



# Mineral Resources Tasmania

## Report 1994/25

### The geological setting and interpretation of the geophysical anomalies of the Anio Creek – Mt Remus area

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#### INTRODUCTION

This report deals with the geology of the Anio Creek–Mt Remus area, in the Cradle Mountain–Lake St Clair National Park, and arises from investigations carried out in the area by Mineral Resources Tasmania (MRT) in 1993 and 1994. In particular, a helicopter-borne aeromagnetic survey was flown over the area in November 1993, and a ground-based geological mapping survey was carried out by the authors in March 1994. Complementary reports have been prepared on the geophysics (Richardson, 1994), petrology of rock and mineral samples collected (Bottrill, 1994), and fluid inclusions in a quartz vein sample from the anomaly (Taheri, 1994).

Anio Creek is located in the northwest corner of the National Park (now incorporated in the Tasmanian Wilderness World Heritage Area), 12 km northwest of Cradle Mountain (fig. 1). The area is difficult to access, but is served by a rough bombardier track leading off across buttongrass plains from a bulldozed exploration track east of The Heap of Rocks. The track is positioned just north of the Park boundary.

The area consists of an undulating, plateau-like ridge top at about 1000 m altitude bounded to the north by the long slope down to the Vale River, and to the south by the precipitous slope down to Devils Ravine and Fury Gorge. Anio Creek flows west across the central part of the ridge top before plunging steeply down to join the Fury River. The section of the ridge top south of Anio Creek is referred to as Sumer Spur. Mt Remus is a quartzite peak on the north side of Anio Creek.

Vegetation on the ridge top is a fire-influenced mosaic of buttongrass, scoparia-heath, and tea tree scrub, with patches of myrtle rainforest and myrtle-King Billy Pine-deciduous beech rainforest. The slopes of Devils Ravine and the Vale River gorge are clothed in dense rainforest.

#### HISTORY AND PREVIOUS SURVEYS

Prospecting and mining for molybdenite occurred at the Mt Remus prospect on Anio Creek in the 1920s. Nye (1928) reports that a Mr Nichols worked the prospect, which consisted of a number of trenches and shafts, and that

several bags of ore had been carried out on horseback. A hut was built beside a creek on the south side of Anio Creek.

The area was proclaimed a National Park in 1936.

The area was visited and sampled by several Department of Mines geologists in the 1960s, partly in connection with the regional geological mapping of the Mackintosh Sheet (Burns, 1963; Threader, 1965; Collins *et al.*, 1981).

In 1970, a large Exploration Licence (2/70) was granted to Cominco (later to become Aberfoyle) adjacent to the National Park. A helicopter-borne geophysical survey (aeromagnetics and McPhar EM) was flown over the area in 1972, finding "Anomaly 13" in the turn-around area on Anio Creek, and various other anomalies (including Anomaly 8 which proved to be over the Que River ore deposit — Slade and Webster, 1972). The Anomaly 13 feature was located close to the poorly-defined boundary between the Mt Read Volcanics and Precambrian basement rocks, with the possibility that it could represent another Que River-type ore body. Had it been located outside the Park, it would have been immediately investigated and probably drilled.

Geopeko became a joint venture partner on EL2/70 with Aberfoyle/Paringa in 1979, and in 1980 commissioned a helicopter-borne aeromagnetic and Dighem EM survey. This survey also picked up "Anomaly 13" (as both a magnetic and EM anomaly) in the turn-around area at the edge of the Park (Herrmann, 1980, 1984; Large and Duffin, 1981), and again there was pressure to investigate the feature.

In 1988, geological mapping was carried out in the area as part of the Mt Read Volcanics Project, and one of the samples collected in Anio Creek near Anomaly 13 gave an assay of 1.9 g/t gold and 1.06% copper (Pemberton *et al.*, 1991).

In order to clarify the nature and position of the geophysical anomalies in the area, a request was made to the National Parks and Wildlife Service for permission to fly a detailed helimag survey in late 1993 as an add-on to the extensive NETGOLD survey in northeast Tasmania.

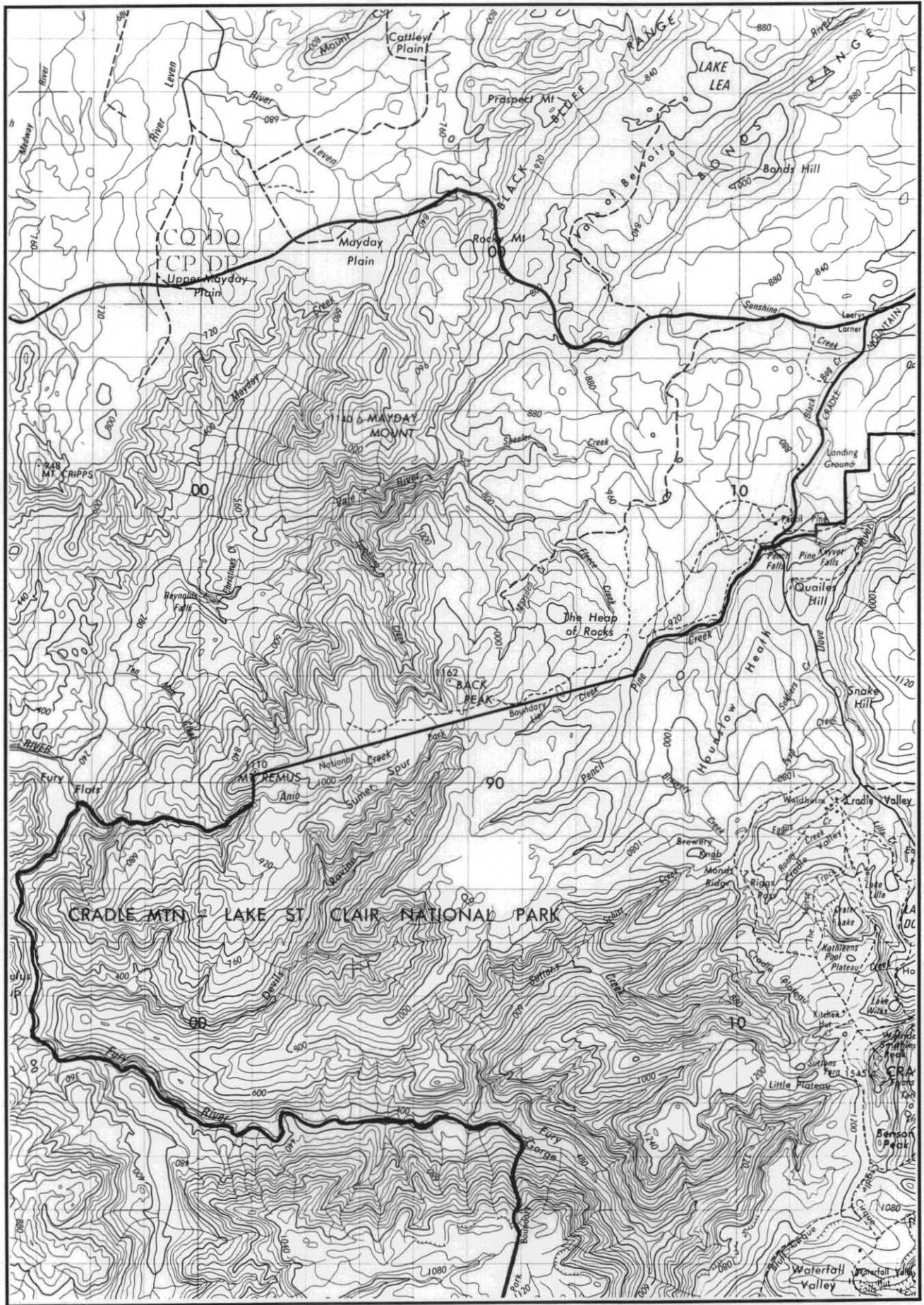
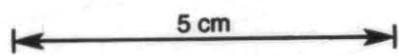


Figure 1

Location map of Anio creek area (scale 1:100 000)



The helimag survey was flown in early November, and was followed by field mapping and sample collection in the area in March 1994.

## GEOLOGICAL SETTING

### *General Geology*

The Anio Creek area lies at the boundary between the Precambrian basement rocks of the Tyennan Massif and the Cambrian Mt Read Volcanics belt (fig. 2). The major strike trend in this zone is NE-SW, between the N-S trends further west and the E-W trends further east. A recent geological map of the area is provided by Vicary and Pemberton (1988), and an older, more regional coverage by Barton *et al.* (1966). The Precambrian rocks are predominantly quartz-mica schist with subordinate quartzite, and have a dominant NE-SW trend. Major quartzite bodies occur at Mt Remus and The Heap of Rocks. The schist generally has a subdued topography with limited outcrop, except in the creeks and gorges.

The Cambrian sequence begins with a basal unit of siliciclastic sandstone and minor conglomerate, correlated with the Sticht Range Beds (Pemberton *et al.*, 1991). This unit varies in thickness from a few hundred metres to zero, with the thickest section developed against the NW-trending cross-fault at Anio Creek. The contact with the Precambrian rocks appears to be an erosional unconformity, and is exposed in Speeler Creek at DP077962.

The overlying Back Peak Beds are grey to green volcanoclastic sandstone and siltstone, and also show variations in thickness apparently related to NW-trending cross-faults. The sequence is well bedded, and dips and faces to the northwest.

The northern margin of the Back Peak Beds is formed by the intrusive boundary of a very large quartz-feldspar-biotite  $\pm$  hornblende porphyry body referred to as the Bonds Range Porphyry (Pemberton *et al.*, 1991). This body is 2–3 kilometres wide and occupies most of the slope down to the Vale River. It extends well to the south into the Fury Gorge area, and to the northeast beyond Bonds Range. The body is in direct contact with the Precambrian rocks in the Mt Remus area.

Numerous smaller dykes and bodies of similar porphyry occur throughout the area, intruding both the Precambrian rocks and the Cambrian sequences. These bodies range from a metre or less to several tens of metres across, and appear to have variable trends.

The Bonds Range Porphyry is overlain disconformably towards the bottom of the Vale River gorge by the NW-dipping siliciclastic sandstone sequence of the Owen Conglomerate correlates. This sequence of mainly pink sandstone is of Late Cambrian–Early Ordovician age, and is overlain by Ordovician limestone of the Gordon Group in the Vale of Belvoir and in the Mackintosh Creek–Vale River valley.

## MAJOR ROCK UNITS AND THEIR DISTRIBUTION IN THE ANIO CREEK AREA

Rock distribution in the Anio Creek area is largely controlled by a major NW-trending fault which offsets the Precambrian–Cambrian boundary from Devils Ravine to north of Mt Remus (fig. 3). This fault appears to have been a Cambrian structure controlling a local basin margin for deposition of the Sticht Range Beds and Back Peak Beds, as these units both thin markedly to the northeast away from the fault. There has probably also been some Devonian movement on the structure, as indicated by fracturing of adjacent rocks in Anio Creek. Some displacement of the porphyry boundary is shown on the fault northeast of Mt Remus, but this has not been confirmed by ground mapping. The fault appears to be steeply dipping or vertical.

### *Precambrian rocks*

The basement rocks are predominantly quartz-muscovite schist with varying amounts of albite, chlorite and biotite. The schist is typically greenish-grey in colour, and may show banding in outcrop. Coarse mica is commonly apparent on foliation surfaces. The dominant foliation or banding strikes northeast-southwest, and dips shallowly (20–30°) to the northwest.

### *Sticht Range Beds*

This sequence of pale grey to white quartz sandstone forms the crest of Sumer Spur and extends part of the way down the slopes of Devils Ravine. Bedding dips steeply to the NNW. The unit is of the order of 500 m thick, and consists of fine to medium-grained sandstone with minor coarse sandstone and granule pebble conglomerate. Detrital quartz grains are predominantly of Precambrian derivation, and some muscovite and tourmaline are also present.

Close blocky jointing is common in the sandstone, particularly near the major cross-fault, giving rise to extensive scree deposits on the slopes.

The unit has a gradational, interfingering contact with the overlying Back Peak Beds.

### *Back Peak Beds*

This unit consists of several hundred metres of grey to greenish-grey, fine to medium-grained volcanoclastic sandstone and siltstone, with minor interbeds of micaceous siltstone. The rocks are commonly glassy in appearance, with a conchoidal fracture. Bedding is usually well defined, and for the most part dips moderately to steeply to the NNW.

Dominant constituents of the sandstone are quartz and feldspar grains, sericite-altered pumice fragments, sericite-altered shards, and small lithic clasts of both volcanic and Precambrian derivation.

### *Porphyry intrusives*

Dyke-like intrusive bodies of felsic porphyry occur throughout the area. They are usually pale grey in colour, with prominent quartz phenocrysts up to 5 mm across. Other phenocryst minerals are feldspar (commonly altered to sericite), biotite (commonly altered to chlorite), and minor hornblende (typically altered to chlorite-actinolite).

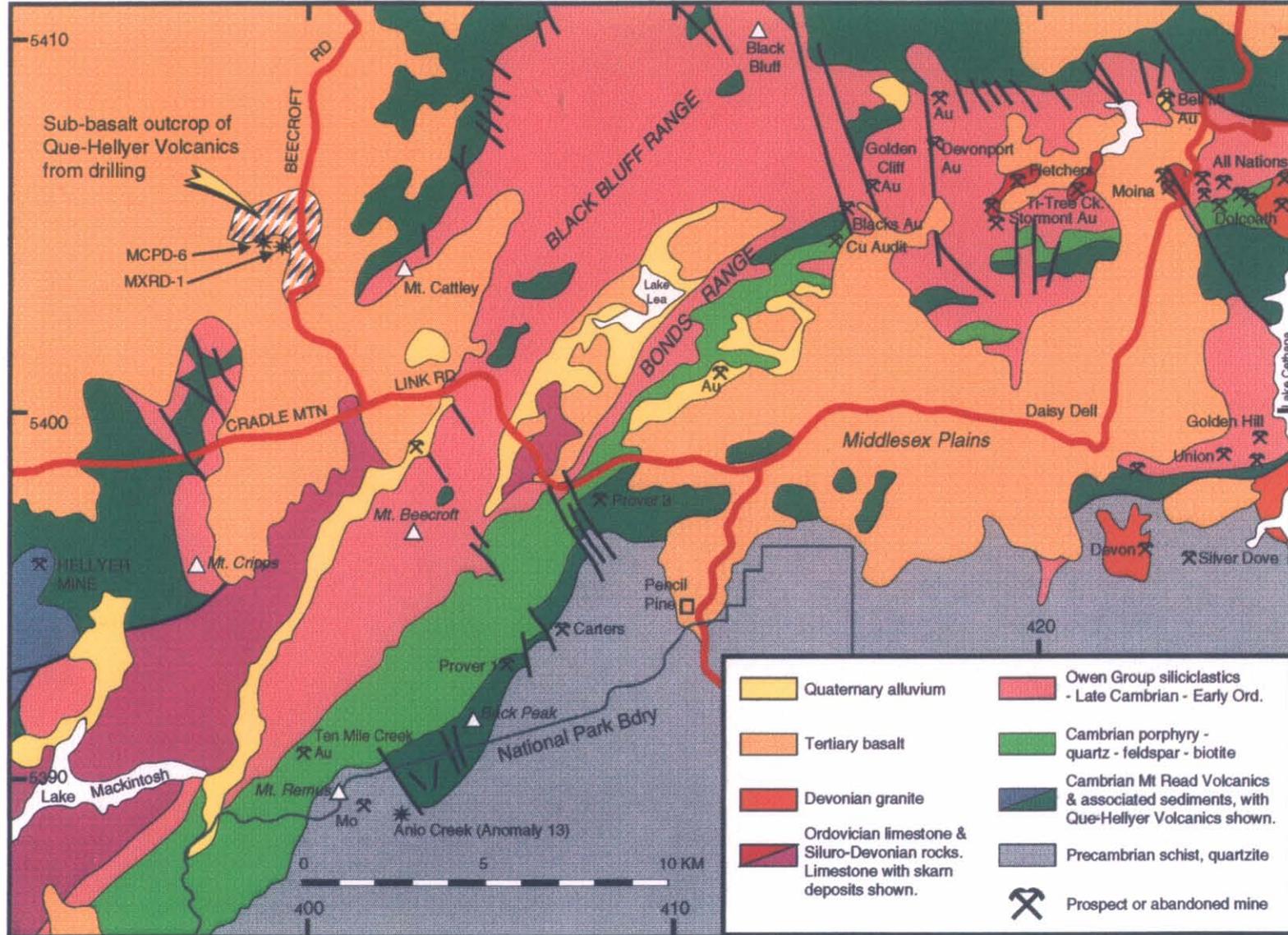


Figure 2

Regional geology of the Aniop Creek - Moina area

5 cm

The coarser-grained varieties (e.g. AC9) become somewhat granitic in appearance.

## MINERALISATION

### *Mt Remus Prospect*

The Mt Remus molybdenite prospect, which was discovered and worked in the 1920s (Nye, 1928), is located on Anio Creek about 700 m southeast of Mt Remus. It consists of a NE-trending band of quartz-pyrite veins which cut the Precambrian schist and carry small amounts of molybdenite. The band of veins has been opened up by several small trenches on the northwest bank of the creek (now largely overgrown).

Assays from across the veins exposed in several of the trenches are given by Nye (1928), and show molybdenum contents of 1.57, 1.33, 0.65 and 0.2%. Traces of cobalt and vanadium are also present. Further descriptions of the same workings are given by Burns (1963), Threader (1965), Collins *et al.* (1981), and Pemberton *et al.* (1991). Only one of the trenches was located in the thick scrub on the 1994 field visit. Dump samples showed mainly pyrite mineralisation with only minor molybdenite, and the pyrite appeared to be concentrated in rod-like blebs and nodules as well as in veins.

Study of two samples from the prospect by Bottrill (1994) shows pyrite with minor molybdenite, tourmaline and allanite, and traces of chalcopryrite and pyrrhotite, in quartz-chlorite veins which have been strongly deformed and boudinaged. At least some of the pyrite is also deformed and brecciated. The amount of deformation and brecciation suggests that at least some of the mineralisation pre-dates the Devonian orogeny and hence is pre-granite. The source of the vanadium is uncertain, as no vanadium-bearing mineral has yet been identified (Bottrill, 1994).

An assay of schist from the prospect (Table 1, sample AC16) shows 463 ppm Mo.

### *Anio Creek—Anomaly 13 Area*

A mineralised breccia was discovered and sampled by Pemberton in 1988 within the Back Peak Beds in Anio Creek, about 50 m upstream of the faulted Precambrian contact (Pemberton *et al.*, 1991). The breccia was re-examined and re-sampled in 1994. It is about one metre wide, strikes southeast across the creek at the foot of a small waterfall, and consists mainly of jumbled, angular to rounded, tabular clasts of Back Peak Beds, up to 50 mm across, but also includes clasts of Sticht Range Beds sandstone, quartz-feldspar porphyry, and possible granite (Bottrill, 1994). The matrix between the clasts consists mainly of quartz, chlorite and pyrite, with minor tourmaline and traces of muscovite, chalcopryrite, sphalerite, marcasite and magnetite according to Bottrill. Evidence for deposition of some of the breccia minerals by boiling of hydrothermal fluids from a granitic source is provided by Bottrill (1994) and Taheri (1994).

The strongest mineralisation in the breccia is on the south bank, and three assays of a single sample of the breccia were made in 1991. Considerable interest was aroused when gold values of around 1.9 g/t and copper values of

1.06% were reported (Pemberton *et al.*, 1991). The three assays from 1991 are given in Table 1, together with a further assay from the south bank (AC1), a north bank sample (AC3), and a sample of breccia float from some metres away on the south bank (AC4).

The south bank samples are fairly consistent, with gold values of 1.1 to 2.4 g/t, Cu values of 0.62 to 1.06% and Ag values of 10–12 g/t. However the breccia on the west bank, and the float sample, have gold below detection limit (0.03 ppm) and negligible Cu, indicating that the mineralisation is very patchy.

Minor pyrite mineralisation was also noted in fractured Back Peak Beds and quartz-feldspar porphyry closer to the faulted contact in Anio Creek. A sample of porphyry (AC5) shows mainly pyrite with minor amounts of tourmaline, chalcopryrite and arsenopyrite (Bottrill, 1994). The assay (Table 1) shows slightly elevated levels of Pb and Zn.

The only other surface mineralisation noted in the area was a sulphide-bearing quartz vein cutting schist in the bed of a small creek draining the Anomaly 13 area (AC12). This vein has an exposed width of 0.6 m, trends 105°, dips 60°N, and has a planar contact against schist on one side. Pyrite occurs along narrow fractures and in small vughs in the quartz, together with chlorite and tourmaline. Traces of chalcopryrite, galena, pyrrhotite, carbonates, cassiterite or rutile(?), allanite(?), and tremolite(?) are contained within the pyrite (Bottrill, 1994).

An assay of the quartz vein (Table 1, AC12) shows negligible gold and silver, slightly elevated Cu (266 ppm), and generally low levels of other elements.

A study of fluid inclusions in this quartz vein has been carried out by Taheri (1994). A wide range of inclusion types is present, a feature considered to be typical of a granite-related fluid. A range of homogenisation temperatures was also obtained, with the formation temperature of the mineralisation estimated to be in the range of 300–350°C, although it could be higher.

### *Other prospects in the general area*

Several other prospects are known from the area between the Cradle Mountain Link Road and Anio Creek (Pemberton *et al.*, 1991). Best known is Carters prospect, on Fleece Creek, 6 km northeast of Anio Creek (fig. 2). Mineralisation here consists of quartz veins and stockworks carrying galena, sphalerite, pyrite and minor chalcopryrite, arsenopyrite and tourmaline. The veins trend northwest and cut through Precambrian schist and basal Cambrian Sticht Range Beds. The mineralisation is poddy and variable.

The Prover 1 prospect is located within the Back Peak Beds about 1.5 km southwest of Fleece Creek (fig. 2), and consists of galena-sphalerite mineralisation occurring as veinlets and blebs associated with zones of chloritic alteration and fracturing. A mineralised quartz-feldspar porphyry was intersected in a drill hole through the mineralisation, and zinc ratios suggest the mineralisation may be linked to the Cambrian porphyry and granite (Huston and Large, 1987; Pemberton *et al.*, 1991).

TABLE 1

Assays of samples from Anio Creek area

Field No. Reg No.	J209A A	J209B B	J209C C	AC1 940243	AC3 940244	AC4 940245	AC5 940246	AC12 940247	AC16 940248
Au (ppm)	1.8	2.4	1.6	1.1	<0.3	<0.3	<0.3	<0.3	<0.3
Ag (ppm)	12	12	10	10	1	1	≤1	≤1	≤1
Cu (ppm)	-	-	-	-	8	63	67	266	≤5
Pb (ppm)	42	51	45	58	31	26	134	23	13
Zn (ppm)	40	39	43	44	32	32	99	27	57
As (ppm)	-	-	-	140	90	90	70	20	≤10
Sb (ppm)	-	-	-	72	57	63	39	36	54
Bi (ppm)	-	-	-	29	17	16	12	7	16
Mo (ppm)	47	47	49	13	117	32	<10	≤10	463
Cd (ppm)	-	-	-	1.0	0.8	2.1	0.5	0.5	0.7
Cr (ppm)	49	50	49						
Co (ppm)	59	59	58	172	71	20	7	14	76
Ni (ppm)	-	-	-	48	16	12	4	7	12
Mn (ppm)	-	-	-	872	837	470	126	122	405
Sn (ppm)	51	47	45						
V (ppm)	47	42	45						
Wt (%)	0.13	0.13	0.14						
Fe (%)	-	-	-	7.7	5.1	5.0	8.5	1.31	4.4
SO <sub>4</sub> (%)	-	-	-	15.3	5.2	1.72	2.94	1.92	0.48
S (%)	-	-	-	5.11	1.73	0.5	0.9	0.6	0.1
Cu (%)	1.05	1.06	1.06	0.62					
Ti (%)	0.17	0.16	0.16						

*Sample Notes*

- J209a, b, c: Mineralised breccia, south bank of Anio Creek, collected by J. Pemberton 1991.  
 AC1: Mineralised breccia, south bank, collected 1994.  
 AC3: Mineralised breccia, north bank.  
 AC4: Float clast of breccia, south bank.  
 AC5: Mineralised porphyry in Anio Creek near Precambrian contact.  
 AC12: Quartz vein in creek bed at Anomaly 13.  
 AC16: Mineralised schist at Mt Remus prospect.

The Prover 3 prospect also lies within Back Peak Beds, about 1 km northeast of Etchells Creek near the Bonds Range Porphyry contact (fig. 2). A hole drilled by Cyprus Minerals to follow up Pb-Zn anomalous stream sediments and soil samples intersected only minor Pb-Zn mineralisation (Jones, 1986; Pemberton *et al.*, 1991).

The Ten Mile Creek gold prospect lies 1.5 km northwest of Mt Remus, within the Bonds Range Porphyry near its contact with the overlying Owen Conglomerate (fig. 2). Follow-up by CRA of anomalous stream sediment samples collected by Shell Metals revealed hematite veining, stockworks and breccias within the porphyry (Funnell and von Strokirch, 1987), with two rock samples being highly anomalous for gold (8.08 and 1.04 g/t). Four short diamond holes drilled by CRA intersected hematite-chlorite alteration with gold grades of up to 0.5 g/t over one metre (Newnham, 1992).

The Ten Mile Creek mineralisation is almost certainly related to the intrusion of the Cambrian Bonds Range Porphyry body, and there is also evidence at Prover 1 for a Cambrian porphyry-related genesis for some of the

mineralisation. However, a Devonian granite-related signature is evident in the occurrence of minerals such as tourmaline in several of the prospects, and of molybdenite (and minor tungsten) at Mt Remus.

## NATURE OF THE GEOPHYSICAL ANOMALIES

### *The Company surveys*

The 1972 survey for Aberfoyle/Paringa used the McPhar H-400 EM/magnetics system developed in Canada. Only those features with a combined EM/magnetic response were considered. The survey located a number of anomalies over the large area of EL 2/70, but only two in the Mt Remus area. These were Anomaly 13, near Anio Creek, and Anomaly 14, just on the south side of Devils Ravine near a small tarn (Slade and Webster, 1972). Follow up of both of these anomalies was recommended, but was not pursued because of their location inside the National Park.

The Dighem survey of 1980 recorded EM responses on two lines 100 m apart at Anomaly 13 (see fig. 3), as well as a

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discrete magnetic anomaly of about 200 nT. Large and Duffin (1981) state that "these are not strong conductors, but the anomalies are real and are well above system noise levels". No EM response was recorded at the Mt Remus aeromagnetic anomaly, although only about half of this anomaly was covered by the survey.

The Dighem EM response was also used to compute apparent ground resistivity for the Anomaly 13 area (conductance and resistivity have a converse relationship), and this produced an anomaly similar in size and shape to the magnetic anomaly (Large and Duffin, 1981). Several other low resistivity areas were recorded in the same survey in an area of Precambrian rocks outside the Park to the east of The Heap of Rocks, with one of these areas having an associated weak magnetic anomaly. Follow-up work by Geopeko geologists resulted in these being ascribed to responses from black shale and/or carbonaceous schist (Herrmann, 1980, 1984; Heithersay, 1982; Pemberton and Sumpton, 1983).

Large and Duffin (1981), in their analysis of the Anomaly 13 data, considered that several aspects of the response indicated a broad, sub-horizontal or surficial zone as its likely source (a negative feature in terms of follow-up potential), but that there were positive aspects in terms of its discrete shape, both in profile and plan, the strong resistivity low (i.e. some definite conductive materials were present), and particularly the clear association with a very discrete magnetic anomaly.

They compared the Dighem response with responses from several known ore deposits (Que River, Mt Lyell, Mt Bischoff, Wilga-Victoria, and Montcalm-Canada), and concluded that it was most similar to that from the pyrrhotite-dominated deposit at Mt Bischoff (pyrrhotite is a form of iron pyrites which is magnetic). They noted that very few features give coincident and discrete magnetic and EM anomalies, and listed three possibilities:

- (i) a basic magnetic intrusive with an oxidised conducting top;
- (ii) a pyrite-magnetite lode;
- (iii) a pyrrhotite lode.

#### *The Mineral Resources Tasmania survey*

A combined aeromagnetics-radiometrics survey was carried out over the Anio Creek area for MRT in November 1993 by GeoInstruments Pty Ltd. The helicopter-borne survey was flown at 200 m line spacing (lines oriented NW-SE) and a terrain clearance of 60 m, with tie lines at 400 m spacing. A GPS navigation system was used to accurately position the data. Details are given in Richardson (1994).

The survey was successful in clearly defining two distinct "bulls-eye" magnetic anomalies at the Anomaly 13 and Mt Remus location (fig. 4). Each anomaly is about 500 m across, with a slight tendency towards elongation in a NE-SW direction. Each has an intensity of about 250 nT over the local background. A strong magnetic gradient rises to the northern part of the survey area, possibly corresponding to the outcrop of the Bonds Range Porphyry.

## *Other geophysical information*

### *Gravity*

The available gravity data give an indication of the deep structure of the area, and particularly the distribution of Devonian granites (Richardson, 1994.) Major east-west trending spines of granite are evident to the north and south of the area (Dolcoath and Granite Tor granites respectively), with a possible offshoot of the Dolcoath spine into the Anio Creek area. The residual gravity data has a low near Anomaly 13 and another just to the north of the Mt Remus anomaly.

### *Regional aeromagnetics*

The area is covered by a 1985 regional survey at 1500 m line spacing flown by the Australian Geological Survey Organisation. These data have been re-processed by Richardson (1994) for the Anio Creek area. This area is seen to straddle the boundary between a NE-trending zone of positive values, corresponding in part to the Cambrian volcanic and intrusive rocks, and a broad zone of low values extending to the south and east.

### *Radiometrics*

Natural gamma ray emissions from potassium, uranium and thorium were measured by scintillometer at the same time as the aeromagnetics were flown for the 1993 MRT survey. Data are presented as colour images for each element, and as total counts (Richardson, 1994). The images are generally complex and difficult to interpret, but recognisable features include the area of low total counts corresponding to the quartzite unit at Mt Remus, and an area of high total counts corresponding roughly to the Back Peak Beds. There is some suggestion of an increase in K and U values in the vicinity of Anomaly 13 and the Mt Remus anomaly.

## **INTERPRETATION OF THE GEOPHYSICAL ANOMALIES**

### *From general geology*

- Both anomalies are sourced in Precambrian schist, not in Cambrian volcanic rocks. Therefore, it is very unlikely that they represent Que River-type volcanic-hosted massive sulphide deposits.
- Graphitic schist or black shale horizons in the schist sequence are unlikely to be the cause because of the very localised nature of the anomalies.
- The possibility that the Precambrian rocks seen at surface have been overthrust above Cambrian or other host rocks seems unlikely, considering the shallow nature of the anomaly sources (100–200 m) and the fact that similar Precambrian rocks are present in the bottom of the 400 m-deep Devils Ravine just to the south.
- The other main possibilities for the anomalies are that they are sourced from some feature related to the Devonian granites or to the Cambrian porphyries, or a combination of both.
- The presence of mineralised quartz veins and breccias at Anomaly 13 suggests that one possible cause of the

anomalies is a cluster of mineralised veins related to granite.

- The Anomaly 13 source is both magnetic and conductive. Very few rock types or mineral deposits have these attributes. The most common are pyrrhotite-rich lodes (e.g. Mt Bischoff) and lodes rich in magnetite-pyrite. Some mafic igneous bodies are rich in magnetite and could produce the magnetic anomaly, but an exposed oxidised top would be needed to give the conductive EM response, and this is not present. Both pyrrhotite and magnetite are present in trace quantities at the surface in the Anomaly 13 area.
- A possibility, suggested by R. S. Bottrill, is that the granitic fluids have interacted at depth with a magnetite-rich sequence (such as occurs at Savage River). This might explain the presence of cobalt, copper and vanadium in the system, as well as tourmaline, chlorite, magnetite and pyrite, and the relative paucity of quartz and mica in the mineralisation.

#### *From petrographic studies (Bottrill, 1994)*

- The occurrence of molybdenite, tourmaline, allanite, pyrrhotite and magnetite all suggest a granite source is involved in the mineralisation, and the Anio Creek breccias may be mainly of this origin. The deformed nature of the mineralisation at Mt Remus suggests there may be a pre-granite component, and the elevated levels of vanadium, cobalt and copper at this prospect are suggestive of some interaction with mafic or possibly ultramafic or magnetite-rich rocks.
- The relative lack of wallrock alteration and veining associated with the breccias suggests that only a small granitic body may have been involved.

#### *From fluid inclusion studies (Taheri, 1994)*

- The wide range of fluid inclusion types and homogenisation temperatures shown by the quartz vein at Anomaly 13 is fairly typical of granite fluids, as is the estimated formation temperature of the mineralisation (300–350°C).

#### *From regional geophysics (Richardson, 1994)*

- Gravity data suggest a small offshoot granite body could be present beneath the Anomaly 13 area and possibly the Mt Remus area. The original estimate of 8 km depth to granite in this area (Leaman and Richardson, 1989) is probably too great.
- Regional aeromagnetics show a strong gradient to the south, interpreted by Richardson/Leaman as due to a zone of ultramafic rocks on a thrust surface beneath the Precambrian rocks.

#### *From geophysics over the anomalies (Richardson, 1994)*

- The two magnetic anomalies are unique in the area. They are isolated, closed anomalies in an area of gently changing magnetic field.

- Two-dimensional modelling shows that the anomaly sources have a maximum depth of 100 m to the top, and that the minimum required magnetic susceptibilities are at least three times higher than any yet measured from surface samples in the area.

## **SUMMARY AND CONCLUSIONS**

1. Work carried out by Mineral Resources Tasmania has greatly clarified the geological setting and the nature of the geophysical anomalies in the Anio Creek area, but the information is not sufficient to give a definitive explanation for the anomalies.
2. The strong magnetic anomalies appear to be caused by pipe-like features which lie at shallow depths — maximum 100 m to the top — but which have very little surface expression (i.e. only minor veins and breccias with trace amounts of magnetic minerals).
3. The magnetic susceptibilities required to produce the anomalies are quite high, suggesting that pyrrhotite ('magnetic pyrites') and/or magnetite are likely to be involved. Both are present in trace quantities at surface.
4. Mineral assemblages and fluid inclusions all point to a granite source at depth, and the regional gravity indicates that a shallow offshoot from the Dolcoath Granite ridge could be present beneath Anio Creek.
5. There are indications of possible interaction with mafic or ultramafic rocks at depth, but the significance of this is difficult to evaluate. The possible presence of a thrust-related zone of ultramafic rocks beneath the Precambrian rocks has been suggested by Leaman *et al.* (1994), but this remains speculative. Similarly, Bottrill's suggestion of a possible interaction with Savage River-type magnetite deposits at depth is speculative, but is difficult to reconcile with the apparently quiet regional magnetic field in the area.
6. Some association of the anomalies with Cambrian porphyry bodies, which are common in the area, also seems possible. The known smaller bodies do not appear to be notably magnetic (they are not apparent on the detailed aeromag map), and it seems unlikely that such bodies alone could produce the anomalies.
7. The mineralised quartz vein seen at Anomaly 13 contains traces of pyrrhotite, and suggests that a possible cause for the magnetic-EM anomaly is a pyrrhotite-rich vein system or replacement body at depth, perhaps lying above a small granite apophysis.
8. An alternative explanation is a magnetite-pyrite rich vein system or replacement body.
9. The possible presence of economic minerals in the anomaly-producing system, such as gold, cassiterite, molybdenite, and sphalerite-galena, remains speculative. Patchy gold is present in a related breccia in Anio Creek, and a small amount of molybdenite at Mt Remus. It may be significant that there have been no reports of alluvial gold or cassiterite around

Anomaly 13, although prospectors have obviously been in the area.

10. The sharply defined magnetic anomalies, and their geological setting within Precambrian rocks, are unusual features for Tasmanian geology and will continue to puzzle geologists both for their general interest and their possible commercial implications. They could represent a new or different type of mineralisation, and their study could provide useful criteria for application elsewhere.

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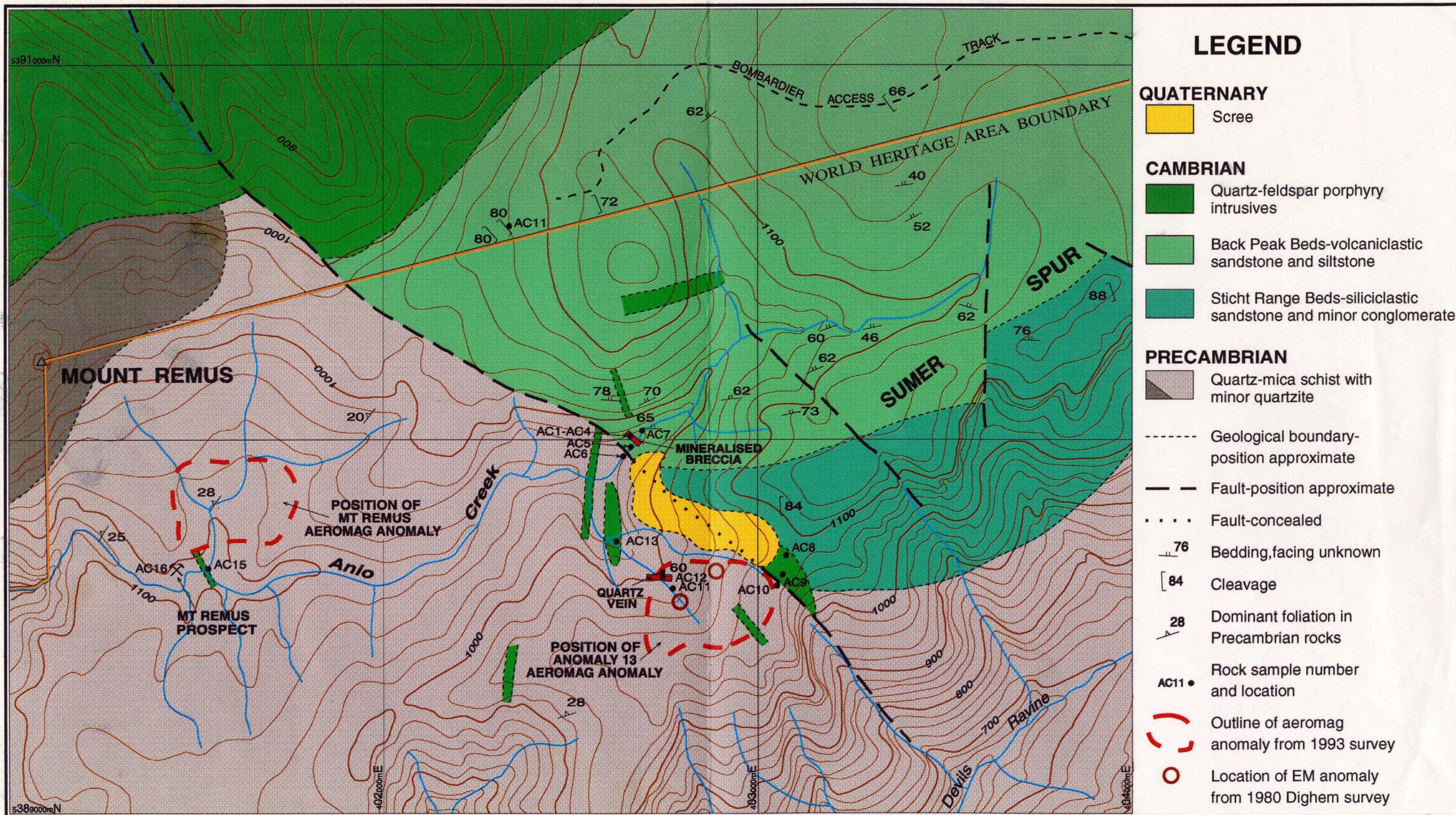


Figure 3

Geological map of the Anio Creek area (scale 1:10 000)

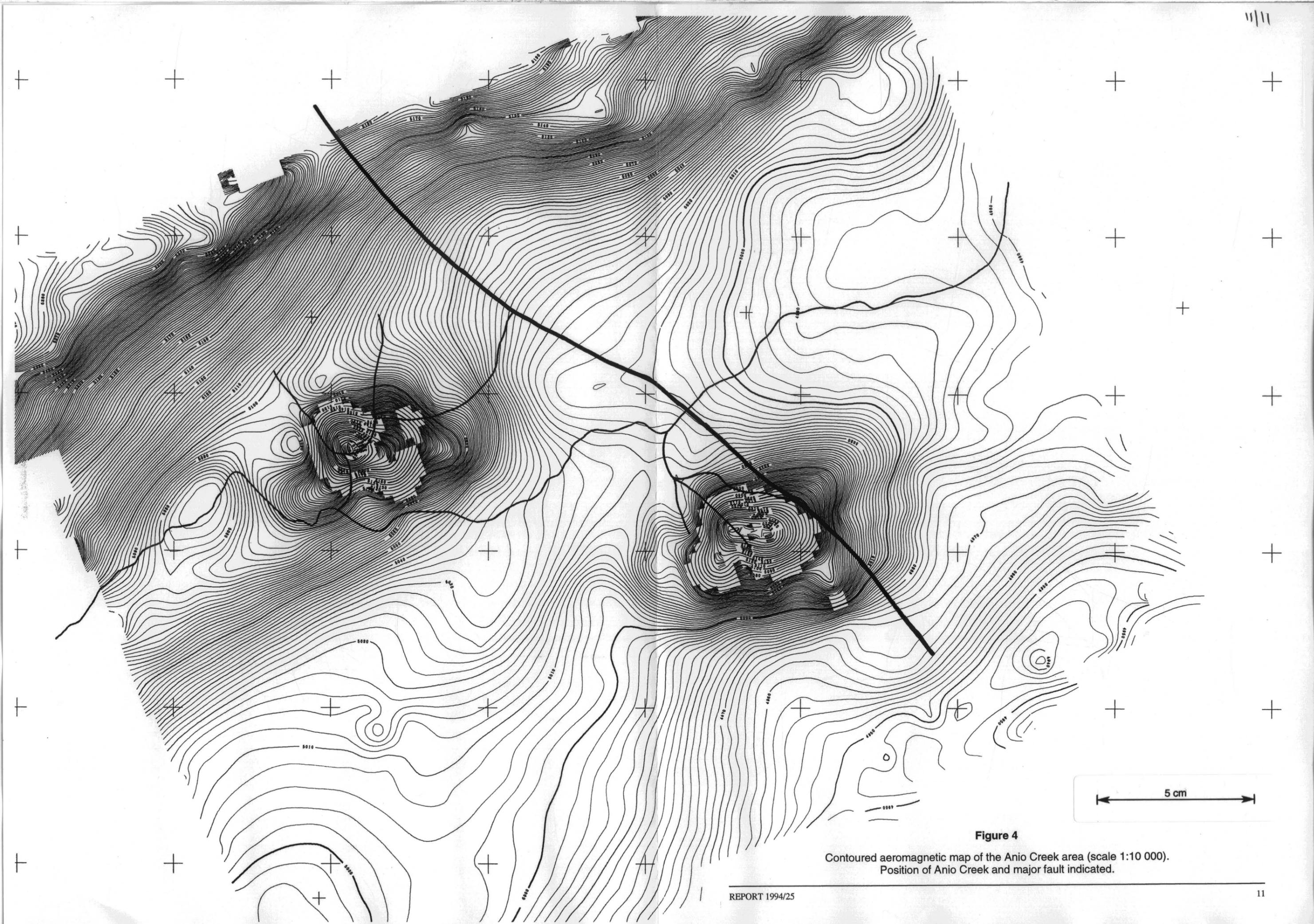


Figure 4

Contoured aeromagnetic map of the Anio Creek area (scale 1:10 000).  
Position of Anio Creek and major fault indicated.