

The Eastern Volcanic sequence is comprised of rhyolites, lithic rhyolitic (?) tuffs, acid lavas of uncertain composition, fine acid volcanics, andesitic rocks (usually fine-grained), volcanic sandstones, siltstones, pelites, and pelite breccias. Alteration and weathering has made positive distinction between andesitic and rhyolitic rocks very difficult in some areas.

Petrology specimen 2606974 from 1595N, 6805E, is described as "an abundantly porphyritic latite, probably a lava". Specimen 2606980, from 1600N, 6885E, is an intensely altered intermediate lava, possibly originally of similar composition. There is some possibility that the groundmass potash feldspar in 2606974 is the result of potassic alteration.

The EVS in the southern part of the grid includes the full range of rock types listed above, with sediments and reworked volcanics dominating, whereas north of 2000N, rhyolitic rocks appear to dominate.

The contact between the EVS and the fine facies of the WVS appears to be gradational, even though it is possible to define it relatively closely on the fact map.

In a few outcrops within the EVS, it was possible to measure bedding in volcanoclastics and sediments, and flow-banding in rhyolites. Most strikes approximate magnetic north, with dips sub-vertical, frequently steeply to the west.

A pervasive fabric is developed in most outcrops, ranging from very weak cleavage in rhyolites, to wider-spaced wavy cleavage traces in fragmental andesite, to locally strong, close-spaced cleavage in siltstones. Where cleavage could be measured, it was sub-vertical and trending slightly west of grid north.

Larger structures, believed to be faults, were interpreted as such on the basis of topographic depressions, and local brecciation and shearing.

The WVS is intruded by a large mass of tonalite to the west and south of the area which was grid mapped. Within this area, dykes of microtonalite up to several metres across, were observed locally. Small "patches" of tonalite and microtonalite also intruded the EVS, in contrast to the main area of fragmental andesites in the WVS, where it is generally lacking.

Along the western margin of the grid-mapped area, and in the northwest quadrant of that area, scattered outcrops of dacite porphyrite and feldspar porphyrite dominate. These rock types are generally absent from the EVS, with some possible exceptions in the south-east corner of the grid. Although the porphyrite outcrops tend to be elongate north-south, possibly due to some imposed fabric (these rock types show little evidence of cleavage in hand-specimen), there is some evidence from outcrop patterns, of north-easterly overall trends. It is believed that this trend represents close-spaced north-easterly trending dykes, particularly in the north of the mapped area.

The porphyrite bodies appear to cut through the tonalite in places, a relationship supported by petrology specimen 2606929. However, it is possible that the porphyrites are later-stage differentiates of the tonalites, as they are often associated with larger areas of tonalite, and the interpreted porphyrite dykes locally appear to emanate from the tonalite areas.

A third intrusive (dyke) rock type noted during the grid mapping, is the biotite-quartz-feldspar porphyry, an aphanitic rock, with distinctive euhedral to subhedral biotite, quartz and feldspar phenocrysts to 3 or 4 mm in size. This rock type is described in petrology specimens 2606953 (from 60 metres north of the railway bridge over Merrygoen Creek - see Figure 5) and 2606973 from 1500N, 6788E. A number of outcrops of this rock type are shown in the EVS between 1600N and 1900N, on Figure 8, as "Dac". Orthoclase feldspar is fairly abundant in the groundmass, and so it appears that this rock type may be genetically related to the rhyolites and latites rather than to the tonalites and porphyrites.

Immediately north of "Ben Bein" homestead, a roughly 300 x 300 metre area of largely brecciated rock was mapped. In outcrop, this rock comprises closely-packed rounded clasts typically from 1 to 10 cms in diameter, with interclast rock debris and crystalline material. Many outcrops show the strong, sub-vertical, northerly-trending fabric referred to earlier. Rock types noted within outcrops and clasts, include tonalite, microtonalite, silicified andesite, sericite-carbonate altered andesite, siltstone and silicified slate. Almost all of the clasts and outcrops of more coherent material are strongly altered, and variably gossanous. Polymict clast assemblages were locally noted within individual outcrops.

Petrological specimens 2606951 and 2606954 were collected from within this zone, and are described as "andesitic volcanolithic arenite" and "poorly sorted, pebbly arenite, rich in rounded clasts of microtonalite . . . or a milled breccia". The volcanoclastic origin attributed to these specimens by the petrologist on the basis of two specimens of very coarse-grained material, is considered unlikely to be correct, in view of field relationships within the grid.

Also within the breccia zone are two small outcrop/subcrop areas of limestone, with very limited strike continuity. One of these, at 1550N, 6470E has been investigated in the past by a shallow pit, which shows lumps of highly ferruginous weathered haematite-quartz-siderite-andradite skarn material, on its dump. Petrological specimen 2606934 was obtained from this material, and 2606935, of siderite-quartz-pyrite-chalcopyrite vein material, from the same dump. The area of interpreted limestone extending north-easterly from grid point 1500N, 6500E is brecciated, sheared and strongly silicified and ferruginous/jarositic (see Appendix I), locally altered to purple-grey and red flinty jaspilite, or a sandy pulverent ferruginous rock.

It is believed that the altered limestone outcrops are partly-coherent rafts within the breccia zone. In view of the wide variety of rock types noted within the zone, it is referred to on the interpretive plan, as a polymict breccia zone. It may be hydrothermal in origin, and similar to a pebble dyke or plug.

The main polymict breccia zone, and several adjoining smaller ones, abut a significant north-easterly trending wrench fault, interpreted from topography, local shearing of lithologies, and apparent offsets of lithological horizons.

Numerous faults of similar orientation have been interpreted to the north across the grid, and appear to strongly influence soil geochemical anomalies for the various major metals. As mentioned previously, this structural direction is also evident in the porphyrite intrusions at the northern end of the grid, and appears to control a series of smaller polymict breccia zones around 2500N, described in section 3.4 of this report.

The Wongoni Copper Mine is a main shaft of relatively shallow depth, with numerous shallow pits and shafts oriented along a 210-220° grid trend from it, for several tens of metres. Rock types exposed in the pits comprise malachite and pyrite-bearing, intensely sericitised and silicified andesite and dacite (??porphyrite), and where alteration is less intense, strong shearing is apparent. Petrology specimens 2606931, 32 and 33 were collected from the Wongoni Mine workings. The shear zone, where mappable, appears to be narrow (10 metres or less) and may continue right across the main polymict breccia zone. A small pit at 1590N, 6490E apparently lies on this structure.

Petrology specimen 2606981, from 1600N, 7020E, in the south eastern corner of the grid, was described by the petrologist as an altered quartz feldspar porphyrite, or a porphyritic acid lava. The specimen was collected from the margin of a large outcrop of weathered "polymict breccia", associated with flat-lying siltstones. This outcrop area is a remnant of cover rock, the breccia being a basal breccia (relict land surface). The thin section apparently only spanned one moderately large clast from the specimen, resulting in the description of a single Tucklan Beds lithology.

3.4 1:500 Scale Grid Mapping

Detailed mapping of the area surrounding old gold prospecting pits and shallow workings in the North Shaft area, was undertaken late in July and early in August, to determine the controls on the gold-base metals-arsenic mineralisation. The "North Shaft Grid" is actually an integral part of the north eastern quadrant of the Hillview Grid.

The area from 6500E to 6800E between 2450N and 2700N, and a small area from 2400N to 2450N between 6500E and 6600E, were pegged at 25 metre intervals to form a square grid, and mapped on to plastic graph paper at 1:500 scale. The area along and surrounding line 2400N between 6350E and 6600E, part of the main 50 metre centre pegged Hillview Grid, was mapped at 1:2,500 scale at the completion of the 1:500 scale mapping, and the data enlarged to 1:500 scale for plotting, on Figures 13 and 14.

Outcrop within the detail-gridded area is generally poor, except along the low north-south trending ridge along the eastern edge of the area.

The outlines of a distinctive "vegetation anomaly" - dense growth of a squat, heath-like native shrub - were plotted on the field sheets, and are shown on Figures 13, 14 and 15. Due to its abundance around the groups of old workings it was originally thought that the anomaly could be related to metal concentrations in the soil, or a particular alteration assemblage. However, comparison of the area of the anomaly, with areas of anomalous copper, lead, zinc, arsenic and gold in soils shows no correlation, nor is there any relationship with mapped distribution of gossanous rocks. There is a good correlation between the anomaly, and the distribution of rhyolite outcrops, although this relationship does not hold towards the southern end of the mapped area. It is believed that the vegetation grows preferentially in areas of very poor soil cover (which are mainly areas of abundant rhyolite outcrop and subcrop, and ground

disturbed by the old workings and partly rubble-covered), where there is little competition from other species.

The mapping (see Figure 13) showed the presence of WVS andesitic rocks, with rare finer volcanics and vitric tuffs, occurring across the grid from its western margin to about 6700E. To the east of 6700E, rhyolitic rocks and possible fine acid tuffs of the EVS form abundant low craggy outcrops and subcrops. These acid volcanics are frequently intruded by small areas of microtonalite and tonalite, which are strongly altered (sericite, and haematite after carbonate) and usually very difficult to distinguish from quartz-phyric acid lavas.

The WVS rocks are abundantly intruded by dacite porphyrite and feldspar porphyrite rocks, possibly forming a network of dykes, with both northerly and north easterly trends locally discernible from outcrop patterns. In a few areas (eg the northwest corner of the mapped area), no other rocks outcrop.

Across the centre of the area, the main group of old workings are aligned along an east-north-easterly trend, which coincides with a very gentle, cross-cutting topographic ridge. The general location of this ridge also coincides with a seventy metre offset to the west, of the contact between the WVS and the EVS. Notwithstanding the difficulty in distinguishing strongly altered and weathered andesites, porphyrites, rhyolites and fine volcanoclastics from each other, this offset appears to occur as a series of steps, interpreted as east-north-easterly trending fault offsets. North of 2600N, the WVS-EVS contact appears to be offset about thirty metres back to the east (although outcrop is poor to the north), indicating a tensional fault component within the overall pattern of compressive faulting.

The east-north-easterly trend of old workings, through the North Shaft area, and detected again on the western scrubby hill (around 6400E-6450E on line 2400N), is also the locus of widespread brecciation. Most outcrops along this trend show strong fracturing, and some show fragmental textures. Material examined on

many of the old dumps, which is now covered by a weathering crust, shows coarse breccia textures, and when sawn and lacquered, many specimens were catalogued as coarse polymict breccias. On other dumps, with only pieces of rubble available, a variety of degraded rock types were identified with difficulty in different fragments, suggestive of a coarse polymict breccia.

The breccias within the WVS (see descriptions in Appendix I) are comprised mainly of strongly altered and frequently gossanous porphyrites, andesites, and siltstones, with rare rhyolites and microtonalites, although microtonalites are more common in the western hill breccias. Within the EVS workings, the clasts are dominated by rhyolite and "siltstone", with andesite and microtonalite, and rare porphyrite.

Photographs of some reference specimens of the breccias are given in Appendix III.

On the dumps of the more prominent workings, at 2535N, 6652E (the North Shaft) and 2560N, 6685E, coarse multiphase breccias of angular to rounded clasts of rhyolite, rhyolite breccia, dacite porphyrite breccia, jasperoidal rhyolite, extremely pyritic grey chalcedony, and cavity-filling brecciated brown and grey agate (?opal), were found. These breccias are usually cemented by sericite-limonite mixture±haematitic rock debris±fine silica±botryoidal goethite±gossan. The clasts are usually strongly sericitised and frequently jarositic.

A frequent association noted with the breccias, is that of dacite porphyrite, both as clasts within the polymict breccias, and as discrete outcrops. The brecciation appears to be related to either the intrusion of dacite porphyrite along the east-north-easterly trending faults (with associated hydrothermal activity), or to re-faulting and intense hydrothermal activity (given the apparent strong milling of clasts) of porphyrite dykes previously intruded along these structures.

Also recorded from many of the old dumps, and in several areas of float, between 2500N, 6600E and 2560N, 6685E (a distance of 100 metres) were large lumps of grey, saccharoidal silica, containing disseminated fine pyrite, and bands of sericite, jarosite, limonite and jasper, with rare small cavities infilled with malachite and pyromorphite or scorodite, and locally abundant openings filled with cryptocrystalline silica. This material usually gave very high gold values in sampling, and was evidently the focus of early mining activity. It may have formed by local replacement of brecciated material. The persistence and orientation of these veins is not known, although their maximum thickness (indicated by block sizes) was evidently around 30 cms. There is also no indication of how much silica was removed from the workings.

A large outcrop at 2368N, 6528E is comprised of large angular and sub-angular clasts of sericites, silicified (?)feldspar porphyrite, in a matrix of gossan-limonite-sericite-silica.

A brief inspection was made of the Liamena Roadbase Quarry in the south of the licence area early in August and the rock types exposed there are discussed in the section on geochemistry.

3.5 Alteration

Throughout the entire Hillview Prospect area, exposures of the Tucklan Beds and related intrusives have been variably sericitised, and carbonate-altered, with local patchy silicification. This is interpreted as a series of overlapping phyllic alteration systems, with potassic alteration zones (if they are exposed at the present-day surface) possibly overprinted by phyllic alteration, or rendered difficult to recognise by the palaeoweathering regime.

One area of potassic alteration was detected in two petrological specimens, from an area of very limited exposure at the eastern margin of the Hakoni Inlier.

In the middle branch of Ukebung Creek (see Figure 7), one specimen (2606940) from an outcrop of strongly altered volcanics, was described by the petrologist as a chloritised and slightly silicified trachyte. On re-examination of the section, he concluded that the rock was strongly altered by secondary fine potash feldspar and fine green hydrothermal biotite (originally described as chlorite). Specimen 2606941 of pelitic hornfels, collected nearby, contains abundant sericite and biotite, believed to be secondary. The rocks in this area are believed to be part of a potassic alteration zone.

Within the Hillview grid area, zones of more intense phyllic alteration, and remnants of propylitic alteration were mapped, although it was difficult to be very objective about the degree of phyllic alteration in some areas, due to the weathering overprint.

Between the Wongoni Copper Mine and the Wongoni Road, an area of silica-dominant intense phyllic alteration coincides with an area of weak to strong gossan development (ex-pyrite), centred over the large breccia zone at the contact between the main tonalite intrusion, and a large area of fragmental andesites (WVS). Partly overlapping this silica-gossan zone, is an annular array of limited areas of locally intense sericitisation, covering approximately 700 metres north-south, by 600 metres east-west. If areas of gossanous rocks developed in the vicinity of 2200N and 2300N, 6400E-6700E are part of the same alteration episode, the gossanous annulus may have overall dimensions of 1,000 metres north-south and 700 metres east-west.

Generalised outlines of the main areas of mapped propylitic, silica-dominant, pyritic (gossanous) and intense sericitic alteration are shown at 1:10,000 scale on Figures 16 and 17. These figures are presented as overlays to the 1:10,000 interpretive geology plan (Figure 10) and to the 1:10,000 soil geochemical anomaly overlays, and are filed in the plan pocket at the rear of Volume 1 of this report.

Alteration assemblages for each outcrop and subcrop area are shown at 1:2,500 scale for the Hillview Grid (Figure 11) and at 1:500 scale for the North Shaft Grid (Figure 14).

The more intense areas of alteration near "Ben Bein" homestead tend to wrap around the major soil copper anomaly developed over the main exposure of fragmental andesite. In particular, weak gossan development was noted around most of the periphery of the copper anomaly (but only locally within it). A similar relationship is noted with the lead soil anomaly, which is offset slightly to the north from the copper, and the zinc anomaly, which is substantially more widespread than copper and zinc.

This crudely annular belt of intense phyllic alteration, is interpreted as a barren pyritic shell, surrounding the copper-enriched core of a hydrothermal porphyry copper system, preferentially developed in permeable and labile andesitic volcanics.

In the North Shaft area, locally intense sericite-carbonate alteration (although not mapped as such due to the strong palaeoweathering overprint) and zones of gossan development and patchy silicification were noted in andesitic volcanics, dacite porphyrite and tonalite intrusives and associated polymict breccias. The zones of brecciation and porphyrite dykes, although not well exposed, appear to be related to northeast-trending structures. Grey, saccharoidal silica-sericite-jarosite±jasper veins of unknown extent, carrying fine sulphide and high gold values, occur within the breccias. This zone of alteration coincides with intermittent, apparently north easterly-controlled soil lead-arsenic-gold-(very minor zinc) anomalies. Although this zone of alteration and mineralisation may be part of an overall porphyry copper system (one small area of strongly anomalous soil gold anomalies coincides with the western peak of the large copper-lead-zinc anomaly around 2000N, 6425E), it appears to be the result of a separate hydrothermal event, possibly slightly younger and in a higher-level setting, and more structurally controlled, than the main porphyry event.

Between 3000N and 3400N on the grid, extensive gold and arsenic soil anomalies, coincide with an area of locally strongly silicified and sericitised, occasionally chalcedonic, volcanics and intrusives. Soil geochemical data from this area is from a very coarse grid, and the area has not been mapped in detail.

An interesting feature of the alteration assemblages is the apparent widespread occurrence of fuchsite, the mid-green chromium muscovite, which however, was rarely recorded during mapping. It was noted at several points along the shear zone south west of the Wongoni Copper Mine, and at the junction of the Inchmoor Lane and the track which links the lane with Hakoni homestead (rock chip sample 2607312). Judging by the high levels of chromium in many of the rock chip samples, fuchsite may be responsible for the bright green caste of some areas of intense sericitisation, and this is discussed in the section on geochemistry.

3.6 Photo Interpretation of Structure

As mentioned in Section 2 of this report, 1:50,000 scale photo-interpretation of lineaments was undertaken from time to time during the mapping. The lineaments have been plotted on a topographic base and are presented as Figure 4 of this report.

There has not been sufficient time available to undertake a detailed analysis of the lineaments.

Three main sets and two minor sets of structures are apparent on Figure 4:

- i a set trending 310°-330° magnetic (the Wiagdon Thrust direction). The interpreted position of the main Thrust plane is shown in darker blue on Figure 4.
- ii a set trending approximately 240° magnetic
- iii a set trending approximately 210° magnetic
- iv a minor set trending 355° - 010° magnetic
- v a minor set trending 250° - 285° magnetic

Sets ii and iii appear to be related, and offset the interpreted Wiagdon Thrust. The relationships between and relative timing of the other sets is not known at this stage.

It is apparent from the grid mapping that movement on sets ii and iii may have commenced at the time of or just prior to the mineralising events, which are (?)post-Early Devonian, and probably continued until at least Jurassic times.

Most of the significant set ii structures interpreted from the grid mapping do not show well on the aerial photographs. This is either a function of their relatively small displacements, or the "healing" of the terrain by the porphyrite dyke intrusions, the brecciation, and the alteration.

The most significant feature to emerge from this brief study, is the much greater density of linears, particularly sets ii and iii types, in the vicinity of the Ben Bein and Thirlestane inliers. This is believed to be the result of updoming of the Tucklan Beds during intrusive events. A second, limited area of concentration of these structures, lies 1 to 3 kilometres east of Hakoni homestead, where many outcrops are strongly fractured, and potassic alteration was recorded.

4 GEOCHEMICAL SAMPLING

During initial assessment of the Hillview Prospect, rock chip sampling, bulk and - 80 mesh stream sediment sampling and total-fractions soil sampling was carried out.

4.1 Rock Chip Sampling

During the three phases of geological mapping, a total of 207 rock chip and rock grab samples, ranging in weight from 3 to 8 kgs, were submitted for analysis. The objectives of collecting the samples were as a prospecting technique, and to geochemically characterise different rock types and alteration styles.

The samples were submitted in six different batches between early March and early August, 1991, under CRAE DPO's Nos. 50555, 50557, 50562, 50568, 50573 and 50585, to Australian Laboratory Services Pty Ltd ("ALS") in Orange. They were analysed for gold by 50g charge fire assay, followed by DIBK extraction, with AAS finish (technique PM-219); and for copper, lead, zinc, silver, arsenic, bismuth, nickel, chromium, cobalt, molybdenum, iron and manganese, by ICP spectrometer analysis, after a hydrofluoric acid-aqua regia digest (technique IC-586). After DPO 50557, tungsten was added to this array, but along with arsenic and molybdenum, was analysed for by the XRF technique. Higher levels of molybdenum were reported from samples analysed by the XRF technique.

Sample collection sites are shown on figures 5, 6, 7, 12 and 15. Most sample sites shown on the 1:2,500 grid plan (Figure 12) are not duplicated on the corresponding (Ben Bein) 1:5,000 geology plan, whereas all samples shown on the 1:500 plan (Figure 15) are duplicated on Figure 12.

Descriptions of the material sampled, the type, coverage and representivity of the sample, and sample location, as well as analytical results, are given in the rock sample ledgers (Appendix III).

Three grab samples were collected from heaped bedrock debris (of Tucklan Beds) during a brief visit to a roadbase quarry on the south side of the main road at Liamena (for location, see Figure 3). The materials separately sampled, were a strongly haematitic, fractured lithic arkose (sample 2607443), a very fractured, locally brecciated siltstone, with abundant haematite and minor quartz veinlets (2607444), and green and purple banded cherty argillite with thin interbeds of fine (?)tuff (2607445). The first two samples gave high iron and manganese, and elevated copper and zinc (maxima 140 and 250 ppm respectively). Chromium (maximum 120 ppm) and cobalt (maximum 75 ppm) were elevated, typical of altered Tucklan Beds at Hillview. Sample 2607443 contained 20 ppm molybdenum, which is considered to be anomalous.

Within the Hillview Prospect area, anomalous metal values were obtained from several areas outside of the Hillview Grid:-

- a In the bed of Wallingarah Creek, near the south eastern extremity of the Thirlestane inlier (see Figure 5), three samples (2607279, 280 and 282) of frequently ferruginised, very weathered volcanics, gave maxima of 290 ppm copper, 340 ppm zinc and 16 ppm molybdenum. Iron levels were quite high, so some scavenging is suspected.
- b In an outcrop area approximately 100 metres east of the old house site on "Ben Bein" south (see Figure 5), two samples (2607284, 285) gave maxima of 580 ppm copper, 230 ppm zinc, 12 ppm molybdenum, 90 ppm cobalt, 110 ppm chromium and 160 ppm nickel. Sample 285 is of a strongly altered, only locally ferruginised andesite or greywacke. In the cultivated paddock up to 350 metres north of the old house site, samples (2607388-391) of variably limonitic and gossanous rocks collected from boulder dumps, gave weakly anomalous copper (maximum 190 ppm), zinc (210 ppm), molybdenum (16 ppm), chromium (220 ppm) and nickel (320 ppm).
- c In the north eastern corner of "Thirlestane", one extensive rock chip sample (2607283, see Figure 5) of strongly quartz-limonite-ochre veined

- sheared and fractured metasediments gave 175 ppm copper, 160 ppm zinc, 440 ppm arsenic, 12 ppm molybdenum and 80 ppm chromium.
- d In the bank of a small southern tributary gully to Wallingarah Creek, in the northern extremity of the Thirlestane inlier (see Figure 5), sample 2607286 of quartz veining in silicified sheared volcanics and chert, gave 51 ppb gold, 100 ppm copper, 95 ppm zinc, 80 ppm arsenic and 150 ppm chromium.
 - e In the north eastern corner of "Nareela" (see Figure 6), sample 2607287, a non-selective chip sample from an 8 x 6 metre outcrop area of carbonate-flecked, quartz±limonite±gossan veinletted dacite porphyrite, gave 190 ppb gold.
 - f In the south east corner of "Hakoni" (see Figure 7), sample 2607307 from a large outcrop area of very fractured and locally brecciated, silicified, argillised (?) dacite porphyrite, with quartz-limonite-haematite veinlets and minor (?) jarosite, gave 44 ppb gold, 330 ppm copper, 195 ppm zinc, 30 ppm arsenic and 45 ppm chromium. The rocks in this area appear to be strongly leached, lying just below the unconformity trace.

Within the Hillview Grid,

- i samples from immediately north west of "Ben Bein" homestead of skarn; silicified, ferruginous limestone and jaspillite (2607266, 7330, 7331 and 7366) were strongly anomalous in copper (maximum 1500 ppm) and chromium (340 ppm), and weakly anomalous in zinc (115 ppm).
- ii gossanous samples from the main polymict breccia zone north west of the homestead, were generally barren, except for chromium. A maximum of 800 ppm chromium was recorded from an extremely sericitised, strongly gossanous, fuchsite-bearing breccia (2607385), taken from a small pit believed to be located on the north easterly trending shear zone.

In the North Shaft Grid area (see Figure 15), a total of 78 rock chip samples were collected during several phases of mapping, beginning with the early

1:5,000 scale work. Prior to that, nine rock chip samples had been collected by Tim McConachy, during his initial reconnaissance visit to the area.

Sample sites, sample numbers and gold values (in ppb) for all generations of sampling are shown on Figure 15. Anomalous gold values have been highlighted in three colours, to correspond to the value ranges 0.1-0.49 ppm, 0.5-1.99 ppm, and 2.0+ ppm. In addition, gold analytical results (also in ppb) for the four lines of 25 metre-spaced composite soil samples which cross the North Shaft Grid area, are shown on this plan.

As well as several distinct north easterly trends being defined by old workings across the area, there is a clearly-defined linear zone of higher gold values evident, bearing approximately 053° grid (040°magnetic). The majority of these samples were collected from the dumps of old prospecting pits, a few were from outcrop/subcrop and mixed outcrop/dump material, and a few (2607236, 37, 38) were from areas of scattered float. These last three samples may represent material derived from underlying bedrock, or early stockpiled "ore" material from one of the nearby pits, later levelled and scattered by a tractor clearing scrub, or cultivation.

Gold values range up to a maximum of 24,900 ppb (25g/t) in grey, saccharoidal silica, with jasperoidal, jarositic, gossanous and ochreous patches, in sample 2607213. Selective samples of this siliceous material from the old workings invariably gave high gold values, with high lead, and strongly anomalous copper, zinc and silver, and moderately anomalous chromium, nickel and arsenic.

A selective sample of crudely banded milky vein quartz (2607415), collected from the dump of a pair of old workings, gave 10,700/9,800 ppb gold, with 1800 ppm lead, and strongly anomalous copper, zinc, silver, arsenic and chromium.

Samples of polymict breccia and some rhyolite breccia from dump material (2607214, 7237, 7413, 7416, 7425, 7421, 7420) gave gold values ranging up to

5 g/t. Base metals and arsenic were also strongly anomalous, and chromium and nickel were often moderately anomalous in these samples, but silver values were generally low.

In the south western corner of the grid area, sample 2607437 of strongly ferruginous (?) polymict breccia gave anomalous gold (500 ppb) and anomalous copper, lead, zinc, arsenic and chromium. Sample 2607451, of gossan-supported breccia, also gave around 500 ppb gold, with strongly anomalous arsenic (525 ppm), bismuth (30 ppm), lead and zinc, and weakly anomalous copper and chromium. Soil gold values supported these rock chip results.

Soil gold values on line 2500N rose to 32/23 ppb just south of the North Shaft workings, and on line 2600N, a broad zone situated between 6625 and 6700E gave a maximum value of 106/124 ppb gold, with supporting high lead and arsenic values.

As the soil samples were composites collected from five 5-metre spaced sites centred on the 25 metre centre, they are regarded as quite reliable. The zone of anomalous gold is an area of almost nil outcrop, cultivated in the past, with abundant scree of altered (?) rhyolite, probably derived from up-slope. Most of the rhyolites sampled during the 1:2,500 and 1:500 scale grid mapping were barren, so it is considered that the soil gold anomaly on line 2600N is derived from concealed mineralisation, possibly from a broad zone of breccia, or dacite porphyrite with local breccia zones.

General comments on the rock chip sample results are:

- i leaching, associated with ancient laterite/pallid zones, may have substantially reduced gold and base metal values in some areas.
- ii where gold is strongly anomalous in the North Shaft grid, repeatability is generally very good, suggesting that the gold is fine-grained and evenly distributed within specific mineral phases.

- iii molybdenum values rose to a maximum of 20 ppm only, and tungsten and bismuth values were usually below or close to their levels of detection.
- iv in the North Shaft grid area, there is a strong correlation between gold, and copper, lead, zinc, arsenic and possibly chromium. The strongest apparent relationship is between gold, and copper, lead zinc, arsenic and possibly chromium. The strongest apparent relationship is between gold and lead, though this may be more a function of lead values being higher than the other elements. A request was made to CRAE management, to generate gold/other metal ratio graphs, to determine the various correlations but this work is still in progress and no results are available yet.
- v Chromium (and occasionally nickel) values are quite high, and appear to be related to enrichment by hydrothermal activity, being highest in the most altered, structurally deformed rocks, with several high chromium values reporting from brecciated rhyolite, where it would obviously have been introduced. High levels of these elements may indicate a basic source in the differentiation process for local magmas, or a possible relationship to shoshonitic magmas.
- vi the few samples collected of tonalites were very low in most metals.

4.2 Stream Sediment Sampling

Two generations of stream sediment sampling were carried out at an early stage of exploration, with four batches of samples submitted to Australian Assay Laboratories ("AAL") in Orange for analysis:

DPO 50558 - 18 bulk stream sediment samples sieved to -3 mm, analysed for gold only by the bulk cyanide leach technique (technique FA-CN, detection limit 1 ppt).

DPO 50559 - 18 -80 mesh sieved stream sediment samples, split from the bulk leach samples, and analysed for gold by fire assay/carbon rod (technique FA-CR,

detection limit 1 ppb); for copper, lead, zinc, silver and molybdenum by ICP spectrometer analysis after a total acid digest (technique D300/ICP); and for arsenic by AAS analysis after an aqua-regia/hydrofluoric acid digest (technique D100/AAS).

DPOs 50564 and 50565 - 52 and 10 stream sediment samples respectively, sieved to -40 mesh, due to the wet conditions. These were analysed for gold by 50 g charge fire assay, lower detection level (technique FA-LD, detection limit 1 ppb); for copper, lead, zinc, silver and molybdenum by ICP spectrometer analysis after a total acid digest (technique D300/ICP); and for arsenic by technique D300/ICP (DPO 50564) and by technique D100/AAS (DPO 50565).

The samples were collected by Senior Field Assistant Alex Kinnear, of Grenfell, and whilst the first generation of sampling was of a reconnaissance nature, the second round of sampling (DPOs 50564 and 50565) gave detailed coverage, undertaken in minor creeks and small tributary gullies.

Analytical results are plotted on Figures 18, 19, 20 and 21. Silver results, which were all either at or below the detection level of 1 ppm, were not plotted.

BLEG gold results ranged up to 8.9 ppb, on the south eastern branch of Mangwell Creek, several hundred metres north of the North Shaft grid area. On Figures 18 and 20, gold results of 1 ppb or greater have been highlighted as anomalous. At almost all sample sites, the Tucklan Beds component in the sediment was very heavily diluted by cover rock material, so gold values at this level are considered to be significant. Anomalous values were also obtained in the north eastern and central branches of Ukebung Creek (sites 2606815 and 6817), and from site 2606810, inadvertently collected in the bed of the major Merrygoen Creek.

-80 mesh and -40 mesh gold values ranged up to 74/103/19 ppb, from the Merrygoen Creek site. An arbitrary threshold value of 12 ppb was chosen for highlighting fine fraction anomalies. A group of gold anomalies is clustered

around the junction of the two branches of Mangwell Creek, north and north-west of the North Shaft Grid, with an obvious contribution from the north east. Other anomalies are located in the three branches of Ukebung Creek, in the main channel of Ukebung Creek near "Hillview" shearing shed, in tributaries of Wallingarah Creek, and in two small southern tributaries of Merrygoen Creek.

An arbitrary value of 10 ppm was chosen as a threshold for arsenic, with anomalous areas clustered around the Mangwell Creek junction (supporting the gold contribution from the north east), from an area south east of "Hakoni" homestead, and from the Wallingarah Creek area. An association between arsenic values and the Triassic unconformity is possible. A similar comment could be made about the distribution of molybdenum anomalies (arbitrary threshold 12 ppm), although several anomalous/threshold molybdenum values were obtained in the Mangwell creek area.

For copper values, a threshold of 30 ppm was chosen. An obvious anomaly is developed in the vicinity of "Ben Bein" homestead, draining the area around the Wongoni Copper Mine, and peaking at 200 ppm. A single-point value of 60 ppm is located to the north east of the Mangwell Creek junction, coincident with anomalous gold, arsenic and zinc values. A second, lower-order copper anomaly is developed near the northern extremity of the Thirlestane inlier (north west of the old house site), and a single-point anomaly (2606760 - 31 ppm) very close to the unconformity, at the south eastern extremity of the inlier.

Lead, also with an arbitrary threshold of 30 ppm, forms anomalies draining the Wongoni Copper Mine, in drainage from the North Shaft Grid, with single-point low-order anomalies downstream along Mangwell Creek, on the central and north eastern branches of Ukebung Creek, on the lower reaches of Diggers Creek (associated with a molybdenum anomaly), and along the north western boundary of the Thirlestane inlier.

For zinc, a threshold of 60 ppm was chosen, resulting in an obvious high order anomaly (peaking at 515 ppm) around the Wongoni Copper Mine, with a second anomaly (114 and 81 ppm) draining the north Shaft Grid area. Scattered single-point low-order anomalies drain the gold-arsenic area north east of the Mangwell Creek junction, the area of rock chip sample 2607287 (190 ppb gold), the northern extremity of the Hakoni inlier, and an area of Triassic cover rocks west of Wongoni Bridge. Two weakly anomalous values were obtained from close to the unconformity, at the southern margin of the Thirlestane inlier.

In summary, the significant anomalies outlined by this technique are the copper-lead-zinc anomaly around the Wongoni Copper Mine, the copper-gold-arsenic-zinc anomaly north and north east of the Mangwell Creek junction, the gold-minor lead anomaly east of the Ukebung Creek junction, the weak arsenic-zinc anomaly in the south western closure of the Hakoni inlier, the extensive but low-order copper-arsenic-gold anomaly north west of the old house site (Thirlestane inlier), and the gold-low order arsenic anomaly in Wallingarah Creek at the south eastern extremity of the Thirlestane inlier.

4.3 Composite Soil Sampling

After the majority of the 1:5,000 scale geological mapping had been completed, the decision was made to install a control grid over the central part of the Hillview Prospect; ie over most of the Ben Bein inlier. The purpose of the grid was to form a base for detailed geological mapping, and to give control for soil sampling, possible ground geophysical surveys, and later drilling.

The grid was set out to conform to the Australian Metric Grid, with a north-south baseline established on a magnetic bearing of 349°, by measuring from a point recognisable on the Mendooran 1:50,000 CMA topographic sheet - a portion corner on the boundary between "Ben Bein" and "The Mount" with AMG's of 647213N, 716973E. The baseline, lying along AMG ordinate 716600E, was set out by theodolite and chain, and checked (where it crossed east-west portion

boundaries) for distance from portion corners, against the topographic sheet. In most cases it checked within about 5 metres.

The baseline was pegged at 50 metre intervals with 1200 x 25 x 25 mm hardwood grid pegs and squat dumpy pegs, with steel star pickets placed approximately every 200 metres, with a beacon plate provided by the writer, showing AMG co-ordinates at the point. Cross lines were pegged perpendicular to the baseline, using line-of-sight and polychain every 100 metres from 6471200N to 6472800N, thence at 200 metre spacings to 6473200N, with 1200 x 25 x 25 mm hardwood grid pegs placed every 50 metres. The cross lines were extended out to the estimated grid position of the eastern and western inlier margins.

Three densities of soil sampling were collected along the cross-lines by the field crew on parameters specified by T McConachy, using a hoepick and spade:

25 metre spaced composites in a central block from (647) 1500N to 2700N and from (716) 6400E to 6900E, with aliquots taken from -10m, -5m, 0m, +5m and +10m from the sample centre point, and composited into a 4-5 kg sample.

100 metre spaced composites in a surrounding block from 1200N to 2800N, and from 6000E to 7100E, with aliquots taken from -20m, -10m, 0m, +10m and +20m from the sample centre point, and composited into a 4-5 kg sample.

200 metre spaced composites in an irregular outer area, extending from 1200N to 7400N, with eastern and western extremities of 5300E to 7400E, with aliquots taken from -40m, -20m, 0m, +20m and +40m from the sample centre point, and composited into a 4-5 kg sample. In addition, each second line of 200 metre spaced samples were offset by 100 metres, to produce a staggered (non-biased) pattern of sample points.

The compositing technique provided good coverage for reduced sample numbers and analytical costs, and some smoothing of the metal responses. However, the 200 metre spaced sampling was essentially of a reconnaissance nature.

The composite samples were not sieved, but were submitted to the laboratory as total fractions, for drying, crushing to a nominal -200#, and splitting down. A total of 486 samples, including prepared blanks and standards, were submitted to AAL in Orange, under CRAE DPOs 50571 and 50582. They were analysed for gold by 50 g charge fire assay with low detection level AAS finish (technique FA-50 LLD), and for copper, lead, zinc, silver, iron, manganese, molybdenum and arsenic by a total acid digest followed by ICP spectrometer analysis (technique D300/ICP).

Soil sample ledgers, showing all analytical results, are given as Appendix V. Copper, lead, zinc, arsenic and gold values and contours are given at 1:2,500 scale in preliminary form, as Figures 22 to 26 respectively. A4-size anomaly plans at 1:10,000 scale, showing several significant contours only, are presented as figures 27 to 31 inclusive, and are intended to be used as overlays to the interpretive geology plan (Figure 10) and alteration plans (Figures 16 and 7).

An extensive central copper anomaly is defined by 50, 100 and 200 ppm contours as a multi-lobe, crudely annular feature with an apparent north-north easterly structural bias. The eastern lobe surrounds the Wongoni Copper Mine and interpreted shear zone and peaks at 605 ppm, whereas the western-most lobe peaks at 587 ppm. The whole anomaly is developed over the main mass of coarse (?) fragmental andesites of the WVS.

Lead anomalies, defined by 100 and 200 ppm contours, are more variable than the copper anomalies, and group into two, possibly genetically separate areas. The main anomaly area is very roughly annular, and developed over the WVS andesites, but is offset approximately 200 metres north of, and partly overlapping the copper anomaly. This anomaly peaks at 512 ppm, to the north-north-east of

the Wongoni Copper Mine. Again it is possible to interpret a north easterly structural bias into the values.

The second lead anomaly area is developed within the North Shaft grid area, and forms two lobes, along a north easterly trend.

The zinc values form a similar anomaly to the lead anomaly, as defined by 125, 500 and 1,000 ppm contours, but it is much broader and more circular in shape, with a striking semi-annular pattern of peripheral lower-order anomalies. Again, a north-easterly trend can be interpreted into the contours. The anomaly is centred over the WVS andesites, but extends out well into the porphyrites and tonalites. The peak value of 1488 ppm was obtained from 2000N, 6450E. Much weaker responses were obtained from the mineralised areas of the North Shaft grid.

Arsenic values show a low-order response (10-30 ppm) over the polymict breccia area north of Ben Bein homestead and over the WVS andesites, but a higher level response is associated with porphyrite bodies and breccia zones in the general North Shaft area. A crudely annular response is suggested in that area. Also of interest are a 10-20 ppm zone developed along the eastern margin of the inlier (?unconformity-related), and a broad 20-30 ppm zone developed in the low sample density area at the northern margin of the grid.

Gold results locally form a variety of anomalies:

- i three discrete but poorly-defined features near the southern margin of the grid, possibly related to north easterly trending structures
- ii sporadic responses over the main mass of WVS andesites, with a 14 ppb high coinciding with copper, lead and zinc highs in the area of 2000N, 6450E

- iii sporadic responses (several of which exceed 100 ppb) in rhyolitic rocks along the western margin of the EVS. These are probably structurally controlled and manifest as small zones of brecciated milky quartz veins.
- iv a group of highs distributed along north easterly trending structures, coinciding with the polymict breccia zones in the North Shaft grid area.
- v several broad zones of +4 ppb in the low sample density northern and south eastern extremities of the grid, generally coinciding with low-order arsenic anomalies.

Two general observations which can be made about the soil results are:

- a the lack of geochemical response (apart from sporadic gold values) over the EVS, and
- b the apparent association of arsenic and possibly gold values with the Permian and Triassic unconformity, a feature also suggested by the stream sediment sample results. If valid, it is believed that the control is likely to have been a laterite-associated hydromorphic one, rather than detrital. Some weak copper and zinc stream sediment anomalies may also belong to this association.

Comments on the relationships between geochemical anomalies and mapped alteration and mineralisation, have been made in section 3.5 of this report.

5 AIRBORNE MAGNETIC SURVEY

A detailed aerial magnetic/radiometric survey was flown over a ten by six kilometre area covering the Thirlestane, Ben Bein and Hakoni inliers, and surrounding cover rocks (from AMG 6468000mN to 6478000mN and from AMG 714000mE to 720000mE). The objectives of the survey were to, on a semi-regional scale, assist interpreting stratigraphy and structure, and delineate alteration zones.

The survey was flown by Austirex Pty Ltd during late July, surveying AMG east-west lines on a nominal 200 metre line spacing, with a sensor height of 60 metres. Two data sets (total magnetic intensity contours and potassium channel contours) are presented herewith in preliminary form, at 1:25,000 scale, as Figures 32 and 33. Despite repeated requests, the data has not yet been made available at a scale suitable for correlation with geological and geochemical data. However, some general comments can be made about these two sets of data.

The magnetic response is generally very low, although some structures (particularly north easterly trending faults) and possible lithological trends, can be discerned. The northern margin of the surveyed area is dominated by an area of high magnetic relief, probably caused by a deep-seated basic intrusion centred to the north of the area. The small area of basalt mapped on the north western margin of the Hakoni inlier, is reflected in a small disturbance to the contours on the magnetic gradient. A discrete circular anomaly on the eastern margin of the survey area, may be the site of a basic plug.

A perturbation to the contours, trending north westerly across the southern half of the surveyed area, appears to be a response to the Dunedoo-Merrygoen railway line, with a discrete high at 2250N, apparently a response to the ferroconcrete structure of the Wongoni (main road) Bridge. However, near the southern margin of the surveyed area, the railway line swings away from the magnetic gradient, raising the possibility that the gradient represents the Wiagdon Thrust,

with the railway line coinciding with its trace over much of its route through the area.

A discrete magnetic high in the southern part of the area is related to buildings at "Thirlestane" homestead, whilst just to the north east, several sharp, north-south gradients are probably sourced by weakly magnetic intrusions, and/or faults. These appear to be offset by east-north-easterly structures.

The potassium contours show a distinct anomaly corresponding (in some detail) to the outline of the Tucklan Beds inliers. This anomaly is believed to reflect the strong phyllic (sericitic) and carbonate alteration and local areas of argillisation.

It is not clear what the intense anomaly located along the northern margin of the surveyed area is caused by, but a response to the Jurassic Ukebung Creek Claystone (mapped in the area by Higgins and Loughnan) is suspected. The major north easterly trending fault, interpreted during the photo-linear study, is clearly discernible, cutting across both anomaly areas.

Within the broad potassium anomaly, there are several smaller areas of more intense response. Some of these appear to relate to areas of abundant tonalite outcrop, and may indicate potassic alteration. One zone, 1200 metres in length parallels the Inchmoor track just north of the Wongoni railway crossing, another is developed in the north east corner of "Nareela", where strong alteration was noted during mapping. Another is located just north east of the North Shaft Grid, where microtonalite and tonalite outcrops were mapped, and are probably more extensive than mapped. A complex area of highs overlies the 'central hill' between the central and north eastern branches of Ukebung Creek, close to where potassic alteration was noted in a creek bed.

In the southern part of the survey area, fairly intense anomalies are located in the "old house site" area, where some encouraging rock chip values were obtained; another group lies immediately east and north east of "Thirlestane"

homestead, an area thought to be covered with ferruginous Triassic sandstone. Follow-up work is warranted in that area.

6 RECOMMENDATIONS

Further exploration work, comprising three main types, is strongly recommended:

- i follow-up surface surveys
- ii drilling of specific targets
- iii sponsorship of low-key research investigations of a number of topics.

6.1 Follow-up Surface Surveys

Infill soil sampling is warranted in a number of areas within the Hillview Grid, and this was the subject of a memo from the writer to T McConachy, dated 30 August, 1991. These areas include the anomalous (?) breccia area between 2500N and 2600N in the North Shaft grid; the north east corner of the grid where anomalous gold, arsenic and copper were obtained in soil and stream sediment surveys, and porphyrite was mapped intruding tonalite and volcanics; the multi-element soil anomaly around 6450E on line 2000N, to help firm up a drill target; the north west corner of the grid where a soil anomaly was detected in 200 metre spaced samples and an outcrop of porphyrite is cut by slightly auriferous quartz veinlets; and follow-up of a 102 ppb gold value in soil samples from the south eastern corner of the grid. Detailed mapping of each area of infill gridding and sampling would be well worthwhile.

Outside the gridded area, extension of the grid is recommended, with soil sampling of limited areas around the old house site on Ben Bein south and in the northern extremity of the Thirlestane inlier; several trial lines of soil sampling over the strongly altered rocks in the south eastern corner of the Hakoni area; and in the area of the potassium anomaly in the middle branch of Ukebung Creek. Subject to initial grid-based mapping, of that timbered area, it may be necessary to collect samples with a power auger rig, as the recent alluvial cover may be extensive.

In view of the relatively high chromium and nickel levels detected in the samples of altered rock, breccia and vein material, assaying of selected sample pulps for

platinum group metals is recommended. Checking for tellurium would also be worthwhile.

Reconnaissance mapping and sampling of the Liamena Rhyolite outcrops and the adjoining aeromagnetic anomaly areas, in the southern extremity of EL3672, is strongly recommended. A "silicified breccia" reported in basal Permian sediments to the north of the main road, by R.W. Corkery, should also be investigated by a geologist, as should the potassium anomalies on Thirlestane and Nareela, referred to in Section 5 of this report.

Additional stream sediment sampling, to follow up the anomalous values obtained in stream sediment sites 2606710/6810, is recommended, to validate the original anomaly and attempt to locate a cut-off in the drainage system.

6.2 Drill Testing of Targets

Initial drill testing of the gold+base metals+arsenic mineralisation in the North Shaft grid area, and the copper±lead±zinc±gold mineralisation in the Wongoni Copper Mine area, is recommended.

More specifically, the objectives of the drilling proposed below, are to:

- a In the North Shaft Grid area, determine grades and widths to approximately 40 metres depth across several of the north easterly structures; to determine host rock-breccia-vein relationships; and determine tenor of mineralisation below the base of oxidation.
- b In the Wongoni Copper Mine area, test the tenor of copper±gold mineralisation in the oxidised zone; the variation of that tenor with depth; and the tenor of mineralisation and the host rock-mineralisation relationship below the base of oxidation. There is concern that palaeoweathering has caused deep metal leaching in this area, with the possible development of a supergene blanket at depth.

Accordingly, the proposed program comprises:

- i North Shaft Grid Area (see Figures 34 and 35) - three fences each of two 50 metre reverse circulation percussion, and one fence of four 50 metre reverse circulation percussion holes, to be drilled across rock chip and soil geochemical anomalies, and mapped breccia zones. These holes, declined at 50°, would test to approximately 40 metres vertical depth, with approximately 7 metres horizontal overlap between holes.

One 100 metre diamond hole, declined at 60°, would be drilled across the area of the North Shaft itself, to a vertical depth of 85 metres, with a horizontal coverage of 50 metres.

- ii Wongoni Copper Mine Area (see Figure 36) - The north western peak of the soil copper anomaly has coincident lead, zinc and gold peaks. On line 2000N, the copper maximum of 587 ppm and gold maximum of 12 ppb are developed at 6425E, whilst the lead maximum of 345 ppm and zinc maximum of 1488 ppm are developed at 6450E. A fence of two 150 metre reverse circulation percussion holes, declined at 60°, is proposed to test this area, in the oxidised, (?)supergene and primary zones. These holes would reach a vertical depth of approximately 130 metres, with a horizontal overlap of 15 metres, and traverse length of 135 metres.

A more substantial copper soil anomaly is developed around the old copper workings, in the south east. Mineralisation in the old workings is associated with locally intensely sericitised, silicified, sulphidic sheared andesites and (?)dacites. One 200 metre diamond hole (percussion drilled to 50 metres) across the zone, and declined at 50°, would test to a vertical depth of approximately 150 metres, with a traverse coverage of 130 metres.

c Drilling Summary

<u>Area</u>	<u>R/C Percussion</u>	<u>Diamond Coring</u>
North Shaft Grid	500 m	100 m
Wongoni Copper Mine	350 m	150 m
TOTALS	850 M	250 M

6.3 Research Work

It is understood that some assistance may be given to a university student, to collect data for an honours thesis on the Hillview geology and mineralisation. Topics which that person could address, provided they fall within the scope of an honours thesis, include:

- i investigate the relationships between the various intrusive rock types, and between the intrusives and the volcanics
- ii initiate studies to determine the ages of the intrusives and the volcanics
- iii investigate the fragmental/(?)agglomeratic/(?)breccia textures of the Western Volcanic Sequence andesites
- iv determine the nature of copper mineralisation in both weathered and fresh rocks, and of gold in the breccias and silica veins
- v determine the mineralogical assemblage and temperature of formation of the gold-rich vein material
- vi investigate chromium levels, their distribution and association with other metals, and the possible source of this metal.
- vii during mapping, use careful sample selection and potassium staining, to check for potassic and albitic alteration in key areas.
- viii by petrological studies, determine the sequence of alteration, and attempt to predict the location of the cores of hydrothermal cells.