmenite	.39
MnO	.01	Orthoclase	23.88
MgO	.33	Albite	22.33
CaO	.04	Anorthite	.14
Na_2O	2.40	Corundum	4.39
K_2O	3.90	Magnetite	.00
P_2O_5	.01	Hematite	.00
L.O.I.	1.54	Diopside	.00
		Hypersthene	3.14
TOTAL	100.40	Quartz	45.71
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_1

Large ragged lithic fragments are conspicuous in hand specimen and thin section textures indicate these are filamentous pumice fragments containing phenocrysts of primary albite. Former vesicle walls now consist of sericite and the former vesicle cavities and general matrix of the rock now consist of a quartzo-feldspathic mosaic. There are a few grains of secondary biotite and iron-titanium oxides.

Chemically the rock contains too much normative quartz and too little feldspar to be regarded as unaltered. However, there is no petrographic evidence of silicification so it is likely that there has been a loss of feldspar constituents.

141058 **Sericitised rhyolite feldspar crystal tuff**

Analyses		Catanorms	
SiO_2	70.40	Calcite	.00
TiO_2	.52	Apatite	.07
Al_2O_3	15.30	Pyrite	.00
Tot. Fe	3.40	Ilmenite	.76
MnO	.02	Orthoclase	21.66
MgO	.91	Albite	26.34
CaO	.09	Anorthite	.26
Na_2O	2.80	Corundum	7.80
K_2O	3.50	Magnetite	.00
P_2O_5	.03	Hematite	.00
L.O.I.	3.20	Diopside	.00
		Hypersthene	7.42
TOTAL	100.17	Quartz	35.69
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_1

In hand-specimen the rock is conspicuously a feldspar crystal tuff but in thin section the original textures are much more difficult to recognise and the rock consists of a recrystallised mosaic of feldspar, quartz and sericite in which only ghostly remnants of large subhedral crystals of primary twinned plagioclase can be discerned. There are sparse grains of titanium-iron oxides.

Chemically the rock contains too little total normative feldspar to be regarded as an unaltered rock and its corundum content is consistent with metasomatic sericitisation. Its parentage is acid, probably rhyolitic.

141060 Sodic rhyolite feldspar crystal lithic tuff

Analyses		Catanorms	
SiO_2	&75.90	Calcite	.00
TiO_2	.30	Apatite	.02
Al_2O_3	13.30	Pyrite	.00
Tot. Fe	1.50	Ilmenite	.43
MnO	.00	Orthoclase	21.27
MgO	.33	Albite	32.33
CaO	.15	Anorthite	.70
Na_2O	3.50	Corundum	3.94
K_2O	3.50	Magnetite	.00
P_2O_5	.01	Hematite	.00
L.O.I.	1.60	Diopside	.00
		Hypersthene	2.90
TOTAL	100.09	Quartz	38.42
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_2

The specimen is a very light coloured crystal lithic tuff composed of subhedral, well twinned albite crystals and sparse rhyolitic lithic fragments set in a groundmass of fine grained fragments of quartz and feldspar. The whole rock is lightly sericitised and dusted with secondary titanium-iron oxides but the original fragmental textures are well preserved.

Chemically the rock has an essentially unaltered rhyolite composition with more normative albite than orthoclase. The sericitisation represents incipient recrystallisation rather than metasomatism.

141061 (Photomicrograph) **Andesite pumice feldspar crystal vitric tuff**

Analyses	
SiO_2	55.00
TiO_2	.73
Al_2O_3	15.70
Tot. Fe	9.60
MnO	.10
MgO	2.20
CaO	4.60
Na_2O	3.20
K_2O	2.80
P_2O_5	.14
L.O.I.	6.15
TOTAL	100.22

Catanorms	
Calcite	.00
Apatite	.32
Pyrite	.00
Ilmenite	1.10
Orthoclase	17.81
Albite	30.94
Anorthite	21.77
Corundum	.00
Magnetite	.00
Hematite	.00
Diopside	1.46
Hypersthene	20.90
Quartz	5.71
Olivine	.00
Nepheline	.00
TOTALS	100.00
Norm. plag.	An_{41}

The rock is dark coloured but shows fragmental textures clearly. Fragments of subhedral twinned andesine, wispy filamentous pumice fragments, a few shards and primary iron-titanium oxide grains are set in a matrix of finer crystals. The andesine is extensively sericitised and the pumice fragments have recrystallised to chlorite, sericite, feldspar and quartz. Carbonate is scattered conspicuously through the rock. Several shards have been pseudomorphed by pennine in their cores and sericite in their rims.

The rock is clearly an andesite and its chemistry indicates that it has suffered only recrystallisation rather than metasomatism.

141062 Sericitised silicified rhyolite tuff

Analyses		Catanorms	
SiO_2	72.00	Calcite	.00
TiO_2	.25	Apatite	.00
Al_2O_3	11.50	Pyrite	.00
Tot. Fe	5.60	Ilmenite	.38
MnO	1.40	Orthoclase	24.66
MgO	.66	Albite	2.17
CaO	.39	Anorthite	2.13
Na_2O	.22	Corundum	7.58
K_2O	3.80	Magnetite	.00
P_2O_5	.00	Hematite	.00
L.O.I.	4.35	Diopside	.00
		Hypersthene	13.56
TOTAL	100.17	Quartz	49.52
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{50}

The specimen is a light coloured hard rock with distinctive blue veins developed on joint surfaces. The rock is finely but intensely sericitised and consists mainly of a fine mosaic of untwinned feldspar, quartz and sericite. There are scattered phenocrysts which were probably feldspar but which are now pseudomorphed by ankerite and possibly siderite. There are a few less regularly shaped fragments composed of sericite and carbonate which may have been lithic fragments. The rock was probably a tuff.

The coarse veins are fissure fillings consisting of ankerite near their walls, sulphides, quartz and ankerite further in, and a core of blue-green tourmaline with minor quartz. There are a few grains of ?metamict zircon. Thin veinlets of carbonate and quartz also branch into the main mass of the rock.

The norm indicates a rhyolitic composition but with metasomatic sericitisation and silicification.

141063 Sodic rhyolite feldspar quartz crystal lithic tuff

Analyses		Catanorms	
SiO_2	73.90	Calcite	.00
TiO_2	.29	Apatite	.04
Al_2O_3	12.60	Pyrite	.00
Tot. Fe	3.30	Ilmenite	.42
MnO	.28	Orthoclase	17.89
MgO	.50	Albite	32.82
CaO	.16	Anorthite	.69
Na_2O	3.50	Corundum	3.95
K_2O	2.90	Magnetite	.00
P_2O_5	.02	Hematite	.00
L.O.I.	2.62	Diopside	.00
		Hypersthene	6.82
TOTAL	100.07	Quartz	37.36
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_2

The rock consists of large subhedral fragments of twinned primary albite and few recrystallised quartz phenocrysts set in a groundmass of feldspar, quartz, sericite, titanium-iron oxides and minor siderite. Lithic fragments were observed in outcrop.

The rock is a sodic rhyolite and neither the textures nor the analysis indicate significant alteration.

141064 (photomicrograph) **Albitised andesite vitric pumice feldspar crystal tuff**

Analyses	
SiO_2	60.20
TiO_2	.86
Al_2O_3	15.90
Tot. Fe	7.50
MnO	.13
MgO	2.70
CaO	3.00
Na_2O	5.10
K_2O	1.80
P_2O_5	.11
L.O.I.	2.75
TOTAL	100.05

Catanorms	
Calcite	.00
Apatite	.24
Pyrite	.00
Ilmenite	1.23
Orthoclase	10.88
Albite	46.87
Anorthite	14.50
Corundum	.42
Magnetite	.00
Hematite	.00
Diopside	.00
Hypersthene	18.50
Quartz	7.36
Olivine	.00
Nepheline	.00
TOTALS	100.00
Norm. plag.	An_{24}

The specimen is dark with conspicuous shard textures and replacement veins of pink albite. It consists of aligned shards, ragged pumice fragments and subhedral plagioclase fragments, in about equal abundance. Most of the plagioclase is extensively replaced by epidote. The shards are pseudomorphed by zoned aggregates of penninе, epidote, quartz and feldspar; these same minerals replace the pumice. Both primary and secondary titanium-iron oxides are visible. Zones of replacement by fine mosaics of turbid albite traverse the section but are less conspicuous in thin section than in hand specimen. (This raises the possibility that more diffuse replacement by albite could be overlooked.) A few thin fissure-filling type veinlets of clear colourless albite cut the replacement zones.

The chemical analysis survived the criteria used initially to screen out altered rocks and was classified as an andesite. When plotted on a Harker diagram for Na_2O, it was recognised as albitised, an interpretation consistent with its petrography.

141065 **Dacite pumice feldspar crystal vitric tuff**

Analyses	
SiO_2	63.00
TiO_2	.73
Al_2O_3	14.70
Tot. Fe	6.00
MnO	.10
MgO	2.30
CaO	4.00
Na_2O	3.20
K_2O	3.50
P_2O_5	.13
L.O.I.	2.25
TOTAL	99.91

Catanorms	
Calcite	.00
Apatite	.28
Pyrite	.00
Ilmenite	1.05
Orthoclase	21.37
Albite	29.70
Anorthite	15.94
Corundum	.00
Magnetite	.00
Hematite	.00
Diopside	2.96
Hypersthene	13.80
Quartz	14.91
Olivine	.00
Nepheline	.00
TOTALS	100.00
Norm. plag.	An_{34}

This specimen is very similar to 141064 except that it contains more pumice and opaque grains and fewer shards. Also it is devoid of albitisation.

Its chemistry is that of an unaltered dacite with a composition close to that of an andesite (63% SiO_2, 0.73% TiO_2). The name dacite was applied because normative quartz exceeds 10%.

141066 (photomicrograph) Rhyodacite

Analyses		Catanorms	
SiO_2	67.90	Calcite	.00
TiO_2	.54	Apatite	.24
Al_2O_3	14.10	Pyrite	.00
Tot. Fe	4.70	Ilmenite	.77
MnO	.07	Orthoclase	24.34
MgO	1.40	Albite	32.38
CaO	1.70	Anorthite	7.95
Na_2O	3.50	Corundum	1.34
K_2O	4.00	Magnetite	.00
P_2O_5	.11	Hematite	.00
L.O.I.	1.99	Diopside	.00
		Hypersthene	10.82
TOTAL	100.01	Quartz	22.16
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00

Norm. plag. An_{20}

The rock consists of abundant phenocrysts of oligoclase or andesine and orthoclase set in a partly micrographic groundmass of untwinned feldspar and quartz. Secondary sericite, biotite, epidote, carbonates and opaques are disseminated through the phenocrysts and groundmass. It is uncertain whether the texture has been produced by magmatic crystallisation or by pyroclastic processes obscured by subsequent recrystallisation. Scattered lithic fragments in the rock suggest the latter, but they themselves are relatively well crystallised biotite bearing dioritic fragments which could be cognate inclusions of chilled marginal rock.

It is possible, if not likely, that the rock is an intrusion or a lava flow.

Chemically the rock is a rhyodacite (bordering on dacite).

141068 (photomicrograph) **Dacite vitric feldspar crystal pumice tuff**

Analyses		Catanorms	
SiO_2	63.99	Calcite	.00
TiO_2	.73	Apatite	.24
Al_2O_3	15.00	Pyrite	.00
Tot. Fe	6.30	Ilmenite	1.05
MnO	.09	Orthoclase	12.20
MgO	2.30	Albite	33.37
CaO	3.80	Anorthite	18.72
Na_2O	3.60	Corundum	.31
K_2O	2.00	Magnetite	.00
P_2O_5	.11	Hematite	.00
L.O.I.	2.39	Diopside	.00
		Hypersthene	15.72
TOTAL	100.22	Quartz	18.40
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{36}

The rock has abundant aligned devitrified shards, some stringy sericitised pumice fragments, and epidotised plagioclase fragments set in a fine matrix composed mainly of chlorite and untwinned feldspar. The shard textures are very well preserved.

Chemically the rock has an unaltered dacitic composition.

141072 **Albitised epidotised andesite feldspar crystal lithic tuff**

Analyses		Catanorms	
SiO_2	52.10	Calcite	.00
TiO_2	.96	Apatite	.51
Al_2O_3	18.00	Pyrite	.00
Tot. Fe	10.00	Ilmenite	1.55
MnO	.24	Orthoclase	2.41
MgO	4.50	Albite	49.46
CaO	5.00	Anorthite	23.70
Na_2O	5.40	Corundum	.19
K_2O	.40	Magnetite	.00
P_2O_5	.24	Hematite	.00
L.O.I.	3.18	Diopside	.00
		Hypersthene	6.97
TOTAL	100.02	Quartz	.00
		Olivine	15.39
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{32}

The rock consists of plagioclase fragments, plagioclase aggregates and andesitic lithic fragments set in a fine matrix of feldspar, epidote group minerals and chlorite. Epidote and chlorite are also present as veins.

The SiO_2 and TiO_2 content of the rock are consistent with andesite and the abundance of olivine in the norm must be a reflection of the abundance of metasomatic epidote group minerals in the mode. Na_2O and normative albite abundances suggest albitisation as well.

141034 Dacite lithic feldspar crystal tuff

Analyses		Catanorms	
SiO_2	62.30	Calcite	.00
TiO_2	.77	Apatite	.58
Al_2O_3	15.20	Pyrite	.00
Tot. Fe	6.30	Ilmenite	1.11
MnO	.11	Orthoclase	14.03
MgO	2.70	Albite	29.66
CaO	4.70	Anorthite	20.99
Na_2O	3.20	Corundum	.00
K_2O	2.30	Magnetite	.00
P_2O_5	.27	Hematite	.00
L.O.I.	2.20	Diopside	1.01
		Hypersthene	16.34
TOTAL	100.05	Quartz	16.28
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00

Norm. plag. An_{41}

The rock consists of pumice fragments, fine grained volcanic rock fragments and feldspar fragments (mainly plagioclase but there is some orthoclase). Some secondary chlorite and epidote are present, especially pseudomorphing pumice fragments.

Chemically the rock is a dacite (close to andesite) and appears to be unaltered.

141031 (photomicrograph) Basalt agglomerate

Analyses	
SiO_2	50.10
TiO_2	.75
Al_2O_3	18.00
Tot. Fe	9.70
MnO	.17
MgO	5.50
CaO	7.50
Na_2O	2.20
K_2O	2.20
P_2O_5	.37
L.O.I.	3.93
TOTAL	100.42

Catanorms	
Calcite	.00
Apatite	.81
Pyrite	.00
Ilmenite	1.09
Orthoclase	13.53
Albite	20.56
Anorthite	34.09
Corundum	.00
Magnetite	.00
Hematite	.00
Diopside	1.69
Hypersthene	23.63
Quartz	.00
Olivine	4.61
Nepheline	.00
TOTALS	100.00
Norm. plag.	An_{62}

The rock consists of large volcanic rock fragments and pumice set in a matrix rich in shards. Although the original textures are very well preserved, the original minerals and glass have been pseudomorphed completely by sericite, epidote minerals, chlorite, carbonates and secondary feldspar.

Chemically the rock is quite consistent with an unaltered basalt composition (SiO_2 50%, TiO_2 0.75%, normative plagioclase An_{62}, normative olivine 4.6%) but this is very difficult to reconcile with the light coloured appearance of the hand specimen. The chemistry is probably consistent with present mineralogy.

GENERAL LOCATION:

141040 **Silicified metamorphosed rhyolite lithic tuff**

Analyses		Catanorms	
SiO_2	79.20	Calcite	.00
TiO_2	.31	Apatite	.09
Al_2O_3	10.80	Pyrite	.00
Tot. Fe	1.50	Ilmenite	.44
MnO	.08	Orthoclase	27.36
MgO	.25	Albite	24.02
CaO	.24	Anorthite	.96
Na_2O	2.60	Corundum	1.48
K_2O	4.50	Magnetite	.00
P_2O_5	.04	Hematite	.00
L.O.I.	.80	Diopside	.00
		Hypersthene	2.79
TOTAL	100.32	Quartz	42.87
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_4

In hand specimen this rock is a massive cream rhyolite but in thin section large irregularly shaped lithic fragments containing subhedral beta-quartz and orthoclase phenocrysts can be discerned. Under crossed polars, the lithic boundaries vanish to reveal a simple quartzofeldspathic mosaic, consistent with a thermally recrystallised rock.

Chemically the rock is a rhyolite showing slightly high normative quartz, suggesting silicification.

The rock probably represents a lithic tuff which has been recrystallised and silicified by a nearby intrusion or an overlying blanket of hot volcanic material.

141041 Silicified rhyolite lithic quartz feldspar crystal tuff

Analyses	
SiO_2	77.10
TiO_2	.12
Al_2O_3	11.90
Tot. Fe	2.40
MnO	.12
MgO	.50
CaO	.60
Na_2O	2.70
K_2O	3.00
P_2O_5	.04
L.O.I.	1.36
TOTAL	99.84

Catanorms	
Calcite	.00
Apatite	.09
Pyrite	.00
Ilmenite	.17
Orthoclase	18.43
Albite	25.22
Anorthite	2.82
Corundum	3.65
Magnetite	.00
Hematite	.00
Diopside	.00
Hypersthene	5.32
Quartz	44.29
Olivine	.00
Nepheline	.00
TOTALS	100.00
Norm. plag.	An_{10}

The specimen consists of abundant volcanic rock fragments and subhedral quartz, plagioclase and orthoclase fragments set in a matrix of similar fine material. Some of the quartz grains show delicate corroded shapes. Minor epidote, chlorite and sericite are visible.

The composition and origin of this sample is probably quite similar to that of 141040, but it contains a little more chlorite and has not been thermally metamorphosed.

High normative quartz and low total feldspar content suggests minor silicification.

141042 Albitised rhyolite agglomerate

Analyses		Catanorms	
SiO_2	74.40	Calcite	.00
TiO_2	.13	Apatite	.06
Al_2O_3	12.80	Pyrite	.00
Tot. Fe	1.60	Ilmenite	.18
MnO	.04	Orthoclase	12.47
MgO	.33	Albite	57.75
CaO	.28	Anorthite	.00
Na_2O	6.70	Corundum	.00
K_2O	2.10	Magnetite	.00
P_2O_5	.03	Hematite	.00
L.O.I.	1.45	Diopside	.96
		Hypersthene	2.81
TOTAL	99.86	Quartz	24.15
		Olivine	.00
		Nepheline	.00
		(Acmite	2.16)
		TOTALS	100.54

Norm. plag. An_0

The rock contains abundant rock fragments of fine grained acid volcanic rock together with fragments of quartz, plagioclase and orthoclase set in a fine grained quartzofeldspathic mosaic. Unlike samples 141040 and 141041, the quartz grains are only fragments of subhedral phenocrysts. Most of the rock, including the lithic fragments, has a recrystallised mosaic texture of quartz and albite.

Chemically the rock is a rhyolite and although it survived the initial criteria for screening out altered rocks, the Harker diagram indicates that it has been albitised and this is reflected in a very high normative albite content together with acmite. Albitisation is compatible with the mosaic texture of the rock, although it would not have been recognised without chemical support.

141043 (photomicrograph) **Sodic rhyolite coarse feldspar quartz crystal tuff**

Analyses		Catanorms	
SiO_2	76.10	Calcite	.00
TiO_2	.28	Apatite	.11
Al_2O_3	12.50	Pyrite	.00
Tot. Fe	2.50	Ilmenite	.39
MnO	.09	Orthoclase	20.84
MgO	.25	Albite	39.82
CaO	.46	Anorthite	1.97
Na_2O	4.40	Corundum	.84
K_2O	3.50	Magnetite	.00
P_2O_5	.05	Hematite	.00
L.O.I.	.30	Diopside	.00
		Hypersthene	4.35
TOTAL	100.43	Quartz	31.68
		Olivine	.00
		Nepheline	.90
		TOTALS	100.00
		Norm. plag.	An_5

The rock consists of coarse broken and magmatically corroded crystals of subhedral quartz, albite and minor orthoclase disseminated in an abundant fragmental matrix of finer quartz and feldspar with dusty grains of opaques and scattered clumps of chlorite and opaques which may be pseudomorphous after some ferromagnesian mineral. The feldspar is lightly kaolinised and specked with minor sericite.

Chemically the rock is a sodic rhyolite and the petrographic evidence indicates that this is a primary characteristic, not albitisation.

141046 (photomicrograph) **Silicified sodic rhyolite quartz crystal tuff**

Analyses		Catanorms	
SiO_2	77.90	Calcite	.00
TiO_2	.27	Apatite	.11
Al_2O_3	12.70	Pyrite	.00
Tot. Fe	1.30	Ilmenite	.39
MnO	.01	Orthoclase	15.24
MgO	.25	Albite	31.49
CaO	.28	Anorthite	1.10
Na_2O	3.40	Corundum	4.52
K_2O	2.50	Magnetite	.00
P_2O_5	.05	Hematite	.00
L.O.I.	1.20	Diopside	.00
		Hypersthene	2.42
TOTAL	99.86	Quartz	44.74
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm plag.	An_3

This rock is quite similar to 141043 but the feldspars show a little more sericitisation and there are thin stringers of quartz cutting the rock.

These same features are reflected in the chemistry: the bulk compositions are similar, but 141046 contains a little too much normative quartz to be regarded as unaltered and its corundum content (reflecting sericitisation) is 4.5% compared with 0.8% in 141043.

141048 (photomicrograph) **Vesicular Rhyodacite**

Analyses	
SiO_2	70.90
TiO_2	.51
Al_2O_3	14.50
Tot. Fe	3.60
MnO	.20
MgO	.50
CaO	1.60
Na_2O	3.60
K_2O	4.20
P_2O_5	.09
L.O.I.	.21
TOTAL	99.91

Catanorms	
Calcite	.00
Apatite	.19
Pyrite	.00
Ilmenite	.72
Orthoclase	25.17
Albite	32.79
Anorthite	7.46
Corundum	1.49
Magnetite	.00
Hematite	.00
Diopside	.00
Hypersthene	6.66
Quartz	25.53
Olivine	.00
Nepheline	.00
TOTALS	100.00
Norm. plag.	**An_{19}**

The rock is a vesicular lava composed of phenocrysts (sometimes agglomerated) of plagioclase, orthoclase and minor quartz set in a finely crystalline groundmass of feldspar, epidote, chlorite and quartz. The plagioclase shows patchy chloritisation and minor flecking with sericite but the orthoclase is kaolinised. Well formed oval vesicles, filled with radiating epidote group minerals, untwinned albite and less common quartz, are prominent. The largest of these filled vesicles are drop-shaped and were mis-identified as lithic fragments in the field.

Chemically the rock has an apparently unaltered rhyodacite composition.

GENERAL LOCATION: [illegible]

141079 (photomicrograph) **Sericitised rhyolite pumice feldspar crystal tuff**

Analyses		Catanorms	
SiO_2	74.70	Calcite	.00
TiO_2	.36	Apatite	.06
Al_2O_3	14.70	Pyrite	.00
Tot. Fe	2.00	Ilmenite	.51
MnO	.04	Orthoclase	27.20
MgO	.66	Albite	22.05
CaO	.11	Anorthite	.36
Na_2O	2.40	Corundum	6.43
K_2O	4.50	Magnetite	.00
P_2O_5	.03	Hematite	.00
L.O.I.	.53	Diopside	.00
		Hypersthene	4.59
TOTAL	100.03	Quartz	38.80
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00

Norm. plag. An_2

The rock consists of irregularly shaped and randomly oriented filamentous pumice fragments together with sericitised feldspar fragments and several quartz grains. The pumice has devitrified to feldspar, quartz, sericite and minor chlorite, blurring the original textures in thin section. However, they can be discerned plainly in parts of the slide and they were visible in weathered outcrops.

Chemically the rock has too little normative feldspar to be regarded as unaltered and its corundum content indicates metasomatic sericitisation. Its general composition is rhyolitic.

141080 **Recrystallised rhyodacite lithic feldspar quartz crystal tuff**

Analyses		Catanorms	
SiO_2	70.40	Calcite	.00
TiO_2	.38	Apatite	.21
Al_2O_3	13.80	Pyrite	.00
Tot. Fe	4.40	Ilmenite	.54
MnO	.13	Orthoclase	26.68
MgO	.75	Albite	31.33
CaO	.98	Anorthite	4.32
Na_2O	3.40	Corundum	2.13
K_2O	4.40	Magnetite	.00
P_2O_5	.10	Hematite	.00
L.O.I.	1.37	Diopside	.00
		Hypersthene	8.79
TOTAL	100.11	Quartz	25.99
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{12}

There was difficulty in the field in deciding whether this rock is crystalline or fragmental. In thin section it can be distinguished with difficulty, but decisively, as being a fragmental rock composed mainly of rock fragments but with some broken crystal fragments. In general appearance it consists of aggregates of coarse feldspar and quartz set in a decussate groundmass of feldspar, quartz, chlorite, epidote, carbonate and opaques. There are several aggregates of chlorite which are pseudomorphous after hornblende. Care is needed to recognise that the rock is composed mainly of lithic fragments, the boundaries of which have been largely obliterated by recrystallisation. Probably the rock has been thermally metamorphosed.

Chemically the rock has an apparently unaltered rhyodacite composition.

GENERAL LOCATION: Mackintosh Damsite

141109 Vesicular Rhyodacite

Analyses		Catanorms	
SiO_2	69.00	Calcite	.00
TiO_2	.48	Apatite	.20
Al_2O_3	13.40	Pyrite	.00
Tot. Fe	4.90	Ilmenite	.69
MnO	.08	Orthoclase	30.02
MgO	.58	Albite	28.86
CaO	1.50	Anorthite	7.11
Na_2O	3.10	Corundum	.55
K_2O	4.90	Magnetite	.00
P_2O_5	.09	Hematite	.00
L.O.I.	2.01	Diopside	.00
		Hypersthene	8.97
TOTAL	100.04	Quartz	23.61
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{20}

The rock consists of phenocrysts of feldspar, largely replaced by carbonate, and ovoid aggregates of carbonate and quartz, probably filled vesicles, set in a feathery kaolinised feldspathic groundmass containing chlorite and epidote.

The rock is probably a flow of essentially unaltered rhyodacite composition.

141104 Trachyandesite pumice feldspar quartz crystal tuff

Analyses	
SiO_2	55.20
TiO_2	.72
Al_2O_3	15.60
Tot. Fe	4.90
MnO	.19
MgO	1.60
CaO	8.40
Na_2O	2.30
K_2O	5.00
P_2O_5	.18
L.O.I.	5.92
TOTAL	100.01

Catanorms	
Calcite	.00
Apatite	.40
Pyrite	.00
Ilmenite	1.07
Orthoclase	31.65
Albite	22.13
Anorthite	18.74
Corundum	.00
Magnetite	.00
Hematite	.00
Diopside	19.73
Hypersthene	2.25
Quartz	4.03
Olivine	.00
Nepheline	.00
TOTALS	100.00
Norm. plag.	An_{46}

The rock consists of devitrified pumice fragments together with orthoclase, plagioclase and quartz fragments. Epidote group minerals, chlorite and carbonate are prominent secondary minerals formed from the pumice fragments and carbonate extensively replaces feldspar phenocrysts.

Chemically the rock is a trachyandesite and, despite the abundance of secondary minerals, its norm does not indicate appreciable metasomatism.

GENERAL LOCATION: Palm Creek

96035 Recrystallised diorite

Analyses		Catanorms	
SiO_2	54.20	Calcite	.00
TiO_2	.58	Apatite	.30
Al_2O_3	14.20	Pyrite	.00
Tot. Fe	7.90	Ilmenite	.77
MnO	.08	Orthoclase	36.47
MgO	6.00	Albite	.00
CaO	8.80	Anorthite	.00
Na_2O	5.40	Corundum	.00
K_2O	5.30	Magnetite	.00
P_2O_5	.15	Hematite	.00
L.O.I.	1.34	Diopside	32.40
		Hypersthene	.00
TOTAL	103.95	Quartz	.00
		Olivine	7.86
		Nepheline	26.31
		(Acmite	1.73)
		TOTALS	100.43
		Norm. plag.	-

Both in hand specimen and thin section the rock has retained a plainly recognisable igneous crystalline texture compatible with dolerite or microdiorite but it has been recrystallised to the low temperature mineral assemblage of albite, orthoclase, actinolite (almost tremolite), epidote group minerals and chlorite.

The chemistry of the rock was probably dioritic (e.g. TiO_2 0.58%) rather than basaltic (implied by normative nepheline and olivine). The improbable assemblage of normative minerals indicates appreciable metasomatism has accompanied the recrystallisation, probably in the form of addition of alkalis or loss of SiO_2.

The extent of recrystallisation and the lack of metamorphic foliation suggests recrystallisation by contact metamorphic or metasomatic processes.

96039 **Albitised dacite pumice feldspar crystal tuff**

Analyses		Catanorms	
SiO_2	63.40	Calcite	.00
TiO_2	.73	Apatite	3.15
Al_2O_3	15.20	Pyrite	.00
Tot. Fe	5.90	Ilmenite	1.02
MnO	.13	Orthoclase	11.85
MgO	1.80	Albite	48.64
CaO	3.50	Anorthite	7.57
Na_2O	5.40	Corundum	1.52
K_2O	2.00	Magnetite	.00
P_2O_5	1.50	Hematite	.00
L.O.I.	1.86	Diopside	.00
		Hypersthene	13.34
TOTAL	101.42	Quartz	12.91
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{13}

The specimen is dark but shows pink diffuse replacement patches of albite. In thin section the rock is seen to consist of pumice fragments (with subspherical vesicles) together with clusters of plagioclase and minor orthoclase set in a fine clastic quartzo-feldspathic matrix. Epidote and carbonate partly replace the feldspars. The walls of the pumice are replaced by chlorite and epidote and the vesicles are filled with fine feldspar. Secondary opaque grains are abundant. The zone of albitisation visible in hand specimen is recognisable but inconspicuous in thin section and would probably have been overlooked if not detected in hand specimen.

Chemically the rock survived the initial criteria used to exclude altered rocks and was classified as a dacite. The Harker diagram indicated the rock is albitised and the petrography confirms this.

GENERAL LOCATION: **Tullah Tramway**

141003 **Sericitised dacite pumice feldspar crystal tuff**

Analyses		Catanorms	
SiO_2	68.70	Calcite	.00
TiO_2	.68	Apatite	.13
Al_2O_3	15.90	Pyrite	.00
Tot. Fe	4.20	Ilmenite	1.00
MnO	.06	Orthoclase	6.83
MgO	1.80	Albite	21.71
CaO	2.40	Anorthite	12.11
Na_2O	2.30	Corundum	7.70
K_2O	1.10	Magnetite	.00
P_2O_5	.06	Hematite	.00
L.O.I.	2.80	Diopside	.00
		Hypersthene	11.17
TOTAL	100.00	Quartz	39.35
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00

Norm. plag. An_{36}

In hand specimen the rock has abundant fine wispy lithic fragments and white feldspar fragments. In thin section the lithic fragments are seen to consist mainly of wispy sericite pseudomorphing former pumice or shards. The feldspar fragments have been completely pseudomorphed by sericite and/or epidote group minerals. There are a few grains of apparently primary opaque minerals and rare grains of fragmental quartz.

Chemically the rock is a dacite and its normative corundum content indicates metasomatic sericitisation.

141004 **Rhyodacite lithic feldspar crystal tuff**

Analyses		Catanorms	
SiO_2	66.90	Calcite	.00
TiO_2	.78	Apatite	.26
Al_2O_3	14.40	Pyrite	.00
Tot. Fe	6.10	Ilmenite	1.13
MnO	.10	Orthoclase	21.54
MgO	2.30	Albite	14.97
CaO	2.70	Anorthite	13.14
Na_2O	1.60	Corundum	3.82
K_2O	3.50	Magnetite	.00
P_2O_5	.12	Hematite	.00
L.O.I.	1.48	Diopside	.00
		Hypersthene	15.49
TOTAL	99.98	Quartz	29.64
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{47}

In hand specimen the rock clearly shows grey lithic fragments (some droplet shaped) and white feldspar fragments set in an abundant grey matrix with wispy textures. In thin section the feldspar grains are seen to be pseudomorphed by sericite and, less commonly epidote group minerals. The lithic fragments have sharply defined boundaries and have been recrystallised to fine epidote, feldspar, quartz and sometimes chlorite. Devitrified shards are conspicuous in the matrix.

The chemistry of the rock appears to be that of an essentially unaltered rhyodacite.

141005 (photomicrograph) **Dacite feldspar crystal pumice tuff**

Analyses		Catanorms	
SiO_2	65.60	Calcite	.00
TiO_2	.67	Apatite	.19
Al_2O_3	14.70	Pyrite	.00
Tot. Fe	5.50	Ilmenite	.96
MnO	.08	Orthoclase	7.87
MgO	1.80	Albite	32.22
CaO	5.60	Anorthite	21.09
Na_2O	3.50	Corundum	.00
K_2O	1.30	Magnetite	.00
P_2O_5	.09	Hematite	.00
L.O.I.	.87	Diopside	5.43
		Hypersthene	10.29
TOTAL	99.71	Quartz	21.94
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{40}

The rock contains abundant small grey lithic fragments and feldspar fragments. There is an obvious foliation. The feldspar appears to be mainly plagioclase with all grains partly sericitised or, less commonly, epidotised and chloritised. Many of the grains are rounded but this appears to be a primary feature, unrelated to sedimentary processes or mylonitisation, since the grains are set in a matrix of ,compressed, but unsheared, ragged pumice fragments, now devitrified to clays and fine feldspar and quartz. The rock is seen in thin section to contain much more feldspar than is apparent in the hand specimen, presumably because of the colour of some alteration products.

Chemically the rock is a dacite of apparently unaltered composition.

141006 (photomicrograph)

Rhyolite vitric feldspar crystal 1 lithic tuff

Analyses	
SiO_2	68.60
TiO_2	.72
Al_2O_3	14.50
Tot. Fe	4.80
MnO	.04
MgO	1.50
CaO	.46
Na_2O	3.50
K_2O	3.50
P_2O_5	.09
L.O.I.	1.85
TOTAL	99.56

Catanorms	
Calcite	.00
Apatite	.19
Pyrite	.00
Ilmenite	1.04
Orthoclase	21.40
Albite	32.52
Anorthite	1.75
Corundum	4.90
Magnetite	.00
Hematite	.00
Diopside	.00
Hypersthene	11.01
Quartz	27.19
Olivine	.00
Nepheline	.00
TOTALS	100.00

Norm. plag. An_5

The rock has a rather strange texture consisting of unaltered, twinned grains of plagioclase and orthoclase set in an abundant pale brownish groundmass which shows a few wispy shard-type textures in plain light but a feldspar mosaic texture under crossed polars. Presumably the matrix was originally glass shards but it has devitrified to a rather coarse mosaic of secondary feldspar and minor sericite. Vitric textures were noted in the field. There are a few lithic fragments consisting of intergrown fairly coarse feldspar, chlorite and opaques.

Chemically the rock is an unaltered rhyolite.

141008 (photomicrograph) **Dacite lithic feldspar crystal tuff**

Analyses		Catanorms	
SiO_2	61.40	Calcite	.00
TiO_2	.68	Apatite	.25
Al_2O_3	14.10	Pyrite	.00
Tot. Fe	5.70	Ilmenite	1.02
MnO	.08	Orthoclase	15.27
MgO	2.50	Albite	34.82
CaO	2.80	Anorthite	14.19
Na_2O	3.60	Corundum	.89
K_2O	2.40	Magnetite	.00
P_2O_5	.11	Hematite	.00
L.O.I.	1.86	Diopside	.00
		Hypersthene	16.06
TOTAL	95.23	Quartz	17.49
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{29}

The rock consists of some relatively large pumice fragments and smaller massive volcanic fragments set in a matrix of coarse and fine feldspar fragments. The pumice fragments are of the spherical vesicular type and now consist of primary twinned feldspar and secondary untwinned feldspars, chlorite, epidote group minerals and opaques. The more massive fragments consist of primary plagioclase laths and secondary epidote minerals (several types) and chlorite. Quartz, feldspar, epidote and carbonate occur as a small vein filling. Disseminated sulphides were noted in outcrop.

Despite its low SiO_2 content the rock has a norm consistent with essentially unaltered dacite.

141009 **Rhyodacite lithic feldspar crystal vitric tuff**

Analyses		Catanorms	
SiO_2	65.60	Calcite	.00
TiO_2	.75	Apatite	.21
Al_2O_3	15.40	Pyrite	.00
Tot. Fe	5.80	Ilmenite	1.07
MnO	.06	Orthoclase	20.00
MgO	2.20	Albite	33.15
CaO	1.40	Anorthite	6.45
Na_2O	3.60	Corundum	4.03
K_2O	3.30	Magnetite	.00
P_2O_5	.10	Hematite	.00
L.O.I.	1.82	Diopside	.00
		Hypersthene	14.47
TOTAL	100.03	Quartz	20.61
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{16}

In hand specimen this rock shows distinctive dark green droplet and shard-like fragments. In thin section it is seen to consist of abundant (?)dacitic rock fragments, displaying various internal grainsizes, together with feldspar crystals and the green "droplets" set in a fine feldspathic matrix. The feldspars are all very fresh. The droplet and shard-like masses consist of various combinations, often zoned, of chlorite, actinolite, epidote group minerals, pale biotite and untwinned feldspar. These are presumably devitrification products of former glass.

Chemically the rock appears unaltered, being transitional between a,rhyodacite and a dacite, but with rather low SiO_2. Since some primary orthoclase can be seen in the rock, it is arbitrarily called a rhyodacite.

141010 Dacite lithic feldspar crystal tuff

Analyses		Catanorms	
SiO_2	62.50	Calcite	.00
TiO_2	.78	Apatite	.28
Al_2O_3	15.70	Pyrite	.00
Tot. Fe	6.40	Ilmenite	1.10
MnO	.09	Orthoclase	4.08
MgO	2.20	Albite	40.11
CaO	6.10	Anorthite	21.42
Na_2O	4.40	Corundum	.00
K_2O	.68	Magnetite	.00
P_2O_5	.13	Hematite	.00
L.O.I.	.87	Diopside	6.76
		Hypersthene	11.89
TOTAL	99.85	Quartz	14.36
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{35}

The rock consists of andesitic or dacitic rock fragments of various internal grainsizes set in a matrix of coarse and fine feldspar fragments. There is conspicuous secondary epidote and chlorite, plus minor sericite and actinolite. There are a few large fragments of orthoclase. Quartz is conspicuous in the matrix and also forms several large amoeboid aggregates which appear to be some form of cavity filling. There are several small vesicular droplet shapes, heavily altered to clay, which probably represent former glass.

Chemically the rock is a dacite but its SiO_2 content is low and this feature taken with the occurrence of quartz in apparent cavity fillings may suggest an original andesitic composition.

141012 **Dacite pumice feldspar crystal lithic tuff**

Analyses		Catanorms	
SiO_2	66.50	Calcite	.00
TiO_2	.69	Apatite	.24
Al_2O_3	14.20	Pyrite	.00
Tot. Fe	7.30	Ilmenite	.99
MnO	.09	Orthoclase	12.16
MgO	2.70	Albite	33.28
CaO	1.20	Anorthite	5.39
Na_2O	3.60	Corundum	4.72
K_2O	2.00	Magnetite	.00
P_2O_5	.11	Hematite	.00
L.O.I.	1.89	Diopside	.00
		Hypersthene	18.47
TOTAL	100.28	Quartz	24.75
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{14}

The rock contains conspicuous large lithic fragments which are pumice with spherical vesicles and sparse phenocrysts of plagioclase and opaques. The former glass of the pumice has altered to bright green chlorite. The rest of the rock consists of plagioclase fragments and a few aggregates of plagioclase and minor quartz, set in a quartzofeldspathic groundmass containing minor chlorite, sericite and opaques.

The chemistry is essentially unaltered dacite, although the corundum content of the norm suggests minor metasomatic sericitisation.

141013 **Fine rhyolite feldspar quartz crystal tuff**

Analyses		Catanorms	
SiO_2	75.00	Calcite	.00
TiO_2	.34	Apatite	.08
Al_2O_3	14.20	Pyrite	.00
Tot. Fe	2.30	Ilmenite	.48
MnO	.03	Orthoclase	25.10
MgO	.50	Albite	30.88
CaO	.05	Anorthite	-.01
Na_2O	3.40	Corundum	4.49
K_2O	4.20	Magnetite	.00
P_2O_5	.04	Hematite	.00
L.O.I.	.07	Diopside	.00
		Hypersthene	4.57
TOTAL	100.03	Quartz	34.40
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_o

Scattered 0.5 mm grains of albite, orthoclase and minor quartz are set in an abundant fine fragmental matrix of feldspar and quartz. Minor fine sericite forms a wispy foliation in the groundmass but this is probably a weak tectonic feature.

The rock has an unaltered rhyolitic chemistry.

141014 **Silicified rhyolite fine feldspar quartz crystal tuff**

Analyses		Catanorms	
SiO_2	77.90	Calcite	.00
TiO_2	.30	Apatite	.09
Al_2O_3	13.50	Pyrite	.00
Tot. Fe	2.10	Ilmenite	.43
MnO	.02	Orthoclase	10.33
MgO	.41	Albite	29.57
CaO	.09	Anorthite	.19
Na_2O	3.20	Corundum	7.11
K_2O	1.70	Magnetite	.00
P_2O_5	.04	Hematite	.00
L.O.I.	.60	Diopside	.00
		Hypersthene	4.11
TOTAL	99.86	Quartz	48.17
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

This rock is very similar to 141013 but it contains more conspicuous quartz fragments and some fine secondary biotite.

Chemically the rock has a rhyolitic composition but its normative quartz content is sufficiently high to indicate silicification. There is petrographic support for this in the form of several very narrow quartz veins.

GENERAL LOCATION: **Pinnacles**

141082 **Sheared (?)silicified sericitised (?)rhyolite**

Analyses		Catanorms	
SiO_2	77.90	Calcite	.00
TiO_2	.30	Apatite	.02
Al_2O_3	12.20	Pyrite	.00
Tot. Fe	1.20	Ilmenite	.45
MnO	.02	Orthoclase	29.64
MgO	.83	Albite	1.92
CaO	.00	Anorthite	-.07
Na_2O	.20	Corundum	7.94
K_2O	4.70	Magnetite	.00
P_2O_5	.01	Hematite	.00
L.O.I.	2.78	Diopside	.00
		Hypersthene	4.02
TOTAL	100.14	Quartz	56.09
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00

Norm. plag. An_0

In hand specimen the rock is a pale, hard, even-textured rock with a tectonic foliation. In thin section it is seen to consist of equidimensional grains of quartz with interstitial sericite. The sericite forms two sets of foliation planes.

Normatively the rock contains too much quartz and too little feldspar to be regarded as igneous. However, there is a general similarity to the chemistry of a rhyolite so the rock may be a silicified sericitised rhyolite.

141083 **Sericitised rhyolite lithic tuff**

Analyses		Catanorms	
SiO_2	69.00	Calcite	.00
TiO_2	.44	Apatite	.04
Al_2O_3	17.30	Pyrite	.00
Tot. Fe	1.40	Ilmenite	.65
MnO	.05	Orthoclase	41.41
MgO	1.20	Albite	2.48
CaO	.00	Anorthite	-.14
Na_2O	.26	Corundum	11.34
K_2O	6.60	Magnetite	.00
P_2O_5	.02	Hematite	.00
L.O.I.	3.96	Diopside	.00
		Hypersthene	5.25
TOTAL	100.23	Quartz	38.96
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

The rock consists of very fine sericite and quartz or feldspar but ghostly lithic fragmental textures can be plainly recognised. Parts of the specimen are sheared.

The rock was probably a rhyolite lithic tuff originally but it has been extensively metasomatically sericitised.

141084 **Mineralised silicified sericitised rhyolite pumice tuff agglomerate**

Analyses		Catanorms	
SiO_2	83.20	Calcite	.00
TiO_2	.25	Apatite	.05
Al_2O_3	8.50	Pyrite	.00
Tot. Fe	1.80	Ilmenite	.38
MnO	.01	Orthoclase	19.22
MgO	.50	Albite	.39
CaO	.00	Anorthite	-.14
Na_2O	.04	Corundum	6.20
K_2O	3.00	Magnetite	.00
P_2O_5	.02	Hematite	.00
L.O.I.	2.71	Diopside	.00
		Hypersthene	4.16
TOTAL	100.03	Quartz	69.76
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

The rock consists of large ragged fragments of sericitised filamentous pumice and a few fine grained quartzofeldspathic fragments. There are abundant veins and cavity fillings of quartz. There are no phenocrysts. Opaques, including sulphides, are present in the quartz veins and fillings.

The rock has chemistry of rhyolitic affinities but its norm plainly reflects metasomatic seritisation and very extensive silicification.

141086 Mineralised sericitised silicified rhyolite pumice tuff

Analyses		Catanorms	
SiO_2	69.10	Calcite	.00
TiO_2	.45	Apatite	.00
Al_2O_3	17.50	Pyrite	.00
Tot. Fe	1.90	Ilmenite	.68
MnO	.02	Orthoclase	29.90
MgO	1.20	Albite	4.06
CaO	.00	Anorthite	.00
Na_2O	.42	Corundum	13.78
K_2O	4.70	Magnetite	.00
P_2O_5	.00	Hematite	.00
L.O.I.	4.71	Diopside	.00
		Hypersthene	6.10
TOTAL	100.00	Quartz	45.49
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

This specimen represents the "sericite schist" from the east end of the Pinnacles trench. It is ver similar to 141084 but shows more sericitisation, more sulphide mineralisation and less silicification. In addition to occurring in quartz veins, the sulphides have preferentially replaced some of the smallest pumice fragments in which sericite is conspicuously coarser. The rock is not conspicuously schistose.

Chemically the rock is rhyolitic but shows more evidence of metasomatic sericitisation and less silicification than 141084.

141000 Albitised silicified rhyolite feldspar crystal tuff

Analyses		Catanorms	
SiO_2	81.00	Calcite	.00
TiO_2	.22	Apatite	.04
Al_2O_3	9.50	Pyrite	.00
Tot. Fe	1.20	Ilmenite	.32
MnO	.02	Orthoclase	12.95
MgO	.41	Albite	30.00
CaO	.48	Anorthite	2.35
Na_2O	3.20	Corundum	1.30
K_2O	2.10	Magnetite	.00
P_2O_5	.02	Hematite	.00
L.O.I.	1.94	Diopside	.00
		Hypersthene	2.84
TOTAL	100.09	Quartz	50.20
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_7

This is a conspicuously altered rock collected near the Comstaff campsite. It has large pink patches of albitisation and conspicuous thin dark veinlets.

In thin section it is seen to consist of plagioclase and orthoclase phenocrysts set in an even-grained, weakly sericitised quartzofeldspathic groundmass. It is probably a fragmental rock. Thin fissure fillings of quartz together with less abundant epidote and chlorite (presumably giving the dark colour in hand specimen) are abundant. Parts of the groundmass have been albitised but, again, this is inconspicuous in thin section compared with the hand specimen.

Chemically the rock is a rhyolite with a conspicuous excess of SiO_2.

141160 Vesicular andesite

Analyses		Catanorms	
SiO_2	53.50	Calcite	.00
TiO_2	.59	Apatite	.29
Al_2O_3	13.90	Pyrite	.00
Tot. Fe	8.10	Ilmenite	.88
MnO	.17	Orthoclase	4.01
MgO	6.10	Albite	11.60
CaO	10.00	Anorthite	33.04
Na_2O	1.20	Corundum	.00
K_2O	.63	Magnetite	.00
P_2O_5	.13	Hematite	.00
L.O.I.	3.67	Diopside	15.57
		Hypersthene	23.26
TOTAL	97.99	Quartz	11.35
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{74}

This is another sample of the same unit as 141159. It is a vesicular andesite or basalt, porphyritic in clinopyroxene and plagioclase. However it contains ovoid vesicles filled with quartz and carbonate and some feldspar phenocrysts have been very selectively replaced by quartz, epidote, chlorite and sericite. Veinlets of quartz are conspicuous.

Chemically this rock is consistent with silicified andesite or possibly basalt. Both 141159 and 141160 contain low enough TiO_2 to be andesite and are free of groundmass titanium-iron oxides which would be common in most basalts. The normative plagioclase composition of 141160 is no guide to classification because the carbonates in the rock alter the normative anorthite content.

The rock is probably Cambrian but final assessment must hinge on a field decision.

95877 **Vesicular dacite**

Analyses		Catanorms	
SiO_2	57.60	Calcite	.00
TiO_2	.62	Apatite	.61
Al_2O_3	12.50	Pyrite	.00
Tot. Fe	7.50	Ilmenite	.93
MnO	.15	Orthoclase	10.76
MgO	5.10	Albite	25.01
CaO	6.10	Anorthite	18.67
Na_2O	2.60	Corundum	.00
K_2O	1.70	Magnetite	.00
P_2O_5	.27	Hematite	.00
L.O.I.	2.53	Diopside	9.49
		Hypersthene	22.11
TOTAL	96.67	Quartz	12.42
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm plag.	An_{42}

This specimen closely resembles 141160 in being a fine grained greenish rock with pyroxene phenocrysts and ovoid vesicles filled with quartz and other minerals. Its thin section appearance is also essentially the same, except that minor secondary green biotite occurs as a replacement of some phenocrysts in addition to the other secondary minerals seen in 141160.

Chemically the rock has a simple dacite composition but it's likely that it was originally andesite and that the quartz veinlets and vesicle fillings have increased the normative quartz to that of a dacite.

95886 **Extremely silicified and mineralised rhyolite lithic feldspar quartz crystal tuff**

Analyses		Catanorms	
SiO_2	81.60	Calcite	.00
TiO_2	.39	Apatite	.00
Al_2O_3	8.00	Pyrite	.00
Tot. Fe	3.10	Ilmenite	.60
MnO	.00	Orthoclase	16.93
MgO	.43	Albite	.49
CaO	.00	Anorthite	.00
Na_2O	.05	Corundum	6.14
K_2O	2.60	Magnetite	.00
P_2O_5	.00	Hematite	.00
L.O.I.	3.01	Diopside	.00
		Hypersthene	6.00
TOTAL	99.18	Quartz	69.83
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

This is a conspicuously altered and mineralised rock with a very cherty aspect in fresh hand specimens but a fine grained volcanic appearance in weathered specimens. In thin section it is seen to consist largely of quartz irregularly distributed in abundance and grainsize. Rare relict subhedral quartz phenocrysts and ghosty lithic fragments and replaced feldspar fragments indicate that the rock was a lithic crystal tuff prior to very extensive silicification and less conspicuous sericitisation. Very fine sulphides are distributed abundantly throughout the rock, increased grainsizes and abundances being noted in some obvious replacement veinlets and selectively pseudomorphed original fragments.

The extreme silicification is conspicuous in the chemistry of the rock and, although it is largely a guess, the original parentage may have been rhyolitic. Support for this is low iron and titanium and the presence of some quartz phenocrysts.

95887 **Mineralised sericitised silicified dacite (?)crystal vitric tuff**

Analyses		Catanorms	
SiO_2	66.40	Calcite	.00
TiO_2	.49	Apatite	.68
Al_2O_3	16.10	Pyrite	.00
Tot. Fe	3.90	Ilmenite	.77
MnO	.02	Orthoclase	26.51
MgO	.83	Albite	2.01
CaO	.24	Anorthite	-.79
Na_2O	.20	Corundum	14.33
K_2O	4.00	Magnetite	.00
P_2O_5	.29	Hematite	.00
L.O.I.	3.37	Diopside	.00
		Hypersthene	8.62
TOTAL	95.84	Quartz	47.88
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

This pale green-grey rock has conspicuous small dark green droplet and shard-type shapes. These now consist of secondary green biotite, sericite, pennine and coarse quartz but their shapes are consistent with former vitric fragments. These fragments are set in a fine even-grained matrix of recrystallised quartz, feldspar and sericite. A notable feature is that very fine pyrite is disseminated abundantly and fairly evenly throughout the rock, a feature not conspicuous in hand specimen.

Chemically the rock has dacitic affinities but its norm reflects considerable silicification and sericitisation. Iron and titanium content are too low for an andesitic parentage.

GENERAL LOCATION: **Lyell**

141586 **Mineralised sericitised rhyolite feldspar quartz crystal tuff**

Analyses		Catanorms	
SiO_2	74.10	Calcite	.00
TiO_2	.51	Apatite	.13
Al_2O_3	14.60	Pyrite	.00
Tot. Fe	2.10	Ilmenite	.73
MnO	.03	Orthoclase	18.17
MgO	.48	Albite	34.06
CaO	.06	Anorthite	-.10
Na_2O	3.70	Corundum	5.94
K_2O	3.00	Magnetite	.00
P_2O_5	.06	Hematite	.00
L.O.I.	1.60	Diopside	.00
		Hypersthene	4.01
TOTAL	100.24	Quartz	37.05
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

The hand specimen has dilatational veins and contains pink feldspar resembling the colour of albitised rocks. In thin section the rock is seen to consist of abundant fragments of quartz, plagioclase and minor orthoclase set in a less abundant groundmass of pennine, sericite, quartz and feldspar. The plagioclase grains show minor recrystallisation but primary twinning and zoning is retained in many grains indicating that the pink colour is not attributable to albitisation. The dilatational veins traversing the section are filled with pennine, sulphides and acicular quartz, albite and microcline. Small replacement veinlets of these minerals and of sericite do permeate the surrounding rock.

The chemistry is rhyolite with minor metasomatic sericitisation. Neither the petrography nor the chemistry suggest significant metasomatic albitisation.

141587 **Albitised trachyte feldspar quartz crystal lithic tuff**

Analyses	
SiO_2	60.10
TiO_2	.50
Al_2O_3	15.70
Tot. Fe	8.70
MnO	.05
MgO	1.80
CaO	.30
Na_2O	4.60
K_2O	3.60
P_2O_5	.27
L.O.I.	2.47
TOTAL	98.09

Catanorms	
Calcite	.00
Apatite	.59
Pyrite	.00
Ilmenite	.73
Orthoclase	22.28
Albite	43.28
Anorthite	-.29
Corundum	4.97
Magnetite	.00
Hematite	.00
Diopside	.00
Hypersthene	18.68
Quartz	9.76
Olivine	.00
Nepheline	.00
TOTALS	100.00
Norm. plag.	An_0

The rock contains abundant fragments of feldspar and minor quartz, together with lithic fragments of similar size to the crystal fragments. Both plagioclase and orthoclase are present but all the feldspar is heavily sericitised. The lithic fragments consist mainly of opaque minerals and it is not clear whether this is an original feature (difficult to envisage) or a replacement feature. The matrix material is rich in sericite, opaques and chlorite. Some replacement veinlets of sericite impart a foliation to the rock.

On the basis of its norm the rock must be classified as trachyte. The Harker diagram for Na_2O indicates albitisation and this is confirmed by a pink patch of albitisation in the hand specimen. It was not seen in thin section. Since the rock contains quartz phenocrysts it may have been acid in composition but it does contain substantial iron and only 9.76% quartz so the term trachyte is probably a reasonable description.

141589 **Silicified sericitised dacite feldspar crystal tuff**

Analyses		Catanorms	
SiO_2	69.80	Calcite	.00
TiO_2	.42	Apatite	.16
Al_2O_3	12.80	Pyrite	.00
Tot. Fe	4.40	Ilmenite	.64
MnO	.04	Orthoclase	15.43
MgO	.91	Albite	23.45
CaO	1.10	Anorthite	5.44
Na_2O	2.40	Corundum	5.26
K_2O	2.40	Magnetite	.00
P_2O_5	.07	Hematite	.00
L.O.I.	2.73	Diopside	.00
		Hypersthene	9.58
TOTAL	97.07	Quartz	40.05
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{19}

This is a grey siliceous rock not unlike 95887 from Anomaly 8, except that it lacks former vitric fragments. It consists of sparse plagioclase and orthoclase phenocrysts set in an even quartzofeldspathic groundmass. A fragmental origin is not conspicuous but is suggested by one sericite aggregate resembling a shard and by several aggregates of crystals which are probably lithic fragments. Chlorite and sericite are abundant in the groundmass and impart a foliation to the rock. Several thin veinlets of quartz and sulphide, mainly dilatational, but partly replacement type, traverse the specimen.

Chemically the rock is a dacite or perhaps rhyodacite and its norm shows minor silicification and metasomatic sericitisation.

141590 **Silicified sericitised basalt lithic vitric tuff**

Analyses		Catanorms	
SiO_2	54.00	Calcite	.00
TiO_2	.52	Apatite	.55
Al_2O_3	13.90	Pyrite	.00
Tot. Fe	17.60	Ilmenite	.82
MnO	.39	Orthoclase	11.39
MgO	4.59	Albite	.51
CaO	.23	Anorthite	-.41
Na_2O	.05	Corundum	14.99
K_2O	1.70	Magnetite	.00
P_2O_5	.23	Hematite	.00
L.O.I.	4.11	Diopside	.00
		Hypersthene	44.87
TOTAL	97.23	Quartz	27.29
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm; plag.	An_0

The hand specimen is dark green with a phyllitic aspect but showing flattened lithic fragments. In thir section the fragments are seen to consist variously of sericite and chlorite, and some have conspicuous delicate shard shapes. The groundmass consists of abundant chlorite, untwinned feldspar, a surprising amount of quartz, sericite and scattered opaques. There is no evidence of strong shearing.

Chemically the rock contains too little normative feldspar to be an unaltered igneous rock. Its norm has 27% quartz compared with 54% total SiO_2 indicating either silicification or sedimentary additions; an igneous-type Al_2O_3 content favours silicification despite the lack of petrographic evidence of veining. High iron and magnesium plus low silicon indicates a basaltic parentage, although andesite is not precluded. High corundum indicates metasomatic sericitisation.

141591 | **Mineralised extremely silicified sericitised basalt lithic tuff**

Analyses		Catanorms	
SiO_2	58.10	Calcite	.00
TiO_2	.34	Apatite	.22
Al_2O_3	13.00	Pyrite	.00
Tot. Fe	14.70	Ilmenite	.55
MnO	.61	Orthoclase	14.35
MgO	2.70	Albite	.42
CaO	.03	Anorthite	-.51
Na_2O	.04	Corundum	13.66
K_2O	2.10	Magnetite	.00
P_2O_5	.09	Hematite	.00
L.O.I.	4.97	Diopside	.00
		Hypersthene	35.51
TOTAL	96.68	Quartz	35.81
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

This has a general similarity to 141590 but has larger, and sometimes more siliceous looking, rock fragments and some aggregates of sulphides similar in size and shape to the lithic fragments. In thin section the coarse nature of the fragments is emphasised even more but the secondary mineralogy of chlorite, sericite, feldspar and quartz is the same. Minor carbonate is also present. The sulphides are present as cavity fillings and replacement veinlets, not primary fragments. They are closely associated with coarse quartz and sericite.

Chemically the rock resembles 141590 and is therefore basaltic or andesitic. It is more strongly silicified. The silicification can be observed petrographically in this specimen.

141592 **Recrystallised reworked acid volcanic rock**

Analyses		Catanorms	
SiO_2	72.70	Calcite	.00
TiO_2	.21	Apatite	.05
Al_2O_3	10.30	Pyrite	.00
Tot. Fe	8.20	Ilmenite	.33
MnO	.54	Orthoclase	1.40
MgO	1.80	Albite	.51
CaO	.00	Anorthite	-.15
Na_2O	.05	Corundum	12.41
K_2O	.21	Magnetite	.00
P_2O_5	.02	Hematite	.00
L.O.I.	2.91	Diopside	.00
		Hypersthene	20.63
TOTAL	96.94	Quartz	64.82
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

This dark green rock has a more "sandy" appearance and consists of a chlorite and sericite rich recrystallised quartzo-feldspathic mosaic containing a few relict large grains of beta-quartz. Several of these grains are conspicuously rounded in a fashion attributable to sedimentary processes. Despite its fine grained mosaic texture now, the rock has a ghosty texture under plain light of grains similar in size and shape to the large quartz grains and it is almost certainly a reworked tuff. There are a few disseminated grains of sulphide.

Chemically the rock is dominated by quartz, hypersthene (reflecting chlorite) and corundum (reflecting muscovite). This mineralogy is consistent with an immature sandstone.

The specimen is very significant because it occurs near the Lyell mineralisation and is of subaqueous origin.

141593 Silicified recrystallised reworked acid volcanic rock

Analyses		Catanorms	
SiO_2	75.90	Calcite	.00
TiO_2	.22	Apatite	.04
Al_2O_3	11.40	Pyrite	.00
Tot. Fe	6.50	Ilmenite	.33
MnO	.08	Orthoclase	19.04
MgO	1.00	Albite	.77
CaO	.00	Anorthite	-.14
Na_2O	.08	Corundum	9.47
K_2O	3.00	Magnetite	.00
P_2O_5	.02	Hematite	.00
L.O.I.	2.29	Diopside	.00
		Hypersthene	13.59
TOTAL	100.49	Quartz	56.90
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

Thi- rock has a phyllitic sandy appearance and shows similar sparse rounded beta-quartz grains comparable to those in 141592. It also now consists of a mosaic of quartz, feldspar, sericite and chlorite but its remnant former fabric is not as well preserved as in 141592. It is possibly more poorly sorted. There are diffuse replacement veinlets of quartz and scattered grains of sulphide.

The high SiO_2 combined with very low normative feldspar, brand the rock as reworked but the beta-quartz relics indicate acid igneous affinities.

99211 **Sericitised dacite feldspar quartz crystal pumice tuff**

Analyses		Catanorms	
SiO_2	64.30	Calcite	.00
TiO_2	.46	Apatite	.18
Al_2O_3	16.60	Pyrite	.00
Tot. Fe	4.30	Ilmenite	.67
MnO	.12	Orthoclase	34.79
MgO	2.50	Albite	11.33
CaO	1.40	Anorthite	6.75
Na_2O	1.20	Corundum	7.13
K_2O	5.60	Magnetite	.00
P_2O_5	.08	Hematite	.00
L.O.I.	2.67	Diopside	.00
		Hypersthene	13.79
TOTAL	99.23	Quartz	25.36
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{37}

The rock consists mainly of abundant ser citised feldspar fragments (mainly plagioclase), quartz and sericitised irregularly shaped lithic fragments which were probably filamentous pumice. Epidote minerals, chlorite and opaques are disseminated through the rock and also form veinlets.

Chemically the rock is a dacite, or perhaps rhyodacite, showing metasomatic sericitisation.

141844 **Albitised carbonatised silicified andesite feldspar crystal tuff**

Analyses		Catanorms	
SiO_2	63.80	Calcite	.00
TiO_2	.60	Apatite	.02
Al_2O_3	14.40	Pyrite	.00
Tot. Fe	2.80	Ilmenite	.88
MnO	.21	Orthoclase	16.26
MgO	1.20	Albite	47.53
CaO	3.20	Anorthite	9.72
Na_2O	5.00	Corundum	.00
K_2O	2.60	Magnetite	.00
P_2O_5	.01	Hematite	.00
L.O.I.	5.78	Diopside	5.62
		Hypersthene	4.75
TOTAL	99.60	Quartz	15.21
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{17}

In outcrop this rock is extremely tough and massive and has a pale cream colour. In thin section it can be seen that it was a crystal tuff consisting mainly of plagioclase fragments with occasional finegrained lithic fragments. It has been extensively recrystallised to a fine grained quartzofeldspathic mosaic, extensively replaced by carbonate and flecked by sericite. One dilatational veinlet containing coarse quartz and carbonate can be seen.

Prior to petrographic examination the rock was classified as a dacite but the Harker variation diagram indicated major albitisation (neither confirmed or precluded by the thin section) and it is now apparent that silicification and carbonatisation have occurred. Since there is no evidence of quartz phenocrysts, the rock was probably andesitic, rather than dacitic, prior to alteration.

GENERAL LOCATION: Rosebery mine

141250 Rhyodacite agglomerate

Analyses		Catanorms	
SiO_2	71.80	Calcite	.00
TiO_2	.36	Apatite	.16
Al_2O_3	13.10	Pyrite	.00
Tot. Fe	2.80	Ilmenite	.53
MnO	.17	Orthoclase	18.22
MgO	.50	Albite	26.69
CaO	1.30	Anorthite	6.37
Na_2O	2.90	Corundum	3.48
K_2O	2.90	Magnetite	.00
P_2O_5	.07	Hematite	.00
L.O.I.	2.15	Diopside	.00
		Hypersthene	5.83
TOTAL	98.05	Quartz	37.71
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{19}

This is the agglomerate from the hanging wall. The section is too small to be representative of the material analysed but it does reveal sericitisation, silicification and carbonatisation in the form of veinlets and pseudomorphs.

The bulk chemistry, in contrast, shows a rhyodacitic composition with no conspicuously abnormal features.

141254 Mineralised barytes-bearing sericite-quartz schist

Analyses		Catanorms	
SiO_2	58.40	Calcite	.00
TiO_2	.58	Apatite	.38
Al_2O_3	16.80	Pyrite	.00
Tot. Fe	3.60	Ilmenite	.93
MnO	.76	Orthoclase	33.93
MgO	1.80	Albite	3.09
CaO	1.80	Anorthite	9.06
Na_2O	.30	Corundum	10.04
K_2O	5.00	Magnetite	.00
P_2O_5	.16	Hematite	.00
L.O.I.	6.71	Diopside	.00
		Hypersthene	12.55
TOTAL	93.91	Quartz	30.01
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{74}

This is "host rock" from 15 level. It is a schist composed of sericite and quartz. Quartz also occurs as discrete bands parallel to the schistosity and containing barytes and minor carbonate and sphalerite. A few opaque sulphides are scattered through the rock. A few larger rolled quartz grains and carbonate pseudomorphs apparently after feldspar suggests a volcanic contribution in the original rock type.

The chemistry of the rock confirms that it is inconsistent with a simple igneous composition.

141255 Mineralised (?)chert

Analyses		Catanorms	
SiO_2	76.90	Calcite	.00
TiO_2	.24	Apatite	.07
Al_2O_3	9.60	Pyrite	.00
Tot. Fe	3.70	Ilmenite	.37
MnO	.15	Orthoclase	16.33
MgO	.63	Albite	1.09
CaO	.00	Anorthite	-.22
Na_2O	.11	Corundum	8.19
K_2O	2.50	Magnetite	.00
P_2O_5	.03	Hematite	.00
L.O.I.	3.16	Diopside	.00
		Hypersthene	11.58
TOTAL	99.02	Quartz	62.59
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

This is a "quartz schist" from the footwall of 15 level. It consists of alternating bands composed of sphalerite and sericite, quartz mosaics with sericite and simple quartz mosaics. There is some disseminated pyrite.

The rock is probably essentially a mineralised chert, but whether it formed as a sediment or by extreme silicification of some other rock is quite uncertain.

141257 **Sericite schist of andesitic or dacitic affinities**

Analyses		Catanorms	
SiO_2	67.40	Calcite	.00
TiO_2	.31	Apatite	.21
Al_2O_3	11.60	Pyrite	.00
Tot. Fe	4.90	Ilmenite	.49
MnO	.14	Orthoclase	14.68
MgO	3.20	Albite	2.43
CaO	1.80	Anorthite	9.42
Na_2O	.24	Corundum	7.12
K_2O	2.20	Magnetite	.00
P_2O_5	.09	Hematite	.00
L.O.I.	5.18	Diopside	.00
		Hypersthene	18.32
TOTAL	97.06	Quartz	47.32
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{79}

This is "host rock" from 15 level. It is a sericite schist containing bands and augen of quartz with minor chlorite and scattered carbonate. There are rare grains of tourmaline and scattered sulphides. Several carbonate aggregates resemble tectonically rolled grains, phenocrysts or fragments of subhedral feldspar.

The chemistry of the rock is compatible with sericitised and silicified andesite or dacite.

141264 Chert

Analyses		Catanorms	
SiO_2	75.60	Calcite	.00
TiO_2	.31	Apatite	.49
Al_2O_3	10.80	Pyrite	.00
Tot. Fe	2.80	Ilmenite	.48
MnO	.04	Orthoclase	21.10
MgO	.75	Albite	1.80
CaO	.07	Anorthite	-1.15
Na_2O	.18	Corundum	9.04
K_2O	3.20	Magnetite	.00
P_2O_5	.21	Hematite	.00
L.O.I.	2.21	Diopside	.00
		Hypersthene	6.74
TOTAL	96.17	Quartz	61.49
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

Chert from the hanging wall of F lens. This is an extremely fine grained mixture of quartz and sericite cut by a few veins carrying various proportions of quartz, carbonate, sulphides and chlorite. The texture is more compatible with an original chert than with a silicified rock.

The chemistry confirms domination by quartz and sericite but is otherwise uninformative.

141270 **Sheared sericitised acid crystal tuff**

Analyses		Catanorms	
SiO_2	61.40	Calcite	.00
TiO_2	.69	Apatite	.30
Al_2O_3	20.40	Pyrite	.00
Tot. Fe	3.10	Ilmenite	1.05
MnO	.02	Orthoclase	33.49
MgO	1.80	Albite	4.89
CaO	.07	Anorthite	-.55
Na_2O	.50	Corundum	16.82
K_2O	5.20	Magnetite	.00
P_2O_5	.13	Hematite	.00
L.O.I.	4.37	Diopside	.00
		Hypersthene	9.64
TOTAL	97.68	Quartz	34.36
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

This is "host rock" from the surface. It is a sericite schist containing numerous relict chips of quartz of pyroclastic origin. Some aggregates of sericite appear to represent pseudomorphs after feldspar.

The chemistry of the rock is acid but with major metasomatic sericitisation.reflected in its high normative corundum. In view of the abundance of relict quartz, the rock may well have been rhyolitic.

GENERAL LOCATION: South of Queenstown

145061 **Sericitised silicified rhyolite lithic feldspar quartz crystal tuff**

Analyses		Catanorms	
SiO_2	73.20	Calcite	.00
TiO_2	.22	Apatite	.09
Al_2O_3	13.40	Pyrite	.00
Tot. Fe	2.70	Ilmenite	.33
MnO	.01	Orthoclase	26.52
MgO	1.00	Albite	13.43
CaO	.01	Anorthite	-.23
Na_2O	1.40	Corundum	7.74
K_2O	4.20	Magnetite	.00
P_2O_5	.04	Hematite	.00
L.O.I.	3.43	Diopside	.00
		Hypersthene	7.11
TOTAL	99.61	Quartz	45.01
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

The rock is a lithic crystal tuff of acid composition. One striking fragment consists of quartz and orthoclase phenocrysts in a micrographic groundmass. Other fragments consist of quartz or feldspar or fine tuff, all set in a stringy matrix of sericitised (?)pumice.

The chemistry is consistent with sericitised silicified rhyolite.

145062 **Albitised trachyte feldspar pyroxene quartz crystal lithic tuff**

Analyses		Catanorms	
SiO_2	55.10	Calcite	.00
TiO_2	.89	Apatite	.25
Al_2O_3	15.30	Pyrite	.00
Tot. Fe	9.60	Ilmenite	1.33
MnO	.10	Orthoclase	13.96
MgO	3.90	Albite	43.39
CaO	1.10	Anorthite	5.09
Na_2O	4.50	Corundum	4.44
K_2O	2.20	Magnetite	.00
P_2O_5	.11	Hematite	.00
L.O.I.	4.36	Diopside	.00
		Hypersthene	26.37
TOTAL	97.16	Quartz	5.17
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{10}

The rock consists of numerous grains of plagioclase and lesser orthoclase plus conspicuous euhedral clinopyroxene (rims altered to pale actinolite and forming rolled pressure trails), conspicuous but not abundant quartz, one euhedral grain of hornblende, several trachytic feldspathic and quartzofeldspathic rock fragments, and scattered large opaque grains.

Chemically the rock is a trachyte but its Na_2O content is so high that albitisation is indicated. Pink patches consistent with albitisation are visible in hand specimen but are not present in thin section.

145064 Silicified sericitised rhyolite lithic tuff

Analyses		Catanorms	
SiO_2	78.30	Calcite	.00
TiO_2	.23	Apatite	.07
Al_2O_3	9.90	Pyrite	.00
Tot. Fe	3.80	Ilmenite	.34
MnO	.05	Orthoclase	17.53
MgO	1.70	Albite	11.42
CaO	.08	Anorthite	.21
Na_2O	1.20	Corundum	5.58
K_2O	2.80	Magnetite	.00
P_2O_5	.03	Hematite	.00
L.O.I.	2.72	Diopside	.00
		Hypersthene	10.95
TOTAL	100.81	Quartz	53.91
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_2

This rock has a fairly simple texture dominated by fine grained acid rock fragments and a few fragments of orthoclase, plagioclase and quartz together with several streaky sericitic (?)pumice fragments. Under crossed polars extensive recrystallisation is apparent and there is veining by quartz, sericite and chlorite. There are some secondary opaques.

Chemically the rock is a rhyolite but its norm indicates metasomatic addition of quartz and sericite.

145067 Silicified sericitised dacite feldspar quartz crystal (?)tuff

Analyses		Catanorms	
SiO_2	70.30	Calcite	.00
TiO_2	.49	Apatite	.18
Al_2O_3	15.30	Pyrite	.00
Tot. Fe	3.50	Ilmenite	.75
MnO	.02	Orthoclase	16.87
MgO	.63	Albite	11.83
CaO	.01	Anorthite	-.52
Na_2O	1.20	Corundum	12.81
K_2O	2.60	Magnetite	.00
P_2O_5	.08	Hematite	.00
L.O.I.	3.97	Diopside	.00
		Hypersthene	7.15
TOTAL	98.10	Quartz	50.92
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

This is a heavily sericitised rock containing remnant feldspar and minor quartz. Some of the streaks of sericite may represent original shardy material but it is equally likely that the streakiness is tectonic. The specimen is veined with quartz and minor chlorite.

The chemistry is probably dacitic but the norm indicates silicification and metasomatic sericitisation.

145069 Albitised chloritised basalt

Analyses		Catanorms	
SiO_2	51.70	Calcite	.00
TiO_2	.49	Apatite	.16
Al_2O_3	16.10	Pyrite	.00
Tot. Fe	11.10	Ilmenite	.74
MnO	.13	Orthoclase	13.47
MgO	4.80	Albite	44.85
CaO	.16	Anorthite	.36
Na_2O	4.60	Corundum	7.28
K_2O	2.10	Magnetite	.00
P_2O_5	.07	Hematite	.00
L.O.I.	4.26	Diopside	.00
		Hypersthene	32.54
TOTAL	95.51	Quartz	.58
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{180}

The rock consists of ragged recrystallised phenocrysts of plagioclase set in a matrix of feldspar laths, abundant subhedral magnetite grains and oriented secondary chlorite flakes. Some magnetite, hematite and limonite occurs in veinlets parallel to the chlorite foliation. The rock was probably a crystalline basalt prior to recrystallisation.

Chemically the rock is a basalt but it contains so much Na_2O that it must be albitised and its corundum content is also high, presumably related to metasomatic chloritisation, rather than sericitisation (in view of the visible mineralogy).

GENERAL LOCATION: Mt Read road

141781 **Basalt lithic tuff**

Analyses		Catanorms	
SiO_2	50.50	Calcite	.00
TiO_2	.97	Apatite	.30
Al_2O_3	15.90	Pyrite	.00
Tot. Fe	14.10	Ilmenite	1.51
MnO	.48	Orthoclase	5.87
MgO	3.10	Albite	14.04
CaO	5.50	Anorthite	29.54
Na_2O	1.40	Corundum	3.60
K_2O	.89	Magnetite	.00
P_2O_5	.13	Hematite	.00
L.O.I.	4.12	Diopside	.00
		Hypersthene	33.30
TOTAL	97.09	Quartz	11.84
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{68}

The rock is a heavily recrystallised lithic tuff now consisting of epidote group minerals, albite, chlorite, sphene and green biotite.

Its chemistry is not conspicuously altered but high normative quartz suggests possible silicification. There is no petrographic support.

It is interesting to note that this rock resembles a sandy rock in hand specimen but this texture is presumably a reflection of the epidote grains.

141787 Sheared sericitised dacite lithic tuff

Analyses		Catanorms	
SiO_2	62.50	Calcite	.00
TiO_2	.41	Apatite	.09
Al_2O_3	15.90	Pyrite	.00
Tot. Fe	3.60	Ilmenite	.63
MnO	.06	Orthoclase	28.88
MgO	1.30	Albite	20.95
CaO	.84	Anorthite	4.34
Na_2O	2.10	Corundum	7.59
K_2O	4.40	Magnetite	.00
P_2O_5	.04	Hematite	.00
L.O.I.	7.69	Diopside	.00
		Hypersthene	9.65
TOTAL	98.84	Quartz	27.85
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{17}

The rock is a slightly sheared lithic tuff now composed mainly of untwinned feldspar, quartz, sericite, secondary opaques and chlorite. There are a few remnant phenocrysts of twinned plagioclase. Some lithic fragments are large.

Chemically the rock is a dacite and its norm indicates metasomatic sericitisation.

141785 Recrystallised vesicular basalt

Analyses		Catanorms	
SiO_2	43.50	Calcite	.00
TiO_2	1.10	Apatite	.38
Al_2O_3	18.00	Pyrite	.00
Tot. Fe	13.10	Ilmenite	1.62
MnO	.20	Orthoclase	33.86
MgO	4.50	Albite	.00
CaO	10.90	Anorthite	34.85
Na_2O	3.40	Corundum	.00
K_2O	.30	Magnetite	.00
P_2O_5	.17	Hematite	.00
L.O.I.	4.72	Diopside	16.90
		Hypersthene	.00
TOTAL	99.89	Quartz	.00
		Olivine	18.63
		Nepheline	19.36
		TOTALS	100.00
		Norm. plag.	An_{100}

This is a greenish rock with small dark shard and droplet-like textures which are actually small vesicles. A few sub-spherical vesicles were seen in outcrop and the field identification was "andesite flow".

In thin section the rock is plainly a crystalline basalt which has undergone recrystallisation mainly of its mafic minerals to chlorite, actinolite, epidote minerals and sphene. The original lath textures of the plagioclase are well preserved. There are many small irregular vesicles filled with chlorite that have a superficial resemblance to shard shapes. There are several thin veinlets of epidote minerals and chlorite.

Chemically the rock is a basalt but its recrystallisation has not been isochemical and it appears to have lost SiO_2. The norm calculation looks peculiar in that 0.30% K_2O has produced 33.86% orthoclase, some calculating peculiarity that I am at loss to explain.

141779 Silicified rhyolite pumice tuff agglomerate

Analyses		Catanorms	
SiO_2	78.00	Calcite	.00
TiO_2	.32	Apatite	.09
Al_2O_3	12.20	Pyrite	.00
Tot. Fe	2.60	Ilmenite	.46
MnO	.07	Orthoclase	14.03
MgO	.28	Albite	28.74
CaO	.30	Anorthite	1.27
Na_2O	3.10	Corundum	4.69
K_2O	2.30	Magnetite	.00
P_2O_5	.04	Hematite	.00
L.O.I.	1.54	Diopside	.00
		Hypersthene	4.61
TOTAL	100.75	Quartz	46.11
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_4

This is a pumice tuff agglomerate in which some pumice fragments have been replaced by fairly coarse epidote minerals and chlorite (these appear greenish in hand specimen) and others have been devitrified mainly to fine feldspars, quartz and sericite. The pumice is mainly filamentous and gives very ragged, squashed shapes. The pumice contains scattered phenocrysts of albite and orthoclase. There is conspicuous silicification in the form of thin dilatational veinlets of quartz. There are also some veinlets of epidote minerals.

Chemically the rock is plainly rhyolitic but its norm contains enough quartz to indicate metasomatic silicification.

There are a few grains of sulphide in the specimen.

141788 **Recrystallised silicified rhyolite pumice tuff agglomerate**

Analyses		Catanorms	
SiO_2	82.60	Calcite	.00
TiO_2	.28	Apatite	.00
Al_2O_3	10.40	Pyrite	.00
Tot. Fe	1.80	Ilmenite	.40
MnO	.02	Orthoclase	17.75
MgO	.38	Albite	15.81
CaO	.07	Anorthite	.36
Na_2O	1.70	Corundum	4.91
K_2O	2.90	Magnetite	.00
P_2O_5	.00	Hematite	.00
L.O.I.	1.52	Diopside	.00
		Hypersthene	3.60
TOTAL	101.67	Quartz	57.16
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_2

This specimen is also a pumice tuff agglomerate but it differs in showing coarser recrystallisation so that under crossed polars a quartzofeldspathic mosaic dominates. In hand specimen or under plain light the original porphyritic filamentous pumice fragments can be seen. The remnant phenocrysts are albite and minor orthoclase. Original vesicle walls are outlined by sericite.

The chemistry of the rock is similar to 141779 and shows evidence of even more silicification despite the fact that no quartz veins can be seen. Presumably the recrystallisation has obscured any introduced quartz.

GENERAL LOCATION: **North of Queenstown**

99150 **Sericitised dacite feldspar quartz crystal tuff**

Analyses		Catanorms	
SiO_2	63.10	Calcite	.00
TiO_2	1.30	Apatite	.27
Al_2O_3	15.20	Pyrite	.00
Tot. Fe	7.80	Ilmenite	1.96
MnO	.03	Orthoclase	15.98
MgO	3.30	Albite	14.57
CaO	.13	Anorthite	-.15
Na_2O	1.50	Corundum	11.91
K_2O	2.50	Magnetite	.00
P_2O_5	.12	Hematite	.00
L.O.I.	4.04	Diopside	.00
		Hypersthene	21.02
TOTAL	99.02	Quartz	34.45
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00

Norm. plag. An_0

The rock consists of angular fragments of quartz, intensely sericitised plagioclase and opaque minerals. There is minor chlorite and conspicuous limonite (probably a weathering effect).

Chemically and mineralogically the rock is a dacite but it may have been described as an andesite in earlier chemical identification because of its high TiO_2 and iron contents. The intense sericitisation of the feldspars is reflected in the high normative corundum.

99156 **Sericitised silicified rhyolite pumice tuff agglomerate**

Analyses		Catanorms	
SiO_2	77.00	Calcite	.00
TiO_2	.28	Apatite	.07
Al_2O_3	13.40	Pyrite	.00
Tot. Fe	1.80	Ilmenite	.41
MnO	.02	Orthoclase	25.48
MgO	.46	Albite	10.39
CaO	.02	Anorthite	-.10
Na_2O	1.10	Corundum	8.26
K_2O	4.10	Magnetite	.00
P_2O_5	.03	Hematite	.00
L.O.I.	2.37	Diopside	.00
		Hypersthene	3.89
TOTAL	100.58	Quartz	51.60
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

The rock consists of heavily sericitised filamentous pumice fragments with sericitised ,phenocrysts of plagioclase and sparse phenocrysts of quartz. Some fragments are quite large.

The norm is rhyolitic but indicates metasomatic sericitisation and silicification. There is no textural evidence for the addition of quartz but the norm of 51.6% quartz is abnormally high.

99157 **Sericitised silicified rhyolite pumice feldspar quartz crystal tuff**

Analyses		Catanorms	
SiO_2	75.20	Calcite	.00
TiO_2	.43	Apatite	.13
Al_2O_3	15.00	Pyrite	.00
Tot. Fe	3.30	Ilmenite	.62
MnO	.02	Orthoclase	20.88
MgO	1.20	Albite	7.84
CaO	.08	Anorthite	.00
Na_2O	.84	Corundum	11.28
K_2O	3.40	Magnetite	.00
P_2O_5	.06	Hematite	.00
L.O.I.	3.25	Diopside	.00
		Hypersthene	8.17
TOTAL	102.78	Quartz	51.08
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

The rock consists of abundant sericitised filamentous pumice fragments, sericitised feldspar fragments and quartz fragments. Some feldspar fragments and pumice fragments have been pseudomorphed by albite and chlorite but it is not clear from the chemistry of the rock whether this has involved metasomatic albitisation. Replacement veins of sulphide are present.

The chemistry appears rhyolitic and suggests metasomatic sericitisation and silicification to produce a composition very similar to samples 99155 and 99156.

99159 Sericitised silicified recrystallised porphyritic andesite

Analyses		Catanorms	
SiO_2	60.30	Calcite	.00
TiO_2	.62	Apatite	.49
Al_2O_3	14.60	Pyrite	.00
Tot. Fe	8.40	Ilmenite	.97
MnO	.04	Orthoclase	23.27
MgO	4.00	Albite	1.32
CaO	.00	Anorthite	-1.55
Na_2O	.15	Corundum	13.60
K_2O	3.50	Magnetite	.00
P_2O_5	.21	Hematite	.00
L.O.I.	5.27	Diopside	.00
		Hypersthene	26.17
TOTAL	97.09	Quartz	35.52
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

The rock appears to have consisted of subhedral grains of hornblende, feldspar and quartz set in a fine groundmass. The feldspars have been pseudomorphed by sericite and the hornblende by chlorite, sericite and opaque oxides. The groundmass has recrystallised to a sericite and chlorite rich quartzofeldspathic mosaic. Despite the fragmental appearance of the hand specimen, the remnant textures of the thin section may be compatible with a porphyritic crystalline rock.

The chemistry of the rock is altered. The corundum content reflects sericitisation and the low feldspar, high quartz contents suggest silicification. The parent rock was probably andesite. The TiO_2 and iron contents and the abundance of former mafic minerals support this. There is no petrographic proof of silicification.

99162 **Sericitised silicified recrystallised andesitic lithic (?)crystal tuff**

Analyses		Catanorms	
SiO_2	64.00	Calcite	.00
TiO_2	.47	Apatite	.05
Al_2O_3	12.60	Pyrite	.00
Tot. Fe	7.00	Ilmenite	.74
MnO	.07	Orthoclase	19.47
MgO	3.40	Albite	4.59
CaO	.24	Anorthite	1.20
Na_2O	.45	Corundum	10.34
K_2O	2.90	Magnetite	.00
P_2O_5	.02	Hematite	.00
L.O.I.	3.90	Diopside	.00
		Hypersthene	22.36
TOTAL	95.05	Quartz	41.25
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_{20}

The textures are poorly preserved in this rock, but appear to be those of a lithic crystal tuff. The rock consists of fine quartz and feldspar with stringy foliated sericite and patches of chlorite which seem to be pseudomorphous after amphibole or pyroxene. There are a few recrystallised and replaced feldspar fragments and sparse recrystallised beta-quartz grains. Inconspicuous replacement veinlets of quartz and chlorite are visible.

The chemistry is quite similar to 99139 with the titanium and iron contents indicating andesite, but with sericitisation and silicification indicated by the corundum and quartz contents of the norm.

99163 **Foliated sericitised silicified basalt lithic vitric tuff**

Analyses		Catanorms	
SiO_2	48.40	Calcite	.00
TiO_2	1.40	Apatite	1.08
Al_2O_3	24.90	Pyrite	.00
Tot. Fe	10.90	Ilmenite	2.19
MnO	.25	Orthoclase	26.51
MgO	.20	Albite	9.77
CaO	.42	Anorthite	-1.04
Na_2O	.97	Corundum	23.66
K_2O	4.00	Magnetite	.00
P_2O_5	.46	Hematite	.00
L.O.I.	5.13	Diopside	.00
		Hypersthene	17.81
TOTAL	97.03	Quartz	20.03
		Olivine	.00
		Nepheline	.00
		TOTALS	100.00
		Norm. plag.	An_0

The rock has a prominent cleavage in hand specimen and has been extensively recrystallised to sericite, chlorite and opaques. Nevertheless, it retains recognisable lithic and shard-type textures in thin section. There are veinlets of sericite and chlorite.

Low SiO_2, high TiO_2 and high iron indicate basaltic parentage but the low normative feldspar, high corundum and high quartz all indicate metasomatic alteration.

List of miscellaneous slides

Location: North of Farm Creek, Murchison Highway

96015 Flow banded dacite

This rock contains scattered phenocrysts of plagioclase set in a flow-banded matrix of sericitised feldspar with some quartz, chlorite and opaques. It is probably a dacite. There is little doubt that the foliation is flow-banding.

Location: North of Farm Creek

96005 Spherulitic rhyolite

This rock has an unusual hand specimen texture of subspherical pink feldspar aggregates containing specks of quartz. In thin section the specimen is seen to consist of euhedral and subhedral phenocrysts of quartz, albite and orthoclase set in a micrographic groundmass composed of spherulites which are frequently centred on quartz grains. The rock was probably a porphyritic glassy rhyolite which has devitrified to a spherulitic texture.

Location: North of Farm Creek

96011 Albitised chloritised (?)dacite pumice feldspar crystal tuff

This rock is dark green but shows crudely spherulitic textures of a mauve colour. It is quite different from 96005 in thin section. It seems to be a pumice crystal tuff in which spherical vesicles have been filled by finely crystalline albite whilst their walls have devitrified to chlorite. The whole rock is dominated by albite, chlorite and secondary opaque grains. There are some remnant plagioclase fragments. There are veinlets of albite, quartz and chlorite. One particularly regular spherulitic type texture of albite and chlorite bands is almost certainly an intergrowth formed by selective zonal replacement of a former plagioclase aggregate as the same texture in an incipient form of development can be seen close by.

Location: Chester

141093 Sericitised silicified mineralised rhyolite (?)pumice tuff

The rock consists of fine grained feldspar, quartz and sericite with scattered larger sulphide grains. There are no phenocrysts. The rock has abundant, but vague swirly textures which possibly represent recrystallised pumice. It closely resembles sericitised, silicified and mineralised rhyolite tuff agglomerates near the Pinnacles, but its original fragment size was probably finer.

Location: Pinnacles access road

141098 Recrystallised rhyolite

This is a massive cream-coloured siliceous rock which in thin section is seen to contain small, very euhedral phenocrysts of quartz set in a mosaic groundmass of quartz and very fine sericite. The quartz phenocrysts have quartz overgrowths and there are a few narrow quartz veinlets. There are a few veinlets of limonite, some pseudomorphous after pyrite. The rock is almost certainly a recrystallised rhyolite flow or intrusion.

Location: Pinnacles Trench

141581 Mineralised silicified sericitised fine pumice quartz feldspar crystal tuff

The rock is indisputably an unsorted fine tuffaceous rock initially composed of filamentous pumice fragments and feldspar and quartz fragments. It is peculiar in containing some ovoid and even perfectly spherical radiating aggregates of quartz comparable in size to the volcanic quartz fragments. Some of these appear to be gash veins but the spherical types are difficult to explain. They do not seem consistent with vesicles. There are some simple quartz veins in the rock. Extensive sericitisation has occurred and sulphides have been introduced.

Location: Farrell (Tullah) Tramway

141007A Andesite (or dacite) feldspar crystal vitric lithic tuff

The rock consists of abundant lightly sericitised plagioclase fragments, well formed shards pseudomorphed by chlorite, and a few lithic fragments, all set in feldspathic chlorite-rich groundmass. There are a few primary opaque grains and secondary leucoxene.

Despite the pink colour of the feldspar in hand specimen, it does not appear to have been albitised.

Location: Tullah-Rosebery road

141036 Recrystallised basalt

This rock has a sandy appearance in hand specimen but in thin section its texture suggests that it may have been an igneous porphyritic flow. It now consists of actinolite, epidote, chlorite, albite, opaques and sericite. It is probably a basalt that has suffered low grade metamorphism.

An epidote bearing volcanic rock near Mt Read was also misidentified in the field as reworked, so it seems that abundant epidote can be misleading in hand specimen textures.

Location: West of Mackintosh Damsite

141108 Laminated volcanic siltstone or ash

In outcrop this rock is abundantly laminated and of plainly sedimentary volcanic aspect, thought to be reworking. In thin section this specimen is plainly laminated but is inconclusive as a reworked rock because it is very fine grained and has abundant secondary sericite and chlorite - no positive clastic textures are visible. Veinlets of sericite, limonite and quartz traverse the section. The rock could be siltstone or ash, but from memory there were shale and chert fragments floating near the outcrop, favouring siltstone.

Location: Bulgobac Swamp

141049 Greywacke

The rock is a greywacke showing poor rounding and fairly poor sorting. It contains abundant quartz, some of which is recognisable as having been volcanic beta-quartz. There is untwinned feldspar and probably a few grains of microcline. Detrital coarse muscovite and chlorite and a few grains of weathered biotite are very conspicuous; these are not derived from the volcanics and must have a source in the basement rocks. There are a few fine grained sericitic rock fragments which may be volcanic in origin. Minor minerals include tourmaline, opaques and one grain of definite picotite (chrome spinel, originating in ultrabasic rocks).

Location: Que River west of highway (Forestry Road)

141023 Rhyolite pumice vitric feldspar quartz crystal tuff

This rock has excellently preserved ash-flow textures. It contains numerous finely recrystallised ragged filamentous pumice fragments, sericitised shards, and fragments of plagioclase, orthoclase and beta-quartz. There seems to be some remobilisation of sericite into veinlets resembling stylolites.

Location: Que River west of highway

141157 **Phyllite with volcanic crystal fragments**

The rock consists of crenulated fine muscovite and chlorite (two foliation directions) with quartz and feldspar, specked with large angular fragments of volcanic quartz and feldspar (generally extensively replaced by carbonate). Both in thin section and outcrop the rock is consistent with slightly metamorphosed pelitic rock containing variable small contributions of tuffaceous crystals which have fallen unsorted into mud.

Location: Anomaly 8 Grid

145060 Altered andesite tuff-agglomerate

This section was prepared to show some of the light coloured fragments in the agglomerate at anomaly 8 to see whether they are acid and/or showing reaction. The fragments are fine grained flow-textured andesite showing filled spherical vesicles (albite, epidote minerals and chlorite) and sparse phenocrysts of pyroxene. The light colour seems to reflect kaolinisation. Fragment boundaries are sharply preserved but the interstitial matrix is conspicuously recrystallised to albite, epidote group minerals, chlorite and quartz. Dilatational veinlets of quartz, epidote, chlorite, albite and carbonates traverse the section. There are disseminated semi-opaque grains which may be sphalerite.

Location: Short track west of Highway, north of Animal Creek

141111 Albitised (?)dacitic lithic vitric feldspar crystal tuff

The rock contains a few chlorite pseudomorphs of large shards, a few feldspar fragments and numerous lithic fragment shapes pseudomorphed by fine albite. There are also several veinlets of albite. The albite in the fragments is coarser than that seen in other albitised rocks.

Location: Northeast of Animal Creek

141116 Dolerite

The rock is a dolerite composed of clinopyroxene, sericitised plagioclase, opaque oxides and minor chlorite. Whilst this rock is consistent with its original map description of Jurassic dolerite, there is no evidence for its age. The sericitisation of the feldspars could be a recent feature, even deuteric, or it could imply a Cambrian origin.