



**Mt Ramsay  
Exploration Licence 72/2007**

**Annual Report for the period 4/04/2016 to 3/04/2017**

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# 1 Summary

Exploration Licence 72/2007 located in western Tasmania is prospective for tin, tungsten and magnetite mineralisation within meta-sedimentary rocks adjacent to the Meredith Granite. Work to date within EL72/2007 has identified two drill-ready tin and tungsten skarn targets, the RAM A and RAM B skarns. Approval was gained for 5 drill sites to test these targets in 2015 but the proposed drilling has postponed by cuts to Venture's exploration budget. Field activities comprised prospecting of boron, lead and low-level tin soil anomalies in the Ramsay River area and while the work failed to find alteration indicative of concealed Sn+W skarn further work over the RAM EM2 target is recommended.

Petrographic work on the RAM A skarn during the reporting period indicates the presence a quartz-carbonate alteration stage comparable with the high grade cassiterite zones within the Mt Lindsay skarns, albeit largely destroyed by the commercially barren amphibole+titanite and biotite alteration stages. By analogy with the Main and No2 Skarns at Mt Lindsay the RAM A skarn is considered prospective for cassiterite mineralisation in a more distal setting than currently drill tested, and microprobe work being undertaken at UTAS is focussing on the use of garnet chemistry to potentially verify this assertion.

Drill core from MRDD01 (by Malachite Resources) was retrieved from an abandoned house in Waratah and relocated to Venture's core shed in Tullah for inspection and sampling (in progress) for assay and petrography.

# 2 Introduction

Exploration Licence 72/2007 is situated in the tin-tungsten province of western Tasmania within the eastern contact metamorphic aureole of the Meredith Granite. The Meredith Granite is part of a suite of Devonian granites which is very important to tin-tungsten mineralisation in Tasmania, and deposits associated with this suite include the world class Renison Bell tin mine (26 Mt at 1.46% Sn), Mount Bischoff (10.54 Mt at 1.1% Sn), Cleveland (12.4 Mt at 0.62% Sn, 0.25% Cu) and King Island (17 Mt at 0.85% W<sub>3</sub>). Cleveland and Mount Bischoff are situated around the northern margin of the Meredith Granite, and Renison Bell is associated with the smaller Pine Hill Granite c. 15 km to the southeast of the Meredith Granite.

Previous exploration activities mainly for tin and tungsten within the area now covered by E72/2007 also indicate the presence of potentially economic magnetite skarns. There are currently two producing magnetite mines in Tasmania, the Kara magnetite-scheelite mine located near Hampshire approximately 40 km northeast of EL72/2007 and the Savage River magnetite mine (371 Mt at 31.9% Fe in magnetite) situated c. 20 km west, north-west of the Mt Ramsay.

### 3 Location and Access

EL72/2007 currently covers 24 km<sup>2</sup> and is located approximately 80 km by road southwest of the coastal port of Burnie, and c. 16 km by road from the nearest town of Waratah (**Figure 1**). The tenement is on Crown Land entirely within the Meredith Range Regional Reserve. The terrain is characterised by steeply incised valleys into broad forested plateaux and mountains. Elevation ranges from 180 m above sea level in the Ramsay River valley to 855 m on a spur to the north east of Mt Ramsay. Average annual rainfall is approximately 2000 mm and vegetation is dominated by temperate rainforest with relatively open understory away from the Meredith Granite. Eucalyptus forest and dense sub-alpine scrub cover granitic basement in the western part of the tenement, and any areas of regenerating rainforest.

Ground access to the licence can currently be made via Waratah from the north, and via Huskisson Drive from the southeast (Figure 1). From Waratah access is via the Wombat Flat – Mt Ramsay 4WD track which branches off the Waratah Road c. 7 km south west of Waratah.

From the Waratah Rd to the RAM A target area beneath Mt Ramsay the trip takes approx. one hour on quadbike and 4 hours on foot. For the most part road conditions comprise rocky track in rainforest locally covered with loose cobbles and small boulders and water scoured track on granite through scrubby forest. There are some deeply rutted sections, particularly around 372167mE 5399795mN (MGA55 GDA94) where there are permanent bog holes up to c. 1m deep and 50m along the road. ATV access is not recommended after heavy rain. The 4WD road is open to the public and there is evidence of irregular public ATV or 4WD use.

From the South access is via Huskisson Drive, a gravel Forestry road which branches off the Murchison Highway c.12 km south of Fingerpost intersection. Access to Huskisson Drive can also be made from Pearsefield Road. Huskisson Drive is in good condition and driveable all the way to the Hatfield River crossing in a 4WD vehicle. At the Hatfield River crossing the forestry bridge has been washed out. The Forestry bridges across the Que and Huskisson rivers have also been washed away. Vehicle access beyond the Hatfield is essentially restricted ATVs. Between the Hatfield and Huskisson rivers the road travels through low-lying rainforest and is gravelly with significant potholes. After the Huskisson River crossing the 4WD road traverses rainforest with locally very steep sections but there are no large bog holes. Four wheel drive access is also possible from the Huskisson-Hatfield confluence north to Waratah via a rough ridgeline track on the west side of the Coldstream River, as shown on the 1:25,000 and 1:100,000 topographic map sheets. The southern part of this track was used to access, on foot, the Ramsay River area for prospecting during the 2016 field season.

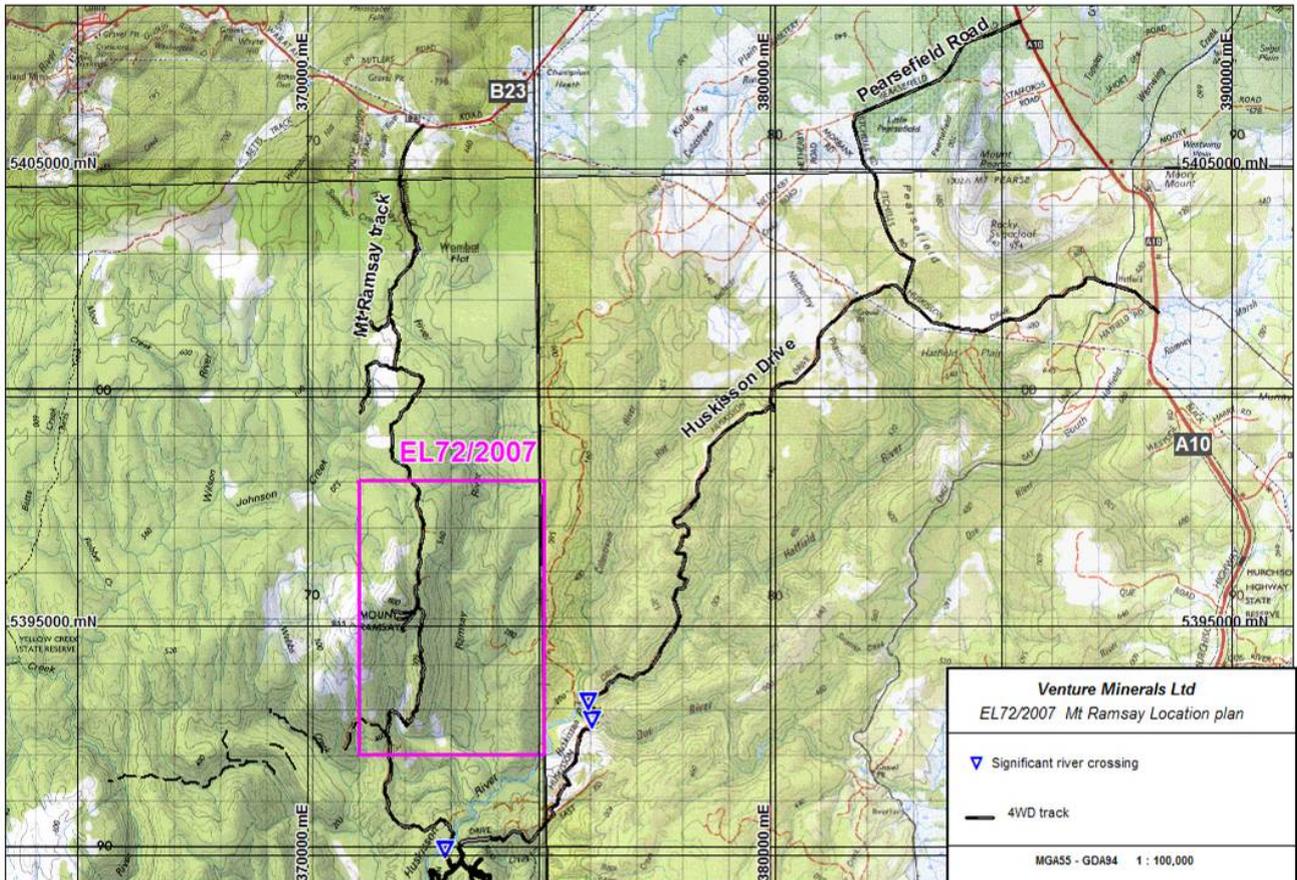


Figure 1: EL72/2007 Location & Access Map

## 4 Geological Setting

The Mount Ramsay area has been mapped by the Tasmanian Geological Survey (Brown 1986) and mineral explorer Comstaff Pty Ltd (“Comstaff”) showing the area now covered by EL72/2007 is underlain from east to west by the Neoproterozoic Oonah Formation, the Neoproterozoic Crimson Creek Formation or correlate and the Devonian Meredith Granite (**Figure 2**). To the north and in the northern part of EL72/2007 these basement units are partly overlain by Tertiary basalt. There are also minor Quaternary fluvial gravel terraces in the larger river valleys.

The Oonah Formation is mainly comprised of strongly deformed (characteristically isoclinally folded) thin to medium bedded quartz sandstone with carbonaceous siltstone, shale, and phyllite. Mapping by Comstaff along the Ramsay River indicates the presence of dolomite units within the Oonah Fm. A fault separates the Oonah Fm. from the younger Crimson Creek Fm. within EL72/2007. The Crimson Creek Fm. consists of thin to thick bedded dark green grey volcanic lithic sandstone, siltstone and thin bedded mudstone with thin to thick bedded calcareous sandstone units with distinctive thin bedded intraclast breccias (flakestone), and locally abundant basalt (flows?), dolerite and microgabbro intrusions.

The Meredith Granite intrudes the Crimson Creek Fm. in the western part of EL72/2007. Historic exploration drilling suggests the granite margin dips moderately to steeply east. The Meredith Granite is an I-type biotite granite, at Mt Ramsay comprising an equigranular adamellite and porphyritic adamellite. The granite contains numerous quartz+tourmaline veins and commonly has roughly circular patches of quartz+tourmaline alteration. A zone of massive quartz-tourmaline alteration is developed in the margin of the Meredith Granite adjacent to the RAM A calc-silicate, amphibole, biotite, magnetite and sulphide skarn within the Crimson Creek Formation on the south eastern flank of Mt Ramsay. Mapping and drilling by Comstaff shows the proximal part of the RAM A skarn dips steeply east and most likely plunges south-southwest. The skarn is approx. c. 80 m wide and exposed for c. 800 m strike extent from the granite contact. End of exposure appears to coincide with a northeast striking fault. A prominent magnetic ridge can be traced a further 2 km along strike, but it is unclear at this stage whether it represents subsurface magnetite-skarn or a stratigraphically separate magnetite-rich hornfels.

An inspection report to the Tasmanian Department of Mines in 1909 on the small shafts and adit at Mt Ramsay is the earliest description of the RAM A skarn. An amphibole-rich mineral assemblage was recorded including native bismuth, arsenopyrite, pyrite, chalcopyrite, ilmenite, magnetite, scheelite, fluorite, garnet and rare axinite. It was noted that specks and "large pieces" of native bismuth were commonly associated with scheelite. Venture Minerals has encountered similar assemblages and associations in the Main and No. 2 Sn-W-magnetite deposits at Mt Lindsay c. 15 km to the southwest of Mt Ramsay. Comstaff drilled several diamond core holes into the RAM A skarn in the 1980s and report a mineral assemblage comprising variable percentages of coarsely crystalline garnet, vesuvianite, diopside and ferrohastingsite with characteristic compositional banding. Massive crystalline and banded magnetite was also recorded throughout the skarn. Fluorite and calcite were reported as common interstitial minerals, with lesser pyrrhotite, pyrite, tourmaline and minor chalcopyrite, ilmenite, arsenopyrite, scheelite and native bismuth. Cassiterite was not identified in hand specimen or thin section. The skarn is typically enveloped by mottled pyroxene, amphibole and biotite hornfels, locally with andalusite pseudomorphs.

Drill testing of other magnetic and EM targets has identified the presence of widespread pyrrhotite mineralisation occurring as minor disseminations, veins and in hydrothermal breccia. Well-developed hydrothermal breccia zones intersected in Malachite Resource drill hole MRD1 c. 750m to the east of the RAM A indicate repeated mineralisation and brecciation from multiple fluid stages. The breccia zones have well-developed amphibole, quartz, pyroxene, biotite and sulphide alteration halos. A petrographic report by Dr B. J. Barron suggests the mineral assemblage of the breccia vein fill would have been formed in high temperature fluid conditions too proximal to the granite to have been conducive for Sn mineralisation. Similar hydrothermal breccia zones have been observed by Venture Minerals at Mt Lindsay in hornfels adjacent to skarn or carbonate protolith.

The Ramsay region has been affected by multiple northeast striking faults which appear to post-date granite emplacement and sinistrally offset the prominent north trending magnetic fabric within the Oonah and Crimson Creek formations.

## 5 Exploration and Mining History

The earliest recorded exploration efforts in the Mt Ramsay area were conducted by the Tasmanian Bismuth and Gold Mining Company who constructed shafts and adits into the Mt Ramsay Skarn close to the granite. In the late 1800's Mt Ramsay was considered to be a significant bismuth deposit but later extension of exploration tunnels identified no further enrichment with the best grades found at surface. Although scheelite was identified the tungsten potential was apparently not considered. There are also no records of tin mineralisation or any mention of tin mining or prospecting being pursued in any significant way.

Comstaff Pty Ltd ("Comstaff") took up the Mt Ramsay area in the 1970's and in the following 15 years conducted geological mapping, geophysical surveying, geochemical sampling and 10 diamond core drill holes. After early reconnaissance works Comstaff established four cut grids named CAF, CAI, CAE and CAL. Each grid was auger sampled and geologically mapped. The western central CAF grid covering the RAM A target was the most extensively sampled area where the soil assay results showed significant Sn (up to 800 ppm) and W (up to 320 ppm W) anomalism over an area up to 60-100m wide with a strike extent of 1.4 km. Grid CAE to the far north contained no soil anomalism; the grid is situated slightly to the east of a large magnetic feature and Comstaff may have missed an interesting target. Grids CAL and CAI have moderate As anomalism but with no significant Sn and/or W anomalism.

Comstaff completed seven (7) diamond drill holes CAF1 to CAF7 totalling 1110.6 m within and adjacent to the historically identified Mt Ramsay Skarn (the "RAM A" target) within the CAF grid (**Figure 2**). CAF2, CAF3 and CAF5 were drilled in the north of the CAF grid close the granite contact and intersected metasediments, minor calc-silicate skarn and granite. Economic grades were not encountered and intersection of the granite at shallow levels indicates limited exoskarn potential. Approx. 200 m south of CAF2, 3 and 5 thicker more substantial calc-silicate skarn zones were intersected and the drill holes were anomalous for Sn, WO<sub>3</sub>, Cu, Fe and Bi. The best results are in the southernmost drill holes; CAF7 intersected 73 m of skarn inclusive of 7.3 m at 0.16 % Sn from 143.3 m down hole, and CAF1 encountered 83 m of skarn including 17 m at 0.17 % Sn from 199.25 m down hole. Cassiterite was not identified in any of the holes. Holes CAF4 and CAF6 were drilled to the east away from the CAF geochemical-magnetic target and significant mineralisation and alteration were not encountered.

Comstaff also drilled one diamond hole at the northern CAL grid and two holes at the southern CAI grid encountering extensive pyrrhotite alteration as disseminations, veins and fracture infill. A little calc-silicate alteration was intersected, but no economical mineralisation was recorded. The extensive pyrrhotite veining and alteration and magnetite-rich hornfels encountered by the Comstaff drill holes indicate the presence of non-skarn sources for magnetic anomalism in the Ramsay area.

Malachite Resources ("Malachite") explored the Mt Ramsay area during the 2004 to 2008 period and represents the only significant works subsequent to the Comstaff relinquishment. Malachite was focussed on identifying Mt Bischoff-Renison Bell style

cassiterite-bearing massive sulphides. A previous (2001-2002) helicopter EM survey by the Tasmanian Geological Survey showed the presence of a significant conductor about 800 m east of the Mt Ramsay Skarn, and a partial (due to very steep terrain) ground EM survey by Malachite confirmed these results. Several conductors potentially representing sulphide mineralisation were identified and checked on the ground. Geological mapping located electrically conductive graphitic shales and minor sulphide veining, but the conductors to the east of the CAF grid were selected to be drill tested due to the favourable logistics, coupled with high magnetic anomalism and the presence of calcareous strata at surface. Malachite drilled one diamond core hole MRDD1 for 408 m which intersected a thick hydrothermally brecciated pyroxene and biotite hornfels unit from approx. 265 m to 408 m end of hole. The breccia returned a best intersection of 30 m at 117 ppm Sn and 50 ppm WO<sub>3</sub> from 354 m. Breccia vein and cement is comprised of pyrrhotite-actinolite with minor chalcopyrite, pyrite and marcasite. No significant exploration has been conducted at Mt Ramsay since 2008.

## **6 2016-2017 Anniversary Year Exploration Activities**

Environmental approval for helicopter supported diamond core drilling of proposed holes into the RAM A and RAM B skarns was gained in 2015 but cuts to Venture's exploration budget have put the proposed drilling on hold. Review of the proposed programme has prioritised two of the proposed drill sites targeting the predicted marble front zone within the RAM A skarn.

Prospecting of low-level Sn and B soil anomalies in the Ramsay River area, including the north-eastern part of the Ramsay EM2 target, failed to identify significantly altered or mineralised material. Elevated and partly cemented river terraces are widespread in the middle reaches of the Ramsay River and the lower part of the Ramsay EM2 Sn anomaly is most likely transported. The topographically upper part of the Ramsay EM2 with elevated Pb (to 350 ppm) and Zn (to 226 ppm) may be in situ or colluvial. It is recommended that the soil sampling grid over Ramsey EM2 be extended at least 300 m north and south of existing lines, and line spacing be closed down to 100 m. The conductivity highs east of Ramsay River appear to be underlain by laminated to thin bedded laminated quartz siltstone and are not considered prospective for Sn+W mineralisation.

After some local enquiries core from the Malachite drill hole MRDD1 into the RAM B target was retrieved from an abandoned house in Waratah and relocated to Venture's core shed in Tullah for inspection and sampling for assay (especially of B and F) and petrography. Results are currently pending. The core was somewhat jumbled but reference with original core photos has allowed reasonable re-ordering. The current priority Sn+W targets within EL72/2007 are shown in Figure 2.

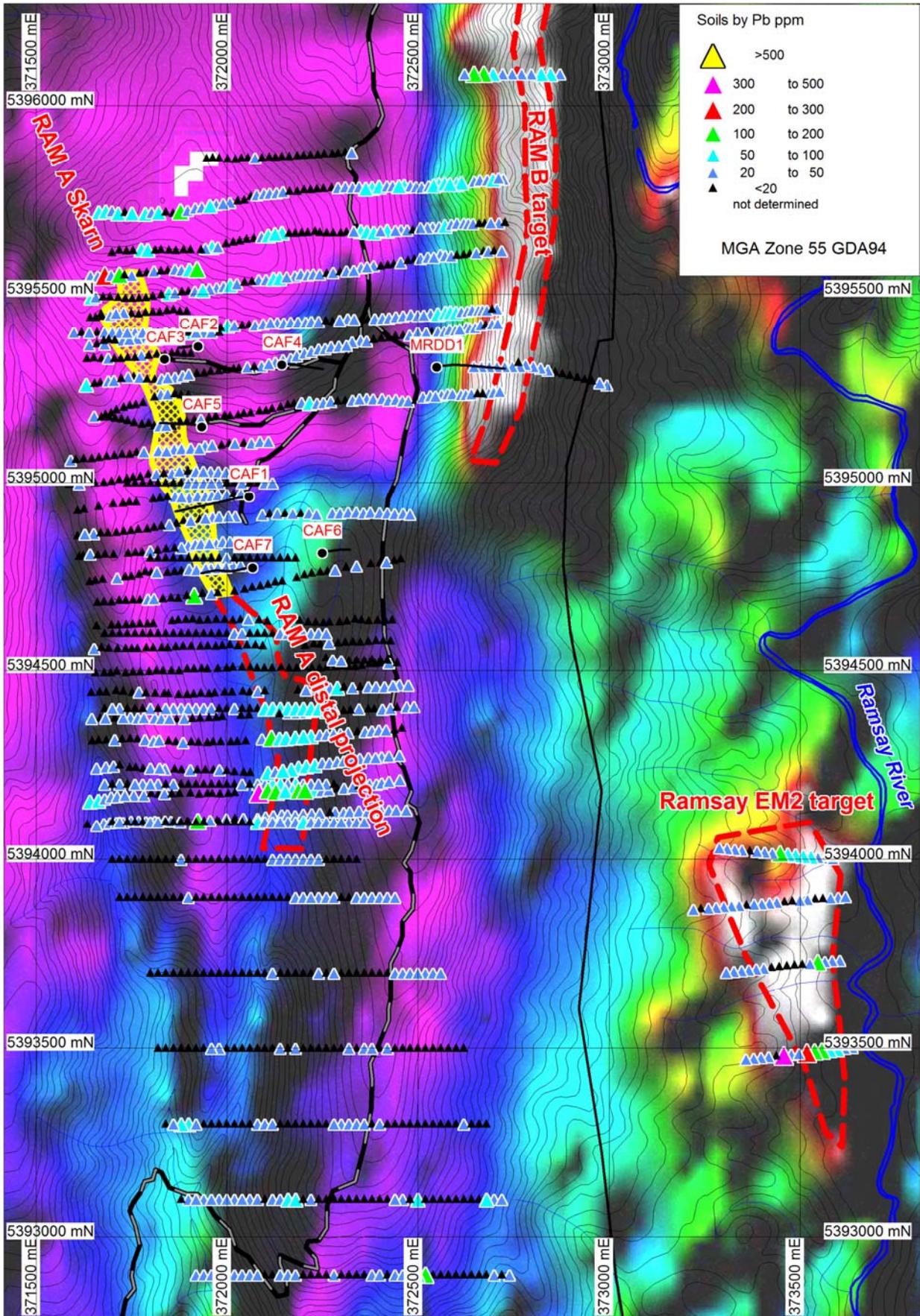


Figure 2: Priority Sn+W targets, drill holes, soil Pb and 10m topographic contours over helibourne EM 980 Hz vertical coaxial conductivity image.

Petrography of 31 specimens (Appendix A) from the RAM A skarn and re-logging of the CAF series drill core supports recognition of the following alteration units:

**Calcsilicate Stage**, comprising garnet, pyroxene and vesuvianite. Garnet and vesuvianite are typically zoned. Garnets are commonly partly to completely replaced by fans of vesuvianite tablets, and granular pyroxene widely partly replaces and infills veinlets cross-cutting both garnet and vesuvianite. Magnetite, pyrrhotite and chalcopyrite are most closely spatially associated with Calcsilicate Skarn (e.g. Figure 3).

**Amphibole+Titanite Stage**, comprising blue green to brown and lesser pale green amphibole everywhere associated with relatively coarse (to c. 5 mm) undulose sheaves of prismatic titanite. Most amphibole is strongly pleochroic blue green to green brown ?hastingsite, and commonly also colour zoned from with pale green to colourless rims (probably tremolite-actinolite). Pyrrhotite is generally spatially most closely associated with amphibole+titanite skarn and probably part of the assemblage. Hastingsite abutting to pyrrhotite commonly has a pale-colourless ?actinolitic rim. commonly conspicuously colour zoned from inner blue green (?hastingsite). Amphibole and titanite widely replace garnet, pyroxene and vesuvianite. The highest tin grades of c. 0.2 % obtained from drilling at Ramsay are associated with this stage (e.g. Figure 4) and the tin is most likely held within the amphibole and titanite.

**Prismatic Quartz+Carbonate Stage**, comprising prismatic quartz and coarse calcite. The texture suggests cavity and vein fill. Minor amounts of very dusty potassium feldspar and albite is commonly associated with this stage. Relict pyroxene and vesuvianite were rarely observed with this stage. In general the coarse calcite and prismatic quartz are partly replaced by amphibole needles and/or biotite, but calcite locally also partly replaces amphibole, and clean non-prismatic quartz also infills, sometimes with colloform texture, between amphibole crystals: a later or extended quartz and calcite alteration/infill also occurs. Because of the apparent wide paragenetic range of coarse calcite and polycrystalline-colloform quartz the presence of prismatic quartz is key to recognition of this stage.

**Biotite-Fluorite Stage**, comprising dirty cryptocrystalline green brown to coarse (c. 1 mm) resinous brown ?annitic biotite and minor pale green ?phlogopitic biotite. Spherulitic and colloform encrusting textures on, and polycrystalline pseudomorphic replacement textures of minerals of the above stages indicate late paragenesis. Microprobe work at Mt Lindsay suggests very fine stilpnomelane is probably present in the biotite spherules. Biotite-rich zones are typically accompanied by abundant fluorite infill, although fluorite is also locally abundant in amphibole+titanite skarn with only minor biotite.

The prismatic quartz+carbonate stage is host to the most significant episode of the cassiterite mineralisation within the analogous Mt Lindsay skarns c. 15 km to the SW of RAM A. Cassiterite and siderite, significant components of the prismatic quartz+carbonate stage at Mt Lindsay have not been recognised in the five holes drilled into the RAM A skarn, but the level of amphibole+titanite overprint within RAM A is comparable with the proximal cassiterite-poor or barren parts of the Mt Lindsay skarns. Although cassiterite-barren the presence of prismatic quartz+carbonate skarn within the proximal parts of the RAM A skarn is considered a positive sign for further exploration success by targeting the granite distal part of the system.

The extent of amphibole+titanite replacement of the prismatic quartz+carbonate stage within RAM A is such that it is difficult to know what the precursor was: calcsilicate relics are

rarely present and by comparison with Mt Lindsay calcareous sandstone or calcsilicate marble may have been the precursor to the prismatic quartz+carbonate stage in many cases. The protolith for RAM A is considered to be a thin bedded calcareous sandstone-mudstone unit stratigraphically equivalent to the host carbonate of the Main Skarn, Mt Lindsay where the “unreacted” core of the host carbonate unit in a granite-distal setting is most prospective for high grade cassiterite (and scheelite) mineralisation. Iron content of garnets in the Main Skarn at Mt Lindsay is typically elevated adjacent to the cassiterite zones and a selection of samples from CAF1, CAF5 and CAF7 have been recently microprobed at UTAS. Results are currently pending.

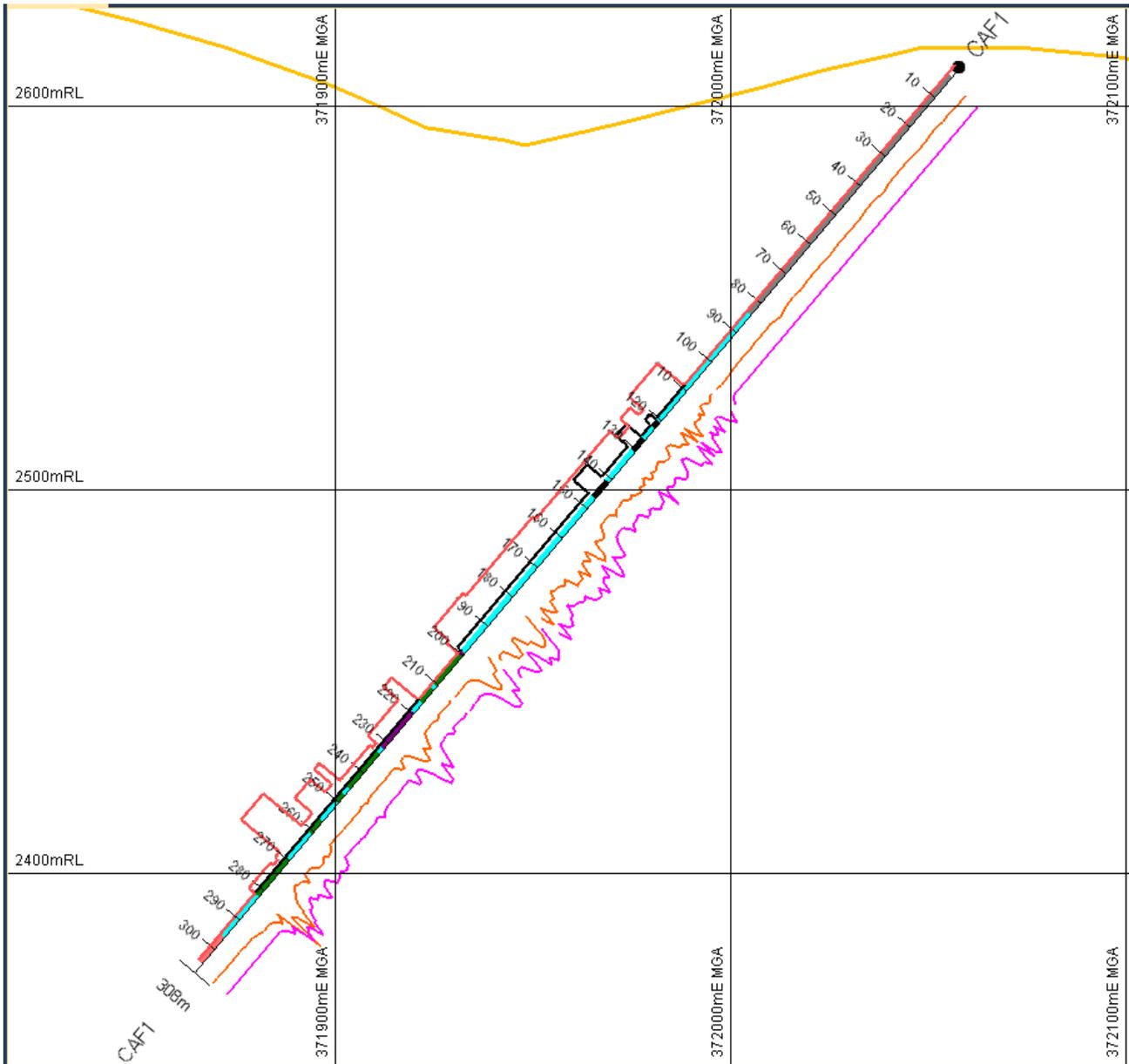


Figure 3: Drill section CAF1 showing logged garnet (pink) and magnetite (black) on left side of trace, assayed Cu (orange) and S (magenta) on right side of trace. Pyrrhotite is the most abundant sulphide with trace chalcopyrite which closely follows pyrrhotite distribution. Pyroxene and vesuvianite abundance essentially follow garnet so that logged garnet shows extent of calcsilicate skarn, and the sulphide association. Depths in metres.

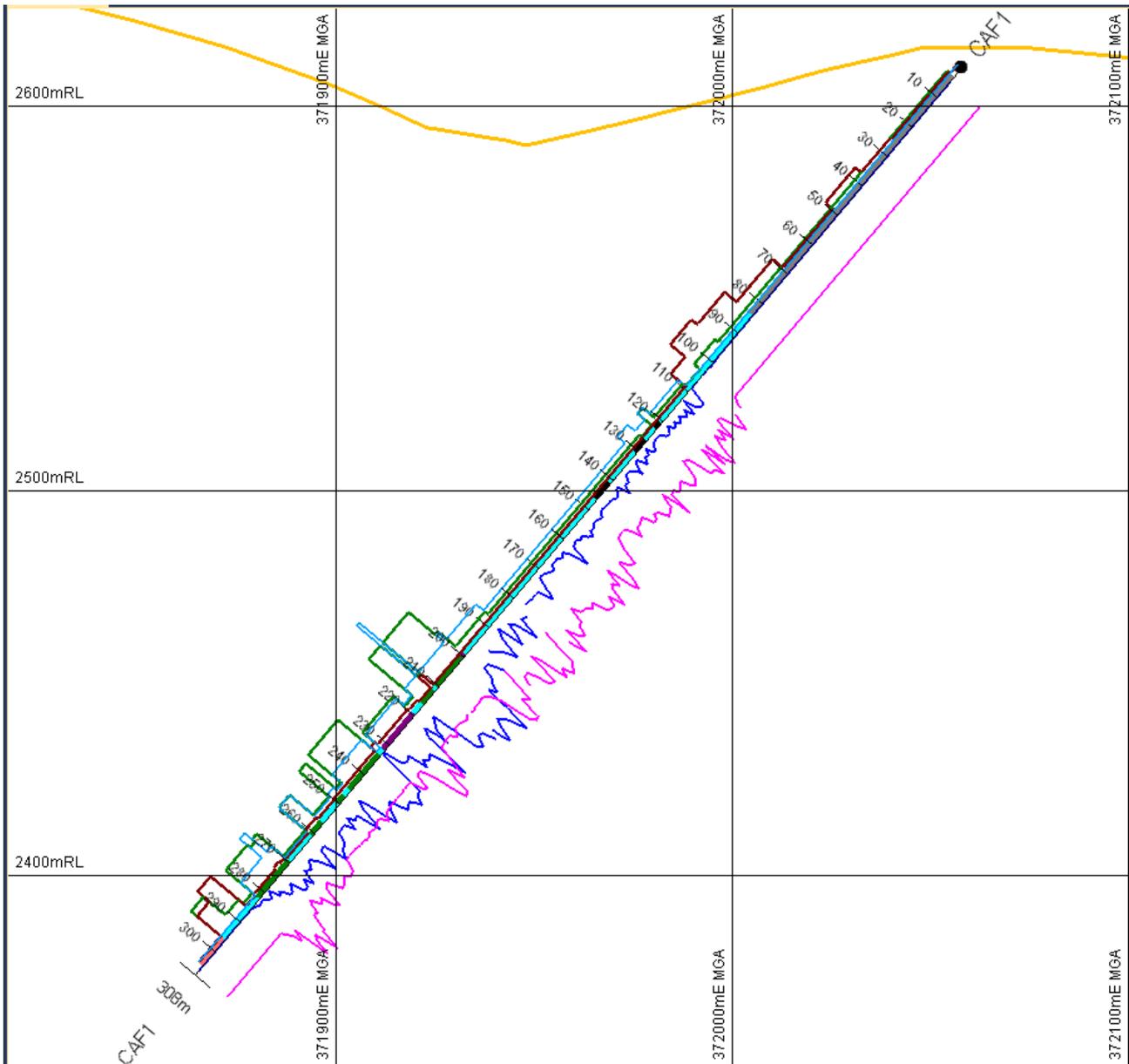


Figure 4: Drill section CAF1 showing logged amphibole (green), biotite-phlogopite (dark brown) and carbonate (blue) on left side of trace, assayed Sn (blue) and S (magenta) on right side of trace. The three main Sn zones (0.1-0.2%) around 210 m, 240 m and 275 m are associated with sulphide-poor amphibole+titanite alteration overprinting prismatic quartz+carbonate stages, and it is expected the Sn is mainly contained by the amphibole and titanite. The alteration is generally so advanced that it is unclear whether there was any significant calcsilicate presence within the three main amphibole-titanite zones. Depths in metres.

## 7 Conclusions and Recommendations

Prospecting of boron, lead and low-level tin soil anomalies in the Ramsay River area failed to identify alteration indicative of and/or suitable carbonate units to host concealed Sn+W skarns or replacement deposits. The somewhat erratic lead anomalism at the Ramsay EM2 target is still considered encouraging and possibly in situ: Extension (300 m north and south) and infill (to 100 m line spacing) of the grid is recommended in order to upgrade or dismiss the anomaly.

Petrographic work on the RAM A skarn during the reporting period indicates the presence a quartz-carbonate alteration stage comparable with the high grade cassiterite zones within the Mt Lindsay skarns, albeit largely destroyed by the commercially barren amphibole+titanite and biotite alteration stages. Microprobe work currently being undertaken at UTAS is focussing on the use of garnet chemistry to potentially verify by analogy with the Mt Lindsay Skarns that the RAM A skarn is prospective for cassiterite mineralisation in a more distal setting than currently drill tested. Results of a first batch of microprobe samples from CAF1, CAF5 and CAF7 are currently pending.

Drill core from MRDD01 by Malachite Resources into the RAM B target was retrieved from an abandoned house in Waratah and relocated to Venture's core shed in Tullah. MRDD01 was terminated in brecciated biotite and pyroxene hornfels which, upon preliminary inspection, compares very favourably with alteration zones adjacent to ore skarn within the Mt Lindsay deposits. Samples for assay (especially B and F) and microprobe analysis have been collected and submitted for preparation.

It is proposed that the laboratory work be followed up with prospecting of the defined targets and adjustment of proposed drilling (two sites at the southern end of the RAM A skarn have been prioritised for drill testing when Venture's exploration budget allows).

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# **Appendix: Petrographic Summaries**

**Appendix: Petrographic Summaries**

H0002	Version	3				
H0003	Date_generated	3/04/2017				
H0004	Reporting_period_end_date	3/04/2017				
H0005	State	TAS				
H0100	Tenement	EL72/2007				
H0101	Tenement_holder	Venture Minerals Ltd				
H0102	Project_name	Mt Ramsay				
H0106	Tenement_operator	Venture Minerals Ltd				
H0150	250K_map_sheet	SK5503 Burnie				
H0151	100K_map_sheet	7914 Pieman				
H0152	50K_map_sheet	na				
H0153	25K_map_sheet	3639 Ramsay				
H0200	Start_date_of_data_acquisition	4/04/2016				
H0201	End_date_of_data_acquisition	3/04/2017				
H0202	Data_format	SG3				
H0203	Number_of_data_records	31				
H0204	Date_of_metadata_update	3/04/2017				
H0500	Feature_Located	Petrographic summary				
H0600	Sample_code	Petrography				
H0601	Sample_type	Drill core, rock				
H0700	Sample_preparation_code	Cover slipped thin sections				
H0800	Assay_code	not applicable				
H0900	Remarks:					
H1000	Sample	Hole	Depth_m	Summary	Description	Comments
D	CAF1_21.9m	CAF1	21.9	Amphibole + magnetite hornfels after medium grained volcanite	Medium grained heavily green amphibole altered sandstone with c. 3% volcanic quartz (monocrystalline, commonly embayed), 15% feldspar largely replaced by sericite & amphibole, 75% felsic & lath textured basaltic-andesitic volcanic lithics replaced by amphibole & microcrystalline feldspar, quartz, amphibole & opaques (magnetite), 3% ferromagnesian detrital grains entirely replaced by amphibole, 2% anhedral magnetite (?entirely authigenic). Minor green amphibole veinlets.	
D	CAF1_143.5m	CAF1	143.5	Vesuvianite + pyroxene skarn with weak amphibole+titanite & biotite stage overprints	Calcsilicate skarn comprising coarse (1-10mm) tabular & locally radiating clusters of zoned vesuvianite (30%), minor relict garnet (2%) & abundant granular pyroxene (25%). Clots of granular subhedral magnetite (20%) & minor euhedral pyrrhotite (2%). Minor euhedral titanite (1%). Vesuvianite cores full of irregular-anhedral pyroxene & calcite (15%), lesser fine grained green amphibole (2%) & biotite (3%) replacement. Granular pyroxene also as irregular veinlets & vugs. Calcite, blue green - green brown amphibole & green brown biotite infill between vesuvianite tablets & locally between pyroxene. Calcite replaces vesuvianite, amphibole replaces vesuvianite & pyroxene, biotite replaces vesuvianite, pyroxene & amphibole.	
D	CAF1_173.9m	CAF1	173.9	Garnet + pyroxene + vesuvianite skarn moderately overprinted by amphibole + titanite stage & weak biotite stage	Granular garnet (10%) & pyroxene (30%) skarn partly overprinted by green amphibole (20%), titanite (3%), calcite (20%), pyrrhotite (10%), magnetite (5%), trace chalcocopyrite (1%). Patches of fine pyroxene possibly replacing coarse garnet. Trace relict vesuvianite (1%), some coarse calcite domains are incomplete pseudomorphs of c. 5mm vesuvianite tablets. Titanite occurs as undulose sheaves associated with amphibole-rich domains. Rare idiomorphic ?monazite with brown metamict haloes. Pyrrhotite & chalcocopyrite veinlets. Minor fine brown biotite (1%).	
D	CAF1_181.5m	CAF1	181.5	Garnet + pyroxene + vesuvianite skarn moderately overprinted by amphibole + titanite stage & weak biotite stage	Coarse zoned vesuvianite (20%), granular pyroxene (20%) & granular euhedral garnet (20%) skarn, moderately replaced by blue green amphibole (25%) + sheaf titanite (3%) & calcite (10%), minor dirty brown biotite (2%), minor sub-anhedral pyrrhotite (2%), subhedral arsenopyrite (0.5%), trace interstitial polycrystalline quartz (0.1%). Garnets moderately replaced by amphibole, calcite, pyroxene & rarely titanite, commonly producing atoll textures from euhedral garnets. Vesuvianite zoned & heavily replaced by calcite, amphibole, pyroxene & titanite, especially in core. Pyroxene partly replaced by calcite & amphibole. Colourless reaction rim within blue green amphiboles enclosing pyrrhotite.	

**Appendix: Petrographic Summaries**

H1000	Sample	Hole	Depth_m	Summary	Description	Comments
D	CAF1_187.8m	CAF1	187.8	Amphibole + titanite skarn replacing vesuvianite skarn with relict patches of prismatic quartz + potassium feldspar + calcite	Green to brown amphibole (30%) + titanite (5%) skarn with irregular patches of polycrystalline kspar (20%) clouded with dusty calcite & amphibole needles, minor prismatic quartz (0.5%, undulose sheaves) & coarse calcite (30%) impregnated with needles of amphibole & sheaves of titanite, accessory pyrrhotite, accessory spherules of fibrous brown biotite (5%) especially in small intergranular cavities. 5% anhedral magnetite & pyrrhotite. 1% ?fluorite & relict porosity amongst amphibole needles. Trace apatite. Calcite, undulose polycrystalline quartz, amphibole & biotite replaces kspar. Amphibole needles partly replace calcite & the undulose quartz. Biotite interstitial to amphibole & titanite, & slightly replaces some amphibole. Pale rims & patches within cores of many amphiboles.	
D	CAF1_193.2m	CAF1	193.2	Garnet + vesuvianite + pyroxene + magnetite skarn overprinted by amphibole+titanite & calcite alteration	coarse granular garnet & tabular vesuvianite (20%) with finer granular pyroxene (20%), all partially replaced by green-brown amphibole (15%), calcite (20%), trace sheaves of titanite (1%), granular magnetite (20%), & minor biotite (2%), trace pyrrhotite. Amphibole & titanite & magnetite closely spatially associated. Calcite, amphibole & pyroxene replace & infill around coarse vesuvianite tablets.	
D	CAF1_201.2m	CAF1	201.2	Coarse quartz & calcite skarn extensively overprinted by amphibole + titanite + pyrrhotite skarn, minor biotite replacement of all	Coarse quartz (10%) & calcite (5%) skarn mostly replaced by coarse acicular amphibole (35%) + titanite (3%) + pyrrhotite (40%) & trace chalcocopyrite (0.5%). Trace relict pyroxene? Early blue green - green amphibole overgrown by pale green brown amphibole. Patches of very fine dirty brown biotite (5%) replacement of amphibole. Amphibole & titanite needles replace quartz & calcite.	
D	CAF1_211.2m	CAF1	211.2	Prismatic quartz + calcite skarn overprinted by amphibole + titanite then biotite	coarse dark green - brown green acicular amphibole (55%) skarn with sheaves of titanite (3%), coarse patches of calcite infill (20%) with amphibole shrapnel, minor patches of relict coarse prismatic quartz (5%), locally undulose & trace kspar (<1%) impregnated with dark green amphibole needles. Rare partial calcite pseudomorphs of amphibole. Modest to locally intense dirty brown to brown green biotite (15%) & chlorite (5%) alteration of amphibole & titanite & quartz prisms. Biotite euhedra commonly rimming & corroding titanite & quartz, penetrating cleavages of amphibole.	
D	CAF1_211.4m	CAF1	211.4	Prismatic quartz + calcite skarn overprinted by amphibole + titanite skarn, then biotite	cg calcite (55%) & prismatic quartz (15%) skarn with minor polycrystalline kspar patches (1%), trace pyroxene (2 grains within calcite domain). Prismatic quartz infilled & partly corroded by calcite, overprinted by coarse blue green to green brown zoned amphibole (10%) needles & titanite (2%) sheaves (amphibole & titanite needles cut across quartz prism & calcite faces), light brown to green brown biotite (15%) encrusts & replaces amphibole & titanite & especially ?kspar.	
D	CAF1_214.2m	CAF1	214.2	Amphibole + titanite + calcite + quartz skarn with minor biotite overprint, trace fluorite	coarse brown to blue green amphibole (70%) & sheaf titanite (5%) set in coarse calcite (15%) & coarse undulose & rarely prismatic quartz (5%). Minor fine dirty green brown biotite (5%) replacing amphibole & titanite, locally small spherulitic & colloform biotite growths on edge of amphibole crystals. Trace purple fluorite (<1%) within the calcite, & trace magnetite (<1%).	
D	CAF1_217.5m	CAF1	217.5	Vesuvianite + pyroxene skarn with minor garnet, modestly overprinted by amphibole + titanite & calcite	coarse (+10mm) zoned tabular vesuvianite (55%) & granular pyroxene (25%) skarn with irregular corroded garnet patches full of pyroxene inclusions, and minor overprint of bright green to dark brown amphibole (10%) + sheaf titanite (2%), calcite (7%) & biotite (1%). Coarse amphibole & titanite (incipient sheaves) infill around vesuvianite tablets. Garnet & cores of vesuvianite tablets heavily replaced with fine pyroxene, amphibole, calcite, titanite & magnetite. Outer zones of vesuvianite cleaner than cores. Pyroxene slightly replaced by amphibole & titanite.	
D	CAF1_241.5m	CAF1	241.5	Amphibole + titanite skarn with calcite ?infill & minor relict patches of pyroxene, rare quartz ?infill	coarse acicular green amphibole (65%) & sheaf titanite (5%) skarn, minor relict patches of coarse pyroxene (3%) heavily replaced by calcite (20%), amphibole & titanite. Irregular patches of calcite, fluorite (7%) & minor quartz (2%) with amphibole needle shrapnel = infill of vugs. Amphibole patchily zoned from bright gn cores to pale brown green rims. Fine banded biotite-chlorite (2%) fill of final porosity & slight replacement of amphibole	

**Appendix: Petrographic Summaries**

H1000	Sample	Hole	Depth_m	Summary	Description	Comments
D	CAF1_258.1m	CAF1	258.1	Pyroxene skarn & amphibole + titanite alteration & skarn, trace biotite overprint	fine & coarse pyroxene (40%) zones passing into closely packed dark green to brown amphibole (40%) + sheaf titanite (3%) zone. Pyroxene partly replaced by calcite (10%) & amphibole. Minor calcite & fluorite (3%) infilling vugs in amphibole + titanite domain, at margin of pyroxene & amphibole domains pale green "felted" amphibole zone with strong calcite replacement of amphibole. Amphibole zoned from dark green cores to pale green rims & discrete patches of pale amphibole within dark green amphibole suggest replacement. Trace qz (<1%) ?infill between amphibole prisms, trace bn very fine ?biotite & chlorite (<1%) spherulitic coatings & alteration of amphibole.	
D	CAF1_264.8m	CAF1	264.8	Garnet + pyroxene marble replcaed by vesuvianite + pyroxene, with modest amphibole & weak biotite overprint	fractured cg slightly pk anisotropic garnet (5%) relicts replaced by weakly zoned very coarse (+10mm) vesuvianite (30%) tablets full of fine pyroxene (10%) inclusions & veined by cleaner vesuvianite & minor calcite (5%). Garnet, vesuvianite & pyroxene all extensively replaced by fine green amphibole (40%) + granular titanite (3%) + calcite & fine pyrrhotite (3%) & minor pale brown biotite (3%). Rare prehinte.	
D	CAF1_271.6m	CAF1	271.6	Vuggy amphibole + titanite skarn with calcite + prehnite + zoisite infill, amphibole partly replaced by biotite & chlorite, very late calcite veinlets	felted gn amphibole (30%) + sheaf titanite (10%) skarn with ?vugs of coarse zoned green amphibole needles & titanite sheaves enclosed in coarse calcite (30%) & prehnite (10%), undulose quartz (3%) & fine clinozoisite (2%) infill. Calcite in vugs tuncates & corrodes amphibole needles. Modest fine gungy green brown biotite & chlorite (10%) alteration & spherulitic growths especially on amphibole, spherules zoned from biotite-rich core to pale ?chloritic rims. Biotite+chlorite weakly replaces titanite. Trace fluorite in vugs in calcite, post-amphibole & pre-chlorite. Rare calcite veins break amphibole needles & cut early vug-fill calcite, and cut biotite+chlorite spherules. Two ?monazites with brown metamict haloes.	
D	CAF1_272.5m	CAF1	272.5	Amphibole + titanite skarn with prismatic amphibole + titanite & calcite + fluorite zones	Felted acicular green amphibole (15%) + sheaf titanite (5%) skarn with vugs of coarse calcite (40%), euhedral fluorite (25%), fine ?clinozoisite (2%), gungy green brown spherulitic biotite + chlorite (10%), pyrrhotite (5%), trace chalcopyrite.	
D	CAF1_277.9m	CAF1	277.9	Greisenised amphibole + titanite skarn	Felted amphibole (5%, originally ?50%) & titanite (1%, originally ?3%) skarn extensively altered to gungy green brown biotite-phlogopite (40%) & chlorite (10%), ?prehnite (10%) chlorite & dusty titanite, flourite (10%) pore/vug fill & dusty calcite (5%) anhedral quartz (10%) + ?kspar (10%) mosaic domains with acicular pseudomorphs of amphibole. Skeletal ?ilmenite + amphibole + biotite + trace epidote + dusty titanite pseudomorphs of bowtie rhombic titanite clusters to 3mm. Abundant sub-anhedral pyrrhotite (10%), trace chalcopyrite, trace idiomorphic ?monazite to 600um long. One relict titanite grain at edge of TS.	
D	CAF1_278.1m	CAF1	278.1	Amphibole + titanite skarn partly replaced by epidote+prehnite+chlorite & fluorite+pyrrhotite & feldspar	Irregular domains to 10mm size of coarse (to 10mm) altered twinned plagioclase (20%) interspersed with domains of felted blue green - green brown amphibole (40%) + titanite (3%) + pyrrhotite (7%) + fluorite (5%). Pyrrhotite subhedral-euhedral with rare prehnite halos. Fluorite subhedra & vug fill, some quartz + fluorite pseudomorphs of amphibole. Plagioclase largely altered to prehnite (10%) + epidote (1%) + chlorite (5%) + fluorite + calcite (5%) + amphibole + sericite (5%). Titanite rhombs occur in sheaves to 3mm size, locally very slightly altered to skeletal ?ilmenite + epidote + secondary titanite. Rare subhedral yellow-orange weathered relict garnet (<1%), trace fine ?monazite prisms with brown metamict haloes.	
D	CAF1_281.2m	CAF1	281.2	Amphibole + titanite skarn partly overprinted by fluorite+pyrrhotite & epidote+prehnite+chlorite alteration	Felted blgn-gbn amphibole (40%) + titanite (5%) + pyrrhotite (7%) + fluorite (5%) rock with 15% dusty twinned plagioclase tablets to 10mm long. Pyrrhotite subhedral-anhedral, some penetrating along titanite cleavages. Plagioclase partly corroded to epidote (1%) + chlorite (5%) + prehnite (5%) + fluorite + calcite (5%) + amphibole. Fluorite occurs as subhedra & vug fill. Titanite occurs in sheaves of undulose extinguishing rhombs to 4mm size, some strongly altered to skeletal ?ilmenite + granular titanite + epidote. Trace idiomorphic ?monazite.	
D	CAF1_282.1m	CAF1	282.1	Biotite + fluorite + pyrrhotite greisen after amphibole+titanite skarn	Fine to medium grained (0.2-2mm) biotite-phlogopite (40%) + pyrrhotite (10%) + fluorite (15%) + quartz (10%) + feldspar (10%) greisen after felted amphibole + sheaf titanite skarn. Felted mass of blue green amphibole (2% relict, original estimated abundance >50%) pseudomorphed by green brown biotite - very pale green phlogopite, polycrystalline quartz, feldspar & fluorite. Distinctive skeletal ?ilmenite + biotite pseudomorphs of prismatic titanite sheaves to 4mm long (10%). Fluorite abundant in vuggy groundmass & veins. Vein to 5mm thick of fluorite + quartz + ?adularia + calcite + pyrrhotite + sericitised albite veins. Trace euhedral ?monazite to 1mm x 0.3mm (metamict haloes in biotite), trace chalcopyrite.	

**Appendix: Petrographic Summaries**

H1000	Sample	Hole	Depth_m	Summary	Description	Comments
D	CAF1_291.2m	CAF1	291.2	Biotite + anthophyllite + quartz + albite + magnetite hornfels	Magnetite-dusted biotite+qz+albite+anthophyllite hornfels, resinous bn biotite, qz & fresh albite & magnetite <50um gsize, anthophyllite skeletal fans & tablets to 10mm size commonly spreading out from qz+magnetite+biotite dusted fractures-veinlets.	
D	CAF1_296.4m	CAF1	296.4	Sericitised biotite granite, weak tourmaline alteration of feldspars, fresh perthite, sericitised plagioclase & sericitised biotite, minor calcite replacement of feldspar, trace fluorite in altered biotite	Medium grained (3mm) sericitised biotite granite, qz (45%) euhedral to subhedral slightly undulose, perthite (30%) slightly dusty & locally weakly replaced by calcite, albite (15%) largely replaced by sericite-muscovite+calcite, gn-bn biotite (5%) largely replaced by sericite-muscovite+titanite(acicular)+chlorite & rarely fluorite, common zircon (esp in biotite) & ilmenite (slightly altered to leucoxene), rare apatite, minor fresh bn & blue tourmaline (3%) replacing perthite (net texture) & albite (tablets largely replacing entire albite)	
D	CAF4_10.2m	CAF4	10.2	Amphibole spotted hornfels after andalusite hornfels	spotted hornfels, spots to 0.5mm comprise clusters of fine (10-200micron) pale green amphibole needles in low relief groundmass of <10micron quartz & ?feldspar dusted with same amphibole needles (15%) to 10x100micron size, dusty trails of opaques (5%) to 50micron size & <50micron size brown biotite (5%). Range of square to diamond to rectangular shapes suggest amphibole spots are pseudomorphs of andalusite. Veinlets of fine amphibole & dusty opaques.	
D	CAF5_73.3m	CAF5	73.3	Garnet + pyroxene + vesuvianite + pyrite skarn, partly replaced by secondary calcite (esp garnet & vesuvianite domains) with rare quartz ?prism relicts, heavily (50%) replaced by amphibole + bowtie titanite, then minor (<5%) gungy gnbn fg biotite alteration & infill, trace final spherulitic-fg qz infill of remnant porosity	Coarse (2-5mm) garnet (15%) + pyroxene (15%) + vesuvianite (20%) + calcite (15%) skarn overprinted by coarse amphibole (30%) + titanite (3%) skarn. Coarse amphibole characterised by relict windows of vesuvianite, garnet and/or pyroxene. Garnet sub-euhedra set in & partly replaced by coarse calcite, & both garnet & calcite partly replaced by coarse deep green amphibole & titanite sheaves. Coarse (1-3mm) pyroxene domains characterised by a net corrosion texture comprising gungy green brown biotite + dusty titanite + calcite + fibrous pale green amphibole + trace epidote. Rare subhedral to prismatic quartz (<1%) set in coarse calcite domains. Coarse vesuvianite tablets (some >5mm) heavily replaced by net-textured calcite + coarse deep gn amphibole, minor coarse (+1mm) anhedral ?pyrite (3%) with corroded margins against deep green amphibole which in turn have narrow pale haloes against the ?pyrite grains. Rare fluorite (1%) infilled vugs in amphibole domain. Minor gungy brown green spherulitic biotite (3%) alteration of all calcsilicate phases esp. pyroxene & as infill of final porosity. Rare colloform & undulose polycrystalline quartz infilling vugs between amphibole tablets & one pocket lining earlier spherulitic biotite infill. Trace fine idiomorphic ?monazite with brown metamict halo in coarse green amphibole.	
D	CAF5_108.6m	CAF5	108.6	granular-tabular pyroxene & vesuvianite skarn moderately (15%) replaced with calcite & amphibole+titanite skarn, minor (3%) late biotite alteration & infill.	Fine to coarse (0.2-2mm) granular pyroxene skarn passing into coarse (to 10mm) vesuvianite tablet skarn at one end of TS. Minor fine calcite + green amphibole + titanite & biotite alteration of granular pyroxene. Vesuvianite tablets zoned with fine pyroxene + green amphibole + titanite + calcite + very fine green brown biotite in cores & fractures. Coarse pyroxene, green amphibole + sheaf titanite & calcite in interstices between vesuvianite tablets. Margin of vesuvianite zone against granular pyroxene zone heavily replaced by amphibole + titanite + calcite + granular pyroxene, some irregular veins of granular pyroxene cut into vesuvianite, vesuvianite tablets within pyroxene zone completely pseudomorphed by amphibole + sheaf titanite, calcite & pyroxene, trace epidote. Minor (3%) cryptocrystalline green brown biotite alteration and spherulitic-colloform vug full throughout.	
D	CAF5_114.7m	CAF5	114.7	Pyroxene+vesuvianite skarn moderately replaced by calcite & amphibole+titanite stages, very minor biotite alteration & infill, very minor interstitial coarse calcite & quartz infill	Coarse (2mm) tabular pyroxene & vesuvianite skarn with moderate (10%) coarse gn amphibole & sheaf titanite & calcite replacement. Pyroxene interstitial to vesuvianite tablets. Minor coarse interstitial calcite & rare coarse monocrystalline interstitial quartz. Vesuvianite more heavily replaced than the pyroxene by amphibole+titanite+calcite. Very minor (1%) gungy cryptocrystalline green brown biotite alteration throughout.	

**Appendix: Petrographic Summaries**

H1000	Sample	Hole	Depth_m	Summary	Description	Comments
D	CAF7_107.2m	CAF7	107.2	Vesuvianite+pyroxene skarn with magnetite, minor amphibole+titanite, calcite, and biotite stages	Fine to coarse (to 5mm) zoned vesuvianite tablets (50%) commonly in radiating fans & fine (0.1-0.4mm) granular pyroxene (25%) skarn, minor coarse calcite (5%), blue-green amphibole (5%), sheaf titanite (1%), bn biotite (2%) & granular sub-euhedral magnetite (5%) in interstices between vesuvianite tablets. Vesuvianite cores 20% altered to fine blue gn amphibole, calcite, magnetite, & pyroxene, rims clean. Narrow interstices between magnetite eu-subhedra typically filled with bn biotite & blue gn amphibole. Magnetite within fine granular pyroxene zones is anhedral-embayed = infilling around fine grained pyroxene?	
D	CAF7_117.3m	CAF7	117.3	Vesuvianite+garnet+pyroxene skarn heavily replaced by amphibole+titanite & calcite & biotite stages with a final corrosive fluorite stage.	Coarse (>1mm) vesuvianite (10%) + garnet (15%) + pyroxene (2%) skarn moderately replaced by coarse calcite (20%), fluorite (20%), distinctive blue green to brown amphibole (10%) & bn biotite (3%), granular magnetite (15%), sheaves & rhombs of titanite (2%) & epidote (1%). Rare idiomorphic ?monazite. Fans of zoned tabular vesuvianite 70% replaced by calcite+amphibole+biotite+euhedral magnetite & trace epidote, marginal zones cleaner than cores. Granular zoned garnets appear fragmented by extensive calcite replacement, minor amphibole, magnetite, epidote & titanite replacement. Calcite scallops & corrodes garnet & vesuvianite (locally corroding marginal zones of vesuvianite), imposing rhombic forms on some corroded garnets, coarse euhedral fluorite corrodes all other phases & forms final infill. Magnetite euhedra in fluorite domains commonly partly rimmed with calcite, amphibole, vesuvianite and/or biotite in a texture that suggests corrosion of silicates hosting the magnetite euhedra to create vugs infilled by fluorite. Trace epidote replacement of vesuvianite, garnet & amphibole.	
D	CAF7_131.4m	CAF7	131.4	garnet+pyroxene skarn infilled & slightly replaced by calcite, slightly replaced by amphibole+titanite & biotite stages.	Coarse granular garnet (50%) + pyroxene (5%) skarn, 30% coarse interstitial calcite. 10% blue green amphibole, 3% bn biotite, 1% sheaf titanite, calcite & trace quartz replacement of garnet (especially core zones) & pyroxene. Replacement finer grained than same phases as infill around garnets. Minor pyroxene inclusions in garnet. Trace fine vesuvianite tablets & minor "embryonic" fans of fine vesuvianite tablets-needles in cores of larger garnets, vesuvianite needles in turn partly replaced by calcite, amphibole & biotite. Biotite partly replaces amphibole.	
D	SORM004	na	0	fine biotite greisen	Fine (up to 2mm, mainly <1mm) brown to slightly green biotite (99%) greisen, <0.5% fine (50-100microns) apatite, <<1% fine anhedral quartz. Origin of fine (<0.1mm) & coarse (0.5-2mm) domains unclear, some appear to be irregular veins.	sample location 371790mE 5395370mN MGA Zone 55 GDA94
D	SORM007B	na	0	biotite+fluorite endogreisen	coarse (1-5mm) bn biotite (40%) + fluorite (20%) greisen replacing granite or monzonite, remnant coarse heavily sericitised (80%) albitic plagioclase (20%, with relict albite twinning) & monocrystalline quartz (5%). Kspar largely to entirely replaced by coarse biotite & fluorite (latter producing sieve texture im biotite pseudomorphs). Trace prehnite alteration of plagioclase, widespread lenses of prehnite alteration along biotite cleavages (3%). Complex fluorite embayments into plagioclase. Rare (<1%) heavily embayed opaques to 2mm size. One 10mm patch of coarse tabular gn-gn bn amphibole & quartz at edge of TS, amphibole partly replaced by coarse biotite & corroded by fluorite.	sample location 371790mE 5395436mN MGA Zone 55 GDA94
EOF						