DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept.Bk.No. 80/86

BASE METAL DEPOSITS - PINDA SPRINGS & WAUKAWOODNA CREEK AREAS, NORTHERN FLINDERS RANGES

GEOLOGICAL SURVEY

by

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MINERAL RESOURCES SECTION

AUGUST, 1980

D.M. No. 232/79

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ABSTRACT

Copper, lead and barite deposits occur at Pinda Springs, Waukawoodna Creek, Jubilee and Wirrapowie Mines in the central Flinders Ranges. Mineralisation is associated with quartz, ironstone, calcite and siderite veins sometimes emplaced along fault planes. Host rocks are of the Wonoka, Bunyeroo, ABC Range Quartzite, Brachina, Nuccaleena and Elatina Formations. All the deposits are small although some grades are high.

INTRODUCTION

During 1977, 1978 and 1979, several mineral claims were pegged over base metal deposits in the Northern Flinders Ranges, northeast of Blinman, in Class A and B Environmental Areas. Information on the location and nature of these and other deposits in the area was inadequate.

In order to document all the deposits, the area was inspected by the writer and I.G. Faulks (Senior Geologist, Metallic Minerals) in April, 1979 and the deposits were mapped using tape and compass by the writer and B.W. Atterton and S. Kent (Field Assistants) in May-June, 1979. The Jubilee and Wirrapowie Mines, have been included as they are close to the graded road to the Pinda Springs Mine. Petrography and mineragraphy by Dr. K.J. Henley (AMDEL) of 11 samples are contained in Appendix I.

LOCATION AND ACCESS

The location of the deposits is shown on Fig. 1, Fig. 2 and Fig. 3.

There are three groups of deposits, referred to in this report as:

- Waukawoodna Creek (northern area)

- Pinda Springs (central area)
- Wirrapowie and Jubilee Mines (southern area)

Note that the geographic features - Pinda Spring and Pinda Creek are located in the northern area.

The first two groups are located north out of hundreds on Block 1159, Pinda Springs Pastoral Lease 2276 held by Mulga View Pastoral Company Pty. Ltd. Pinda Springs Homestead is uninhabited and the lessee, B.E. Reschke, lives on the adjoining Block 1150, Mulga View Pastoral Lease 2352. The Jubilee and Wirrapowie Mines are located on Block 833, Narrina Pastoral Lease.

The Waukawoodna Creek deposits are 39 km north-northeast of Blinman in a Class A Environmental Area as defined in the Flinders Ranges Planning Area Development Plan (Fig. 1). Easiest access is via Copley and Angepena Homestead and then about 30 km south to Christmas Hut. Access can also be obtained by rugged tracks from the west via Beltana and Warraweena Station or from the east via Pinda Springs Mine, Nantawarrina Homestead (Irish Well) and Waukawoodna Gap (four wheel drive required in both cases). All tracks in the area of the deposits south of Christmas Hut require four wheel drive.

The area is fairly rugged with undulating scrub covered areas and rough creeks surrounded by steep hills.

The Pinda Springs deposits are 36 km northeast of Blinman in a Class B Environmental Area. Access is from the Wirrealpa to Wertaloona Road, turning westward 23 km northeast of Wirrealpa Homestead at Little Bobmonie Well. The Pinda Springs Mine is about 20 km along a graded track which passes the Jubilee and Wirrapowie Mines (9 km). The Mount Roebuck deposits can be reached by continuing northwards along the graded road through Bullock Head Gap for about 8 km and then south along a rough track (four wheel drive required).

Topography of the area varies from undulating at the Pinda Springs Mine to more rugged hills around Mount Roebuck.

REGIONAL GEOLOGY

The deposits are located on Cadnia 1:63 360 geological sheet (Grasso et al., 1956) and Arrowie 1:63 360 geological sheet (Horwitz, 1961). Later geological mapping is shown on COPLEY 1:250 000 geological sheet (Coats, 1973) from which the accompanying regional geological plan (Fig. 2a) and geological legend (Fig. 2b) are adapted.

Sedimentary rocks of Adelaidean age are the host for the mineralisation. The deposits occur in Wonoka, Bunyeroo, ABC Range Quartzite, Brachina and Nuccaleena Formations of the Wilpena Group and Elatina Formation of the Umberatana Group. The rocks are folded and cut by predominantly northeasterly trending faults. Several of the deposits are located near these faults or on the margins of diapiric carbonate breccias.

References

Coats, R.P., 1973. COPLEY map sheet, Geological Atlas of South Australia, 1:250 000 series. Geol. Surv. S. Aust.

Grasso, R. and Brock, E., 1956. Cadnia map sheet, Geological Atlas of South Australia, 1:63 360 series. Geol. Surv. S. Aust.

Horwitz, R., 1961. Arrowie map sheet, Geological Atlas of South Australia, 1:63 360 series. Geol. Surv. S. Aust.

PINDA SPRINGS MINE (M1) Pb

1:250 000 COPLEY sheet SH/54-9

1: 50 000 Narrina sheet 6636-II

Location

Adjacent to the graded road from the Wirrealpa-Wertaloona road to Pinda Springs Homestead.

Tenure & Production

1967 - first worked by A.E. Winckel as MC 5076 which was converted to ML 3464.

1968-69 - 132.2 tonnes of ore treated by B.H.A.S. contained
44.2 tonnes of lead
10.6 kgs of silver

1977 - site pegged as M.C. 802 registered for S.J. Starr, abandoned on 1/8/77. M.C. 813 registered for F.A. Nixon, abandoned on 28/8/77.

1977 - M.C. 844 registered for D. Amuso on 18/8/77 and converted to ML 4636 of 13.37 ha due to expire on 11/9/85.
M.C. 860 registered for D. Amuso on 15/9/77 and converted to M.L. 4636 of 6.68 ha due to expire on 11/9/85.
The location of the claim pegs found in the mapping of the deposit is shown on Fig. 4. The pegging is confusing and does not agree with the tenement map.

1978 - 29.9 tonnes treated by B.H.A.S. for Pinda Springs Consolidated contained 10.19 tonnes lead
2.98 kg of silver
1 g of gold

Total Production	Ore treated	162.1 tonnes
contained	Lead	55.1 tonnes
	Silver	13.58 kg
	Gold	1 g

Workings

The main working is a bulldozer cut (Stn. 2 to 3) 50 m long, 3-10 m wide, 4 m deep (Plates 1 & 2). A shaft 6 m deep is located immediately to the east. Five other bulldozer cuts and shallow trenches are located over 200 m to the north. In June 1979, the eastern wall of the main cut had partially collapsed and was unsafe (Plate 2).

Geological Setting

The deposit occurs in brown to grey siltstone, shale and minor fine grained sandstone of the Brachina Formation 50 m east of the boundary with the Bunyeroo Formation. The lode is located in grey to bleached white weathered siltstone and calcareous shale on the crest of a minor anticline in generally westerly dipping rocks. Faulting may have occurred along the axial plane of this fold.

Mineralisation

Mineralisation is restricted mainly to a vein at the base of the eastern wall of the main cut and at the bottom of the shaft. Galena occurs in a gangue of ferruginous quartz with some calcite and siderite. The width of the main vein varies from 5 cm to 30 cm with an average of about 10 cm. Irregular smaller veinlets, less than 2 cm wide, are also present. The lode is exposed for about 30 m along strike and dips about 35^{o} to 090^{o}. Continuity at depth is unknown.

No other mineralisation was observed north of the main cut except for a thin coating of galena on a joint surface in the cut at Stn. 6.

Grade

The results of analysis by A.A.S. of the following 5 samples are detailed in Table 1.

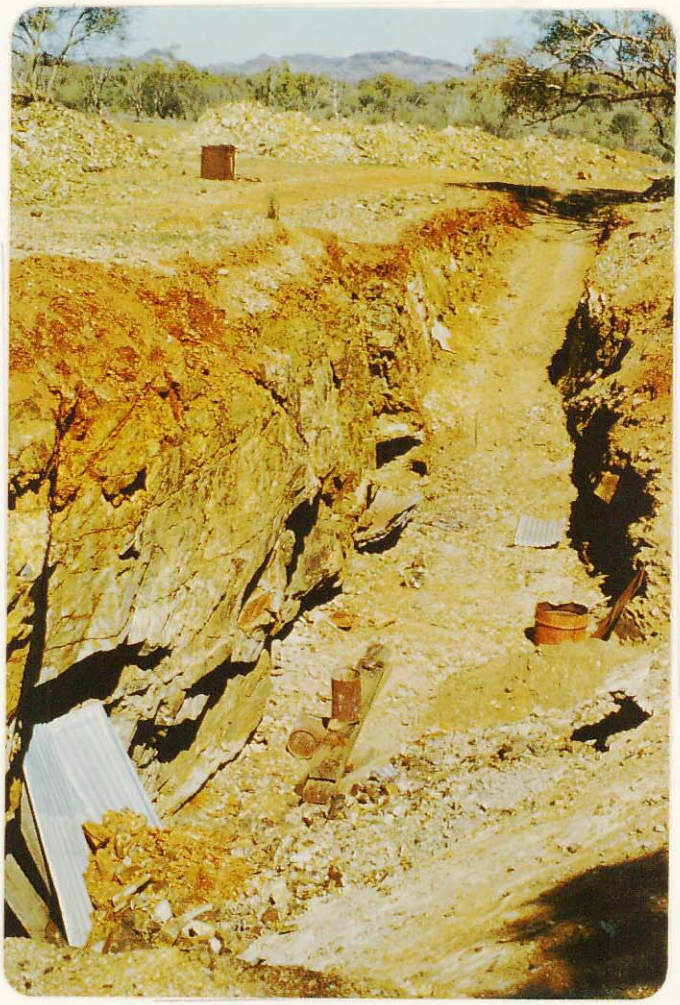


Plate 1. Pinda Springs Mine (M1) - Sept. 1978. View south, main cut. Galena vein at base of left wall.

Plate 2. Pinda Springs Mine (M1) - April, 1979. View north, main cut and shaft with tripod.

Sample No.	Description
A3200/78	Chip sample across lode 30 cm wide in bottom of shaft 2 m east of main cut.
A3201/78	Chip sample across 1.5 m zone including lode at bottom of shaft.
A3202/78	Host rock - light grey weathered siltstone from main cut.
A3203/78	Selected lode material - galena in ferruginous quartz from open cut.
A1440/79	Ferruginous outcrop, 50 m north of camp area in area of reported willemite occurrence.

TABLE 1

Analyses - Pinda Springs Mine

Results in p.p.m. or %

Sample No.	Cu	Pb	Zn	Co	Ni	Fe	Mn	Ag	Mo	Au
A3200/78	520	22.0%	1600	500	300	6.2%	2500	42	5	<0.05
A3201/78	220	6.0%	1250	500	170	7.1%	3900	11	50	<0.05
A3202/78	30	3500	380	45	50	6.7%	650	1	<3	<0.05
A3203/78	80	18.0%	750	300	150	3.0%	1200	65	3	<0.05
A1440/79	8	130	110	8	20	4.8%	6000	<1	2	<0.05

Previous Company Exploration

Noranda Aust. Pty. Ltd. carried out a regional stream sediment sampling survey and a close spaced orientation survey at Pinda Springs Mine. Maximum values of Pb 540 p.p.m. and Zn 190 p.p.m. were obtained in the orientation survey. A gossanous outcrop was reported several hundred metres northwest of the mine containing boxworks after galena and a seam of willemite. Samples of outcrop were said to assay from 17% to 29% Zn. Close spaced stream sampling near this locality gave maximum values of Zn 340 p.p.m. and Pb 160 p.p.m. Sample A1440/79 (see Table 1) taken in this area contained only marginally anomalous Pb and Zn.

Regional stream sampling by Noranda, Aust. Anglo American Pty. Ltd. (Env. 2379) and Kennecott Explorations Pty. Ltd. (Env. 671) showed Pb and Zn anomalies southeast of Pinda Springs Mine.

Conclusions

The narrowness of the easterly dipping galena vein over its limited exposure makes the potential of this prospect low. To properly evaluate the deposit, information would be needed about the nature of the lode at depth. This could be obtained by:-

(a) diamond drilling - say two holes to 30 m located 30 m east of the open cut and angled 55° to the west.

(b) mining - either by a shaft following the lode on the underlay or by a vertical shaft placed east of the open cut to intersect the lode at depth.

References

Australian Anglo American Ltd. 1974. E.L. 107. S. Aust. Dept. Mines and Energy open file Env. 2379 (unpublished).

Kennecott Explorations (Aust.) Pty. Ltd. 1967. S.M.L. 123. S. Aust. Dept. Mines and Energy open file Env. 671 (unpublished).

Noranda Aust. Ltd. 1970 S.M.L. 321. S. Aust. Dept. Mines and Energy open file Env. 1194 (unpublished).

North Flinders Mines Ltd. 1971 S.M.L. 557. S. Aust. Dept. Mines and Energy open file Env. 1638 (unpublished).

MOUNT ROEBUCK LEAD WORKINGS (M2) & MOUNT ROEBUCK BARITE OCCURRENCE (M3)

1:250 000 COPLEY sheet SH/54-9

1: 50 000 Narrina sheet 6636-11

Location

2 km southwest of Mount Roebuck and 3 km east of Pinda Springs Homestead. Access is southwards via rough track between Bullock Head Gap and Roebuck Well. The occurrences are east of the track, the galena workings on a hillside and the barite occurrence east of the creek adjacent to the track.

Tenure & Production

None recorded.

Workings

Workings at the lead occurrence consist of two open cuts at Stns. 4 and 21, an adit at Stn. 6 and a small pit at Stn. 8 (see Fig. 4). There are no workings on the barite veins.

Geological Setting

Country rock comprises pinkish brown feldspathic sandstone and silty sandstone, calcareous or dolomitic in part, with some granule layers (R.S. 6636-1 in Appendix) thought to be the top of the Elatina Formation. An overlying pinkish-brown dolomite band, forming the prominent small cliff southwest of the occurrences, is the base of the Nuccaleena Formation. This dolomite is overlain by a purple shale further to the southwest. Dip is 25^{o}-35^{o} to the southwest.

Mineralisation

In the cut at Stn. 4, veins 1-4 cm wide, of galena with quartz and ironstone gangue are oriented parallel to a prominent cleavage direction which dips 43^{o} to 075^{o}. Ironstone veins have a similar orientation in the pit at Stn. 8. One fragment of galena was observed in the mullock dump. No mineralisation was observed in the adit at Stn. 6.

Plate 3. Mount Roebuck Lead Workings (M2) - May, 1979. Galena in ironstone & quartz veins. Pit at Stn. 4.

Plate 4. Mount Roebuck Barite Occurrence (M3) - May, 1979. View east. Barite veins in foreground. Cut at Stn. 21 top left.

A vein 3-8 cm wide, of quartz and earthy limonite with sparse galena in the cut at Stn. 21 dips 80° to 155°. Dark cerussite coats a slickensided joint surface (Sample R.S. 6636-2 in the Appendix).

Seven barite veins (M3) outcrop along the vermin proof fence on the eastern creek bank in a zone 120 m wide extending from Stn. 17 to Stn. 20 (Fig. 4). Length of the veins varies from 4 m to 20 m and width from 2 cm to 30 cm. The near vertical veins strike southwesterly cross cutting bedding of the Elatina Formation sandstone.

A 5 m wide zone of barite veinlets, individually only 1 cm - 5 cm wide, parallel the galena vein in the cut at Stn. 21. One of these veins is enclosed by siderite.

Other barite veins may be obscured by scree in the intervening 40 m between the cut at Stn. 21 and the vermin proof fence.

Grade

The results of analysis of the following 4 samples are detailed in Table 2.

Sample No.	Description
A2039/79	Galena vein in cut at Stn. 4.
A2040/79	Earthy limonite vein containing galena at Stn. 21.
A3024/79	Chip sample along barite vein Stn. 15 to Stn. 17.
A3025/79	Chip sample along barite vein at Stn. 18.

Table 2

Analyses, Mount Roebuck Lead and Barite
Results in p.p.m. or %

Sample No.	Cu	Pb	Zn	Co	Ni	Fe	Mn	Ag	Mo	Au	
A2039/79	100	73.4%	32	<5	<5	1200	75	250	<1	<0.05	By
A2040/79	5	5400	10	<5	<5	4200	10	2	2	<0.05	A.A.S.

	$BaSO_4$	$SrSO_4$	Al_2O_3	SiO_2	CaO	K_2O	Fe_2O_3	L.O.I.	Soluble Alkaline Earths as Ca.p.p.m.	Brightness R457	Yellowness R57-457	S.G.
A3024/79	96.1	2.59	0.04	0.49	0.09	0.02	0.15	0.37	24	58.4	13.0	4.37
A3025/79	94.5	2.57	0.02	1.1	0.28	0.02	0.14	1.22	25	67.0	10.0	4.37

Previous Company Exploration

Stream sediment sampling by Aust. Anglo American found anomalous Pb with a maximum of 110 p.p.m., Cu maximum 100 p.p.m. and Ba maximum 450 p.p.m. near M2 and M3. High Ba values up to 1 150 p.p.m. were recorded in the area around M2 and M3 south-west of Mount Roebuck.

Conclusions

Narrow veins of galena in quartz and ironstone occur along joint planes in sandstone of the Elatina Formation. Samples from the nearby narrow barite veins meet chemical specifications for industrial use but have low reflectance. Both the galena and barite occurrences are too small to be of any value.

References

Australian Anglo American Ltd. 1974. E.L. 107. S. Aust. Dept. Mines and Energy open file Env. 2379 (unpublished).

SOUTH MOUNT ROEBUCK COPPER WORKINGS (M4)

COPLEY 1:250 000 sheet SH/54-9

Narrina 1:50 000 sheet 6636-11

Location

On a low north-south trending ridge 300 m south of the track between Bullock Head Gap and Roebuck Well, 1.2 km south of M2 and M3. Vehicle access is by leaving the track just south of a creek crossing and heading southwest along a low ridge.

Tenure and Production

None recorded.

Workings

A shaft, 7.5 m deep and underlain a few degrees to the east, and 3 shallow pits are scattered over a north-south distance of 170 m (Fig. 5).

Geological Setting

Massive pink dolomite of the Nuccaleena Formation which forms the ridge on which the shaft is located, is overlain to the west by purple and grey dolomitic shale and siltstone. Bedding orientations in the dolomite are variable probably due to folding. The ridge ends abruptly 20 m north of the shaft due either to faulting or lensing out of the dolomite band.

Mineralisation

Quartz, ironstone and siderite veining occurs in the dolomite near the shaft. Only rare malachite fragments were observed in the dump material from this shaft but gossanous ironstone (A2042/79) outcropping next to the shaft contained 1.7% Cu, although no copper minerals were visible. Spoil from the three pits to the south contains malachite in quartz, ironstone and siderite vein material. The sample taken near the southern-most pit also contained 0.38% Pb.

Plate 5. South Mount Roebuck Copper Workings (M4) - May, 1979. View south. Shaft in centre on dolomite ridge.

Plate 6. Copper Occurrence (M7) - North of Pinda Springs Mine - May, 1979. Malachite in dolomite band in Bunyeroo Formation.

Grade

The results of analysis by A.A.S. of the following 2 samples are detailed in Table 3.

Sample No.	Description
A2041/79	Representative sample of mullock on platform near southern pit.
A2042/79	Gossanous ironstone vein in dolomite outcrop adjacent to shaft.

TABLE 3

Analyses - South Mount Roebuck Copper Workings

Results in p.p.m. or %

Sample No.	Cu	Pb	Zn	Co	Ni	Fe	Mn	Ag	Mo	Au
A2041/79	2.6%	3800	210	10	15	5.7%	1000	15	1	<0.05
A2042/79	1.7%	470	180	10	45	38.0%	1.3%	<1	6	<0.05

Conclusions

Copper mineralisation is contained in quartz, ironstone and carbonate veins emplaced in a folded and faulted dolomite band at the base of the Nuccaleena Formation.

COPPER OCCURRENCE (North of Pinda Springs Mine) (M7)

1:250 000 COPLEY sheet SH/54-9

1: 50 000 Narrina sheet 6636-11

Location

About 1 km south of the Pinda Springs Homestead, 300 m west of the road from Pinda Springs Mine (M1) to Bullock Head Gap.

Geology and Mineralisation

Malachite is scattered along strike in a band of cream dolomite, 0.2 m wide, within purple and grey shale of the Bunyeroo Formation (Plate 6). This and similar bands not located in this investigation are probably the copper occurrences marked in this area on COPLEY (Coats, 1973). Such minor copper mineralisation is common within the Bunyeroo Formation (Eberhard, 1977).

A single rock sample, A2052/79, of the dolomite band was analysed by A.A.S. and gave the following results (in p.p.m. or %).

Sample No.	Cu	Pb	Zn	Co	Ni	Fe	Mn	Ag	Mo	Au
A2052/79	4000	20	30	5	15	1.5%	4900	2	2	<0.05

Reference

Coats, R.P., 1973. COPLEY map sheet. Geological Atlas of South Australia, 1:250 000 series. Geol. Surv. S. Aust.

Eberhard, B.A., 1977. A geochemical appraisal of the Bunyeroo Formation, COPLEY 1:250 000 sheet. Mineral Resour. Rev., S. Aust., 146:29-39.

JUBILEE MINES (M5) Cu, Pb

1:250 000 COPLEY sheet SH/54-9

1: 50 000 Wertaloona sheet 6736-111

Location

Between Jubilee Hill to the north and the graded road to Pinda Springs Mine to the south. Several ruined stone buildings mark the locality on the road about 2.5 km east of Jubilee Bore. The first of the workings is situated on the northern side of a low ridge, 400 m northeast of the road. Other workings are scattered for 400 m to the northeast. There is no track to the workings from the road.

History

The Jubilee Silver Mining Co. was registered in 1887. Its property was Mineral Claims 10686 and 10687 described as being situated "about 12 miles northeast of Wirrialpa Silver Mines, South Australia". Whether this is the property referred to is uncertain (Brown, 1890).

Workings

The main working (Site 1. on Fig. 5) is a timbered shaft 17.5 m deep (to water) and 3 m x 1.5 m wide surrounded by a mullock heap. 150 m northeast of this is a pit (Site 2. on map) (3 m x 8 m x 1 m deep). An inclined shaft (2 m x 1.5 m wide, 10.4 m deep) and some shallow pits (Site 3. on map) are located a further 120 m to the northeast. A further 90 m northeast are 2 shallow pits (1 m and 0.5 m deep) (Site 4. on Fig. 5). No attempt was made to enter the shafts.

Geological Setting

The workings are located in calcareous siltstone and fine sandstone at the top of the Brachina Formation. The rocks generally dip 25-30^{o} to the south. The mineralisation seems to occur along a northeasterly trending fault. A number of faults with a similar trend are shown in the vicinity of the mine

on the COPLEY 1:250 000 geological sheet. The Wirrapowie mines, about 2.5 km to the south, also occur on one of these faults.

Mineralisation

Mullock from the main shaft contains sulphides in coarse siderite and quartz vein rock. A sample submitted for thin and polished section description (RS 6736-35 in Appendix 1) was estimated to contain chalcopyrite and pyrite in the ratio 60:40. The chalcopyrite may postdate the pyrite. Coarse banding in siderite material was described in the thin section and observed in ferruginous quartz rock in samples from the dump.

40 m southeast of the main shaft a 1 m wide, layered, quartz-ironstone vein outcrops (Plate 8). This is probably the surface expression of the vein exploited in the shaft. The vein continues along a low ridge to the southwest.

The shallow pit (2.) N.E. of the shaft has rare malachite staining associated with a quartz and ironstone vein in calcareous siltstone and fine sandstone.

At Site 3., the inclined shaft and pit have been sunk on a quartz and ironstone vein in calcareous siltstone. Galena is present as patches and stringers in the 10-30 cm wide lode.

The shallow pits at Site 4. were sunk on a quartz and ironstone vein which contains rare malachite.

Grade

The results of analysis by A.A.S. of the following 5 samples are detailed in Table 4.

Sample No.	Description
A1442/79	Mineralised rock from mullock heap - main shaft (1.).
A2043/79	Quartz-ironstone vein outcrop, 75 m south of shaft (1.).
A2044/79	Quartz-ironstone vein outcrop adjacent (30 m east) to shaft (1.).
A2045/79	Quartz-ironstone vein outcrop 3 m from inclined shaft (3.). Vein 50 cm wide.
A 3/80	Galena in quartz ironstone vein, 10-30 cm wide, between inclined shaft (3.) and shallow pit to the south.

Plate 7. Jubilee Mines (M5) - May, 1979. View east. Main shaft (Site 1).

Plate 8. Jubilee Mines (M5) - May, 1979. View northeast. Quartz-ironstone vein adjacent to main shaft. Other workings on hill in background.

TABLE 4

Analyses - Jubilee Mines

Results in p.p.m. or %

Sample No.	Cu	Pb	Zn	Co	Ni	Fe	Mn	Ag	Mo	Au
A1442/79	3900	15	150	18	55	38.0%	1.1%	<1	<1	<0.05
A2043/79	400	160	140	15	45	29.7%	9000	<1	1	<0.05
A2044/79	3300	110	140	10	50	40.0%	1.2%	<1	1	<0.05
A2045/79	220	4100	550	15	45	43.5%	9200	<1	2	<0.05
A 3/80	600	39.3%	930	40	45	Not Analysed	5600	140	2	<0.05

Previous Company Exploration

Broadly spaced stream sediment sampling by Noranda Aust. Ltd. and Kennecott Explorations Ltd. did not show any anomalous values near Jubilee Mine.

Conclusions

Cu and Pb mineralisation is contained in northeasterly trending quartz, ironstone and siderite veins which may be fault controlled. The galena lode may be of some interest for a small mining operation but further work would be required to establish reserves.

References

Brown, H.Y.L., 1890. Record of the Mines of South Australia. Government Printer, Adelaide: 59.

Kennecott Explorations (Aust.) Pty. Ltd. 1967. S.M.L. 123 S. Aust. Dept. Mines and Energy open file Env. 671 (unpublished).

Noranda Aust. Ltd. 1970. S.M.L. 321 S. Aust. Dept. Mines and Energy open file Env. 1194 (unpublished).

WIRRAPOWIE MINES (M6) Cu

1:250 000 COPLEY sheet SH/54-9

1: 50 000 Wertaloona sheet 6736-111

Location

The northeasterly trending line of workings occurs in hilly country south of Jubilee Hill. Access is by a track leaving the graded road just south of the Jubilee Mines and south along a vermin proof fence for 2 km. A poorly defined track, 400 m long, branches off to the main workings.

History and Production

The mine was first worked by H. Paull. In a letter dated 1899 he described the mineralisation as "a true fissure lode traceable for at least one mile". A depth of 23 fathoms (42.1 m) was attained in the main shaft before the low price copper brought a halt to the mining (Brown, 1908). In Mining Review 4 (p. 17), the Wirrapowie Mine is listed as having produced 39 tons of ore which yielded 3 tons 10 cwt and 22 lbs (3566 kg) of Cu metal. Other returns report a few tons of ore produced from nearby small workings but no other record could be found of production from the main mine.

Mansfield (1947) reported that Mineral Claims 1129 and 1130 were held over the area by Mrs. E.M. Coad. A new shaft, sunk 21.4 m north of the main shaft, broke through into an old stope at 10.1 m depth. It is not clear whether any further work or production was carried out at this time.

Mansfield estimated from the size of the stope that 1 750 tons of rock (probably both ore and waste) had been removed. This and the presence of a sizeable mullock heap and the timber remains of what was probably a treatment plant suggest a significant production from the mine.

Plate 9. Wirrapowie Mines (M6-1). May 1979. View southeast. Main workings.

Plate 10. Wirrapowie Mines (M6-1) - May, 1979. Malachite, quartz, limonite vein. Pit at Stn. 2.

Plate 11. Wirrapowie Mines (M6-4). Malachite in quartz vein and weathered shale.

Plate 12. Wirrapowie Mines (M6-4). Malachite in ferruginous quartz vein. Outcrop 1 m south of Plate 11.

Workings

The main workings (M6-1 on Fig. 5) in the centre of the line of lode consist of 2 timbered shafts and 2 shallow pits. The southern shaft is presumably the original main shaft although it is now only clear to a depth of 9 m. According to Mansfield (1947) driving took place on the 100 feet (30.5 m) level northward from this shaft and stoping was carried out above this level. A number of small pits extend for 300 m northeast of this shaft as shown on Fig. 4.

More widely spaced workings are located southwest of the main workings, on the same line of lode, as shown on Fig. 3. Shallow pits occur at localities M6-2, 3 and 5. At locality M6-4, there is an inclined open stope 6.5 m deep (Plate 11).

Mansfield mentions several shallow pits containing copper mineralisation east of the main lode.

Geological Setting

The mineralisation is located along a northeast-southwest trending fault cutting rocks of the Wonoka Formation. Dolomite and dolomitic siltstone are located to the east of the fault near the main workings and to the west are calcareous shale and siltstone with limestone interbeds. Further northeast, calcareous shale and siltstone lie on both sides of the lode. At locality M6-4, calcareous shale and siltstone lie to the west of the fault and to the east is a purple siltstone which may belong to the lower part of the Pound Quartzite.

Mineralisation

Copper mineralisation occurs in a vein of quartz, ironstone and minor siderite which is located along the fault. The vein varies in width from 0.15 to 2 m. Copper minerals present are mainly malachite and azurite with some chalcopyrite, chalcocite and minor covellite. Malachite is also disseminated through

the country rocks adjacent to the vein. In the pits near the main shaft, the rocks adjacent to the lode are highly weathered and drag folded. Slickensided joint surfaces were observed at several localities along the lode.

Petrographic descriptions of the following 2 samples are contained in the Appendix.

	Sample No.	Description
Polished section description	R.S. 6736-34	Mineralised ferruginous quartz vein from mullock heap Stn. 7.
Thin section description	R.S. 6736-33	Host rock in mineralised zone - location M6-3.

Grade

The results of analysis by A.A.S. of the following 6 samples are detailed in Table 5.

Sample No.	Description
A2046/79	Mineralised ferruginous quartz vein from mullock heap Stn. 7.
A2047/79	Mineralised rock from mullock heap Stn. 8.
A2048/79	Chip sample across 15 cm wide vein of mineralised (malachite) quartz and limonite Stn. 2.
A2049/79	Chip sample across 1.5 m wide mineralised (malachite) zone in pit (location M6-3).
A2050/79	Chip sample across 0.5 m wide mineralised (malachite) ferruginous quartz vein (location M6-4).
A2051/79	Chip sample across 1 m wide mineralised (malachite) ferruginous quartz vein (location M6-5).

TABLE 5

Analyses - Wirrapowie Mines

Results in p.p.m. or %

Sample No.	Cu	Pb	Zn	Co	Ni	Fe	Mn	Ag	Mo	Au
A2046/79	2.8%	120	60	5	5	3.7%	260	<1	5	<0.05
A2047/79	11.0%	100	350	<5	<5	1.8%	490	<1	4	<0.05
A2048/79	2.6%	120	35	10	10	10.8%	670	<1	3	<0.05
A2049/79	4100	35	8	5	15	1.6%	55	<1	<1	<0.05
A2050/79	4.9%	25	5	5	10	3.5%	60	<1	3	<0.05
A2051/79	1.5%	15	5	5	5	2.7%	550	<1	1	<0.05

Previous Company Exploration

Stream sediment sampling by Noranda Aust. Ltd. and Kennecott Explorations Ltd. found a few anomalous Cu values (mostly low order) near the workings at Wirrapowie.

Conclusions

Copper mineralisation, contained in a 0.15-2 m wide quartz/ironstone vein and in surrounding host rocks, extends for at least 1 km in a northeasterly trending fault zone. More detailed investigation is required to establish the width and grade of the mineralisation.

References

Brown, H.Y.L., 1908. Record of the Mines of South Australia. Government Printer, Adelaide: 152-153.

Kennecott Explorations (Aust.) Pty. Ltd. 1967. S.M.L. 123. S. Aust. Dept. Mines and Energy open file Env. 671 (unpublished).

Mansfield, L.L., 1947. Wirrapowie Copper Mine. Min. Rev., Adelaide, 87: 208-209.

Mining Review, 1905. Ore returns for Wirrapowie Mine. Min. Rev., Adelaide, 4:17.

Noranda Aust. Ltd. 1970. S.M.L. 321. S. Aust. Dept. Mines and Energy open file Env. 1194 (unpublished).

MOUNT EURO MINE (M8)

1:250 000 COPLEY sheet SH/54-9

1: 50 000 Narrina sheet 6636-11

Location

On an east-west trending ridge south of Pinda Creek, east of the junction with Waukawoodna Creek. A rough track from Christmas Hut (8 km) and Pinda Well to Waukawoodna Creek passes south of the workings. Access to the workings can be obtained from this track or from Pinda Creek in the north.

Tenure and Production

The Mount Euro Mine is described by Brown (1908) as being "situated amongst high and rugged hills, 28 miles N.E. from the Blinman". The lessee of Angepena Station, S. Nicholls, identified this working as being the "Euro Mine". A.C. Lively and Mrs. L.C. Lawrence held several mineral claims over the area in the early 1970's. Most of the workings are bulldozer cuts probably carried out as part of an investigation by Westgate Drilling Co. Pty. Ltd. in 1971 (Env. 1653).

There is no record of production.

Workings

The workings are mainly shallow pits and bulldozer cuts trending roughly north-south (M8-1 on Fig. 3). A shaft, 4 m in depth, with the remains of timbering is present at one end of the cut at Stn. 16. Along the ridge 200 m to the east of these workings, shallow bulldozer cuts have exposed more copper mineralisation (M8-2 on Fig. 3).

Geological Setting

Country rocks are faulted and drag folded ferruginous sandstone and banded siltstone, in places calcareous or dolomitic. To the south and east is an area of carbonate breccia of possible diapiric origin. ABC Range Quartzite forms a prominent north-south

Plate 13. Mount Euro Mine (M8). June, 1979. View north, workings and access track.

Plate 14. Mount Euro Mine (M8) - June, 1979. Mineralised zone (malachite) in cut - Stn. 2.

trending ridge west of the occurrence and it is possible that a faulted block of this and the top of the Brachina Formation are the host rocks for the mineralisation.

Mineralisation

The copper mineralisation is associated with fault zones, trending roughly north-south. Malachite and azurite occur as pods, coatings on joint and bedding planes and disseminations in ironstone veins and altered country rocks. The country rocks may be ferruginous, bleached, kaolinized or drag folded (Plate 16). Slickensided joints along the lode are common. Some calcite veining is present. Anomalous gold and molybdenum is present in the samples, notably A2250/79.

Petrographic descriptions of the following 2 samples are contained in the Appendix.

Sample No.	Description
R.S. 6636-3	Sample of country rock near Stn. 7.
R.S. 6636-4	Sample of country rock at Stn. 15.

Grade

The results of analysis by A.A.S. of the following 6 samples are detailed in Table 5.

Sample No.	Description
A2250/79	Grab sample, mineralised ironstone from mullock heap Stn. 1.
A2251/79	Chip sample across 20 cm wide vein Stn. 2.
A2253/79	Chip sample across 1.8 m wide mineralised zone in ferruginous siltstone Stn. 9.
A2254/79	Gossanous ironstone Stn. 11.
A2255/79	Chip sample across 1 m wide mineralised zone in banded siltstone Stn. 14.
A2256/79	Chip sample across 0.9 m wide mineralised altered, ferruginous zone Stn. 19.

TABLE 5

Analyses - Pinda Creek Copper Workings
Results in p.p.m. or %

Sample No.	Cu	Pb	Zn	Co	Ni	Mn	Ag	Mo	Au
A2250/79	5.9%	570	50	50	65	5700	<1	100	0.45
A2251/79	28.0%	20	100	1200	160	1800	<1	2	0.1
A2253/79	10.8%	12	48	190	50	1800	<1	3	0.15
A2254/79	6000	15	18	50	25	490	<1	4	<0.05
A2255/79	5.7%	10	180	50	20	2700	<1	4	0.05
A2256/79	12.5%	50	20	260	80	5000	<1	5	0.15

Previous Company Exploration

Westgate Drilling Co. carried out stream sediment sampling in the area of this occurrence. Anomalous Cu values (max. 150 p.p.m.) were found in several creeks draining the site.

Conclusions

Bands of copper carbonates, 20 cm to 2.5 m wide, occur along fault zones. Over narrow widths, copper grades are high. Anomalous Au and Mo is also present in the mineralised zone.

References

Brown, H.Y.L., 1908. Record of the Mines of South Australia. Government Printer, Adelaide.

Westgate Drilling Co. Pty. Ltd. 1971. S.M.L. 519. S. Aust. Dept. of Mines and Energy open file Env. 1653 (unpublished).

Plate 15. Mount Euro Mine (M8). June, 1979. Copper mineralisation in minor fold. Stn. 14.

Plate 16. Mount Euro Mine (M8). June, 1979. View south. Shear and fold zone in cut Stn. 18-19. Mineralised zone on left.

SOUTH PINDA CREEK COPPER OCCURRENCE (M9)

1:250 000 COPLEY sheet SH/54-9

1: 50 000 Narrina sheet 6636-11

Location

In a small gully 500 m southeast of M8 across a tributary to Pinda Creek.

History and Production

None recorded.

Workings

The only workings are a shallow scrape and a pit 1 m x 1 m x 1 m.

Geological Setting

The occurrence is located in carbonate breccia mapped as diapiric on the COPLEY geological sheet (Coats, 1973).

Mineralisation

Malachite occurs as coatings and small veins in ferruginous and calcite veined carbonate breccia. Malachite was observed in the small pit and in outcrops within a few metres.

A grab sample of mineralised rock near the scrape was analysed by A.A.S. with the following results (p.p.m.).

Sample No.	Cu	Pb	Zn	Co	Ni	Mn	Ag	Mo	Au
A2257/79	3800	35	300	20	25	220	<1	<1	<0.05

Conclusions

Minor copper mineralisation occurs in carbonate breccia.

References

Coats, R.P., 1973. COPLEY map sheet. Geological Atlas of South Australia, 1:250 000 series. Geol. Surv. S. Aust.

WAUKAWOODNA CREEK WORKINGS (M10)

1:250 000 COPLEY sheet SH/54-9

1: 50 000 Narrina sheet 6636-11

Location

Next to Waukawoodna Creek west of the junction with Alieroona Creek. 5 km south of Christmas Hut, on the track to Waukawoodna Gap a track, 1 km long, branches off to the workings.

Tenure and Production

Mineral Claims 6525, 6795 and 7210 (all expired) are shown on the tenement map in the vicinity. Pegs from M.C. 680 were found at the site. This expired claim and M.C. 689 are located incorrectly near Mount Hack on the tenement map. M.C. 6525 was inspected and reported by Blissett (1971), who stated that the claimholders had collected several pounds of loose galena fragments scattered on the surface.

Workings

The workings consist of a number of shallow pits orientated approximately east-west (see Fig. 6).

Geological Setting

The workings are located in limestone, calcareous shale and siltstone of the Wonoka Formation. The boundary with the underlying Bunyeroo Formation lies about 50 m to the north of the workings.

Mineralisation

The mineralisation is associated with a system of quartz, siderite and limonite veins trending approximately east-west. Galena, observed only at Stn. 1, occurs with pyrite and limonite in quartz vein rock mainly in the mullock. Narrow quartz veins (0.01-0.05 m) are exposed in the pit. The host rock is a very weathered kaolinitic shale. The mullock at Stn. 5 contained minor malachite, pyrite and chalcopyrite? in quartz, siderite

Plate 17. Waukawoodna Creek Workings (M10). June, 1979. View southwest.

Plate 18. West of Waukawoodna Creek Workings. June, 1979. Quartz, ironstone and siderite vein. Sample locality A2272/79.

and limonite vein rock. Other pits have exposed quartz, siderite, calcite and limonite veins with pseudomorphs of limonite after sulphides. The veins are lensoidal but have a consistent orientation. Departmental prospector K.A. Salgo has found numerous fragments of galena in Waukawoodna Creek adjacent to the workings. It is not clear whether these fragments were derived from the veins at these workings or from further up Waukawoodna Creek.

Grade

The results of analysis by A.A.S. of the following 2 samples are detailed in Table 6.

Sample No.	Description
A2258/79	Grab sample from mullock heap - Stn. 1. Mineralised quartz vein rock.
A2259/79	Grab sample from quartz-carbonate vein. Stn. 4.

TABLE 6

Analyses - Waukawoodna Creek Workings

Results in p.p.m. or %

Sample No.	Cu	Pb	Zn	Co	Ni	Mn	Ag	Mo	Au
A2258/79	530	28.5%	32	5	5	380	68	<1	0.1
A2259/79	270	950	110	15	25	2100	<1	2	<0.05

Previous Company Exploration

Westgate Drilling Co. carried out stream sediment sampling in the area of this occurrence but no anomalous values were obtained in Waukawoodna Creek where the galena fragments were found. This may be due to the stream sediment samples being -80 mesh size, the galena being only present as coarser fragments.

Conclusions

Minor galena mineralisation occurs in a quartz vein which is one of a number of east-west trending quartz, carbonate and limonite veins.

References

Blissett, A.H., 1971. Silver-lead Prospect southeast of Mount Hack M.C. 6525 (W. McKenzie, S. Coulthard and M. McKenzie). S. Aust. Dept. of Mines report 71/7 (unpublished).

Westgate Drilling Co. Pty. Ltd., 1971. S.M.L. 519. S. Aust. Dept. of Mines and Energy open file Env. 1653 (unpublished).

RICHARDSON, CLARKE & BURKE'S CLAIM (M11)

1:250 000 COPLEY sheet SH/54-9

1: 50 000 Narrina sheet 6636-11

Location

Between two ridges north of Waukawoodna Creek, southwest of Pinda Well. Vehicle access can be obtained with difficulty by continuing 1 km northwest through scrub from the M10 workings.

History and Production

This is marked as a copper occurrence on the COPLEY 1:250 000 geological sheet. Stream sediment sampling by Westgate Drilling Co. Pty. Ltd. (Env. 1653) showed Cu, Pb and Zn anomalies in the area and follow up work to this may have located the Pb mineralisation. Mineral Claim No. 997 which was pegged over the area on 11/9/78 by N. Richardson, B. Clarke and D. Burke lapsed on 24/9/79. At the time of inspection (June, 1979), an estimated 2 tonnes of galena ore had been stockpiled on the site.

Workings

Workings comprise four shallow pits to a maximum depth of 2 m. The three in the southeastern part of the claim expose galena and the one in the northwest is on copper mineralisation (Fig. 6).

Geological Setting

The workings are located in shale, siltstone and limestone of the Bunyeroo Formation. Immediately to the north of the workings is a quartzite, locally ferruginous, which is probably the ABC Range Quartzite although on COPLEY sheet, the Bunyeroo Formation is shown bounded immediately to the north by the Pinda Diapir. Calcareous shale and limestone of the Wonoka Formation form the ridge to the south of the workings.

Mineralisation

Lead and copper mineralisation is contained in a series of quartz, ironstone and siderite veins trending roughly along the

strike of the host rocks (northeast). No galena was observed in situ in the pits. In the ore dumped around the pits, galena occurs in lumps up to 15 cm in diameter as well as in blebs in quartz/siderite vein rock. The galena is often deformed into curved and radiating forms (Plate 20). The mineralisation apparently occurred in near vertical lensoidal veins of no more than 40-50 cm width. The host rock is a weathered yellow-brown silty shale.

In the pit near Stn. 3, copper mineralisation is associated with quartz and gossanous ironstone in weathered shale and siltstone country rock. Most of the copper is malachite although some chalcocite and pyrite was observed.

Petrographic descriptions of the following 2 samples are contained in the Appendix.

Sample No.	Description
R.S. 6636/5	Outcrop north of Stn. 1.
R.S. 6636/6	Quartzite on ridge north of claim.

Grade

The results of analysis by A.A.S. of the following 6 samples are detailed in Table 7.

Sample No.	Description
A2260/79	Outcrop of country rock north of Stn. 1.
A2261/79	Ironstone outcrop north of Stn. 1.
A2262/79	Grab sample of stockpiled galena ore Stn. 2.
A2263/79	Quartz & gossanous limonite vein Stn. 2.
A2264/79	Chip sample of quartz and ironstone vein near Stn. 3.
A2265/79	Grab sample of ore from pit near Stn. 3.

TABLE 7

Analyses - Richardson, Clarke & Burke's Claim
Results in p.p.m. or %

Sample No.	Cu	Pb	Zn	Co	Ni	Mn	Ag	Mo	Au
A2260/79	95	860	15	<5	5	240	<1	<1	<0.05
A2261/79	150	150	28	10	15	170	<1	2	<0.05
A2262/79	100	80.5%	25	<5	<5	10	370	<1	<0.05
A2263/79	420	1.3%	1000	15	20	220	4	1	<0.05
A2264/79	1250	5500	1800	80	140	1300	2	<1	<0.05
A2265/79	13.4%	2900	1500	15	80	140	20	4	<0.05

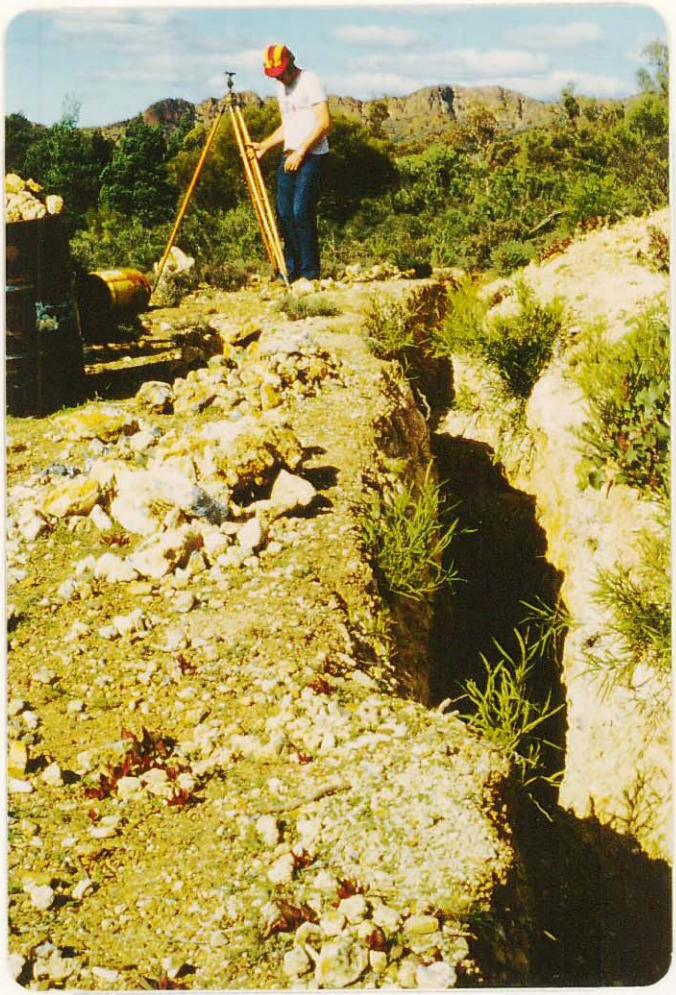


Plate 19. Richardson, Clarke & Burke's Claim (M11). June, 1979. View east. Trench at Stn. 2. Galena ore stockpiled at left.

Plate 20. Richardson, Clarke & Burke's Claim (M11). June, 1979. Galena ore, Stn. 2.

Previous Company Exploration

Westgate Drilling Co. carried out stream sediment sampling around this occurrence. Anomalous Cu (max. 60 p.p.m.), Pb (max. 200 p.p.m.) and Zn (max. 120 p.p.m.) samples were located in creeks draining the locality.

Follow up work located "a mound littered with massive galena in blocks weighing up to ten pounds". A block of galena contained 88.0% Pb and 10 ozs. per ton Ag. (316 gms/tonne). "The lead was traced to a quartz vein in Bunyeroo siltstones which was exposed for a few tens of feet and showed a seam of galena about 1" thick". A piece of chalcocite float was also found in the same area.

Conclusions

Small but rich lenses of galena occur in quartz-carbonate veins in shale of the Bunyeroo Formation. Copper mineralisation is also present in a nearby quartz-ironstone vein.

Other ferruginous quartz veins with a similar orientation were found between occurrences M10 & M11. Chip samples of these contained mainly background Cu, Pb and Zn (Table 8).

In the Waukawoodna Creek area, mineralisation apparently occurs as scattered pods of limited size within the ferruginous quartz-carbonate vein system.

References

Westgate Drilling Co. Pty. Ltd., 1971. S.M.L. 519. S. Aust. Dept. Mines and Energy open file Env. 1653 (unpublished).

OTHER SAMPLES COLLECTED IN AREA

Thin section descriptions of the following 2 samples are contained in the Appendix. For locations see Fig. 3.

Sample No.	Description
R.S. 6636-7 (A2266/79)	Basic intrusive in Pinda Diapir. Contains quartz vein with minor malachite.
R.S. 6636-8	Basic intrusive in Pinda Diapir.

Results of analysis by A.A.S. of the following 8 samples are contained in Table 8. For locations see Fig. 3.

Sample No.	Description
A2266/79	Quartz vein containing malachite within basic intrusive in diapir.
A2267/79	Ferruginous dolomitic siltstone with pyrite relicts. In diapir.
A2268/79	Dolerite and quartz vein containing micaceous hematite. In diapir.
A2269/79	Quartz and ironstone vein in Wonoka Fmn. west of M11.
A2270/79	Ferruginous breccia northwest of M11.
A2271/79	Ferruginous quartz vein east of M11.
A2272/79	Chip sample. Quartz, ironstone and siderite vein 100 m southeast of A2271/79.
A2252/79	Chip sample. Quartz and ironstone vein west of M10.

TABLE 8

Analyses - Samples collected in Waukawoodna Creek area

Results in p.p.m. or %

Sample No.	Cu	Pb	Zn	Co	Ni	Mn	Ag	Mo	Au
A2266/79	1850	970	35	<5	<5	150	<1	<1	<0.05
A2267/79	950	180	18	10	20	70	<1	4	<0.05
A2268/79	310	120	28	20	40	300	<1	<1	<0.05
A2269/79	95	80	90	15	20	1300	<1	<1	<0.05
A2270/79	28	75	5	5	25	200	<1	<1	<0.05
A2271/79	65	55	130	20	30	1900	<1	2	<0.05
A2272/79	12	35	100	15	40	3000	<1	<1	<0.05
A2252/79	850	15	90	5	35	3300	<1	4	<0.05

APPENDIX

Thin and Polished Section Descriptions

AMDEL reports GS4848/79 and 5719/79

by

Dr. K.J. Henley

DESCRIPTION AND IDENTIFICATION OF FIVE SAMPLES

Sample: 6636 RS1; TS41681

Applicant's No. M2-2

Location:
Elatina Formation (?) near Mt. Roebuck

Rock Name:
Quartz sandstone

Hand Specimen:
A brownish sandstone

Thin Section:
A visual estimate of the minerals is as follows:

	%
Quartz	65
Plagioclase	5
Microcline	5
Lithic fragments	15
Carbonate	7
Sericite	3
Tourmaline	trace

This rock is a bimodal sandstone composed of rounded detrital grains 0.2 to 0.8 mm in size in a finer-grained (0.05 to 0.1 mm) matrix of detrital grains cemented by iron-stained carbonate (?siderite).

The detrital grains consist predominantly of quartz, with minor plagioclase, microcline and lithic fragments. The feldspars are commonly incipiently sericitized.

Lithic fragments include chert, granite, volcanic rock, carbonate and quartzite. The larger detrital grains are well rounded but the smaller detrital grains forming the matrix are generally angular or sub-rounded.

Thin films of ?sericite and iron-stained carbonate rhombs (0.02 to 0.2 mm in size) cement the detrital grains.

Sample: 6636 RS2

Applicant's No. M2-21

Location:
Galena and barite working near Mt. Roebuck

Rock Name:
Cerussite

Hand Specimen:
White fragments with dark grey, dense patches.

X-ray Diffraction Identification:
Portions of the dark grey material were extracted and identified by X-ray diffraction. This showed that cerussite ($PbCO_3$) was the dominant mineral present; traces of siderite and quartz were also detected.

Sample: 6736 RS33; TS41682

Applicant's No. M6--4

Location:
Working south of Wirrapowie Mine

Rock Name:
Sericitic chert with quartz veins

Hand Specimen:
A fine-grained, greenish cherty rock transected by white vein quartz.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Host Rock:	
Quartz	55
Sericite	40
Carbonate	2
Opaques	3
Veins: Quartz	100

This rock is made up of a very fine-grained sericitic chert which is transected and partially replaced by vein quartz.

The grain size of the sericitic chert is generally less than 0.1 mm and the relative proportions of quartz and sericite vary. There is a tendency for the sericite flakes to be oriented subparallel. Small (<0.05 mm) euhedral opaque crystals are disseminated through the chert.

One large area of the section consists of vein quartz which appears to have infilled a cavity, the quartz crystals growing out from the cavity margins; the quartz crystals are up to 1 mm in size and are coarsest in the centre of the cavity. Apart from this main area, vein quartz occurs as stringers through, and patches in, the sericitic chert and in some of these situations appears to have replaced the chert.

Some subhedral to euhedral, iron-stained crystals of carbonate up to 1.2 mm in size have locally replaced the sericitic chert and quartz veining.

The sericitic chert is probably of sedimentary origin and the introduction of vein quartz and carbonate post-dates formation of the chert.

Sample: 6736 RS34; PS27857

Applicant's No. M6-1

Location:
Working north of Wirrapowie Mine

Rock Name:
Copper-mineralized quartz vein

Hand Specimen:
White quartz containing secondary brown iron oxide and green copper minerals. Yellow chalcopyrite is visible in some of the iron oxide patches.

Polished Section:
A visual estimate of the minerals is as follows:

	%
Silicate gangue (quartz)	80
Chalcopyrite	5
Djurleite $Cu_{1.95}S$	2
Chalcocite	2
Covellite	<1
Malachite	1
Goethite	10

This rock originally consisted of patches of sulphide up to 2 mm in size disseminated through silicate gangue. The main sulphide appears to have been chalcopyrite and this has undergone partial to complete alteration to secondary goethite, djurleite, chalcocite, covellite and malachite.

Chalcopyrite now occurs in the cores of these patches and is commonly rimmed with a shell of djurleite, then covellite or chalcocite, and then goethite. The djurleite/covellite/chalcocite shell is commonly 10 to 25 µm thick but may be absent. Some pseudomorphs after chalcopyrite consist of cores of chalcocite surrounded by goethite whereas others consist of goethite alone. More rarely the cores contain an intergrowth of chalcocite and djurleite or covellite alone.

Malachite occurs as cross-cutting veins and patches and is generally not associated with the pseudomorphs after chalcpyrite.

Sample: 6736 RS35; TS41683; PS27858

Applicant's No. M5-1

Location:
Mullock heap, Jubilee Mine

Rock Name:
Copper-mineralized carbonate vein

Hand Specimen:
A dense, brownish-black rock with white vein quartz on one side and containing traces of yellow sulphides and greenish secondary copper minerals.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Siderite	80
Quartz	5
Dolomite	5
Opaques	10

The section was cut predominantly from the dense, brownish-black rock and only a small amount of the vein quartz was present. The main component is a coarse, crystalline carbonate of high relief which is believed to be siderite. This carbonate forms massive intergrowths of crystals which range from 0.1 to 2 mm in size. Broad-scale banding is present, with some finer-grained bands in mostly coarser-grained siderite. A vein of ?dolomite and opaques about 1.0 to 1.5 mm wide lies subparallel to this banding, which is also defined by elongate aggregates and lenticles of opaques.

Quartz is intergrown with the siderite in the form of euhedral prismatic crystals up to 2 mm long and patches of fine-grained granular material.

Some orange-brown goethite staining occur marginal to some siderite crystals and siderite is also partially replaced by goethite in places.

Polished Section:
Chalcopyrite and pyrite are the only sulphides present, in the approximate ratio 60:40. The chalcopyrite forms irregular and elongate patches up to 3 mm long which may contain smaller, euhedral pyrite crystals.

Pyrite forms subhedral and euhedral crystals up to 2.5 mm in size which may show fracturing and veining by chalcopyrite. The chalcopyrite therefore appears to post-date the pyrite. The sulphides are essentially unoxidized although in one portion of the briquette, anastomosing veins of goethite (?derived from siderite) are present. Secondary copper minerals such as covellite or chalcocite were not observed.

It appears likely that the sample represents mineralized vein material.

PETROGRAPHY OF SIX ROCKS

Sample: 6636 RS 3; TS41760

Applicant's Number: M8-7

Descriptive Information: ABC Range Quartzite?

Hand Specimen:

A banded dark grey and brown fissile sandstone/quartzite.

Thin Section:

This sample consists of alternating bands from ½ to 6 mm wide, the banding being defined by variations in the relative proportions of quartz, micaceous minerals and iron oxides. The iron oxide-rich bands contain disseminations of goethite which represent altered carbonate, and locally carbonate relics are present. Quartz and feldspar (potash feldspar and plagioclase) in these bands show a range of grain sizes up to 0.2 mm and are generally angular in shape. The micaceous matrix is pale greenish-brown in colour and composed of fine-grained sericite and clay. Minute globules of opaques are disseminated throughout the rock.

This rock represents a banded, carbonate-bearing, argillaceous sandstone which shows evidence of weathering.

Sample 6636 RS 4; TS41761

Applicant's Number: M8-15

Descriptive Information: ABC Range Quartzite?

Hand Specimen:

Pale brown sandstone/quartzite

Thin Section:

This sample consists of a recrystallized aggregate of quartz and minor feldspar with a grain size of 0.05 to 0.2 mm intergrown with patches of finer-grained quartz (chert, sericitic chert) and sericite. Some suturing of quartz grains has occurred but overall the rock has a sedimentary texture. Euhedral patches of opaques (mainly goethite) up to 0.4 mm in size are disseminated through the rock and possibly represent oxidised pyrite.

This rock is a weathered argillaceous sandstone.

Sample: 6636 RS 5; TS41762

Applicant's Number: M11-2

Descriptive Information: ABC Range Quartzite?

Hand Specimen:
Brownish sandstone/quartzite containing pores.

Thin Section:
This sample consists predominantly of quartz grains 0.2-1 mm in size which retain much of their original angular to sub-rounded detrital form but have been modified by recrystallization and cementing by secondary overgrowths of quartz. Minor sericite and clay form irregular patches and lenticles, and narrow selvedges to the quartz grains. Locally, patches of fine-grained cherty quartz are present. Pores are common and possibly represent dissolved carbonate.

This rock represents a slightly recrystallized and cemented sandstone (quartzite).

Sample: 6636 RS 6; TS41763

Applicant's Number: M11-7

Descriptive Information: ABC Range Quartzite?

Hand Specimen:
Greyish mauve quartzite.

Thin Section:
This sample resembles RS 5 although it appears to be somewhat better recrystallized and cemented. Grains of quartz and minor feldspar are mainly from 0.2 to 1 mm in size but some finer-grained interstitial material is locally present. The quartz grains range from sub-rounded to sub-angular and many show evidence of secondary quartz overgrowths. Fine-grained disseminations of opaques (?carbon) or sericite rim quartz grain boundaries and traces of calcite occur as inclusions within the quartz.

This rock represents a slighly recrystallized and cemented sandstone (quartzite).

Sample: 6636 RS7; TS41764

Applicant's Number: PC11

Descriptive Information: Intrusive within diapir

Hand Specimen:
A fine-grained greenish (?epidote-rich) rock with vein quartz and ?hematite along one margin.

Thin Section:
This sample consists of a granular intergrowth of epidote (60-70%), pale green amphibole (10-20%), quartz (5-10%) and calcite (1-2%) through which are distributed coarse, irregular crystals of altered ?ilmenite. The average grain size of the silicates is 0.2-0.4 mm whereas the altered ilmenite ranges up to 1-2 mm in size. The altered ilmenite now consists of leucoxene/sphene through which occur oriented lamellae of opaques, giving the intergrowths a skeletal appearance. The amphibole is a pale green, pleochroic variety, probably actinolite.

This rock represents an altered basic ingeous rock and could be termed an epidotized dolerite.

Sample: 6636 RS 8; TS 41765

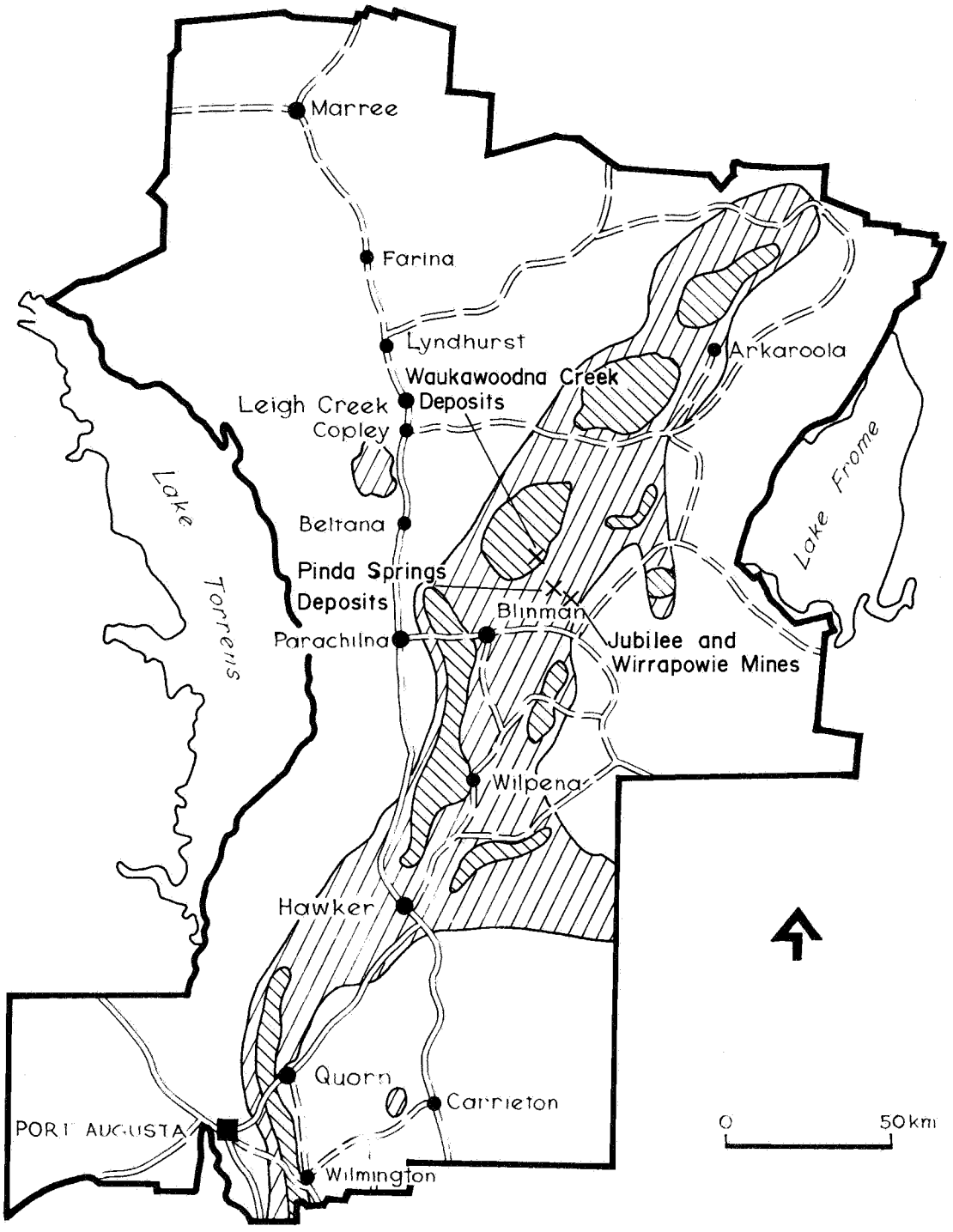
Applicant's Number: PC14

Descriptive Information: Intrusive within diapir

Hand Specimen:
A massive, medium-grained, dark green rock (?amphibolite) with a brown weathering rind.

Thin Section:
This sample consists predominantly of an intergrowth of chlorite, plagioclase, quartz, epidote and altered ilmenite with a grain size of 0.2-2 mm. The plagioclase forms anhedral to subhedral laths which are variably sieved with aggregates of prismatic epidote crystals. The plagioclase/epidote crystals are intergrown with ragged flakes of chlorite and minor calcite; the chlorite has probably replaced pre-existing crystals of a ferromagnesian mineral. Altered ilmenite now consists of leucoxene/sphene with oriented lamellae of opaques but some patches of unaltered ?ilmenite are also present.

This rock represents an altered basic igneous rock (dolerite) in which the pre-existing ferromagnesian mineral has been replaced by chlorite.



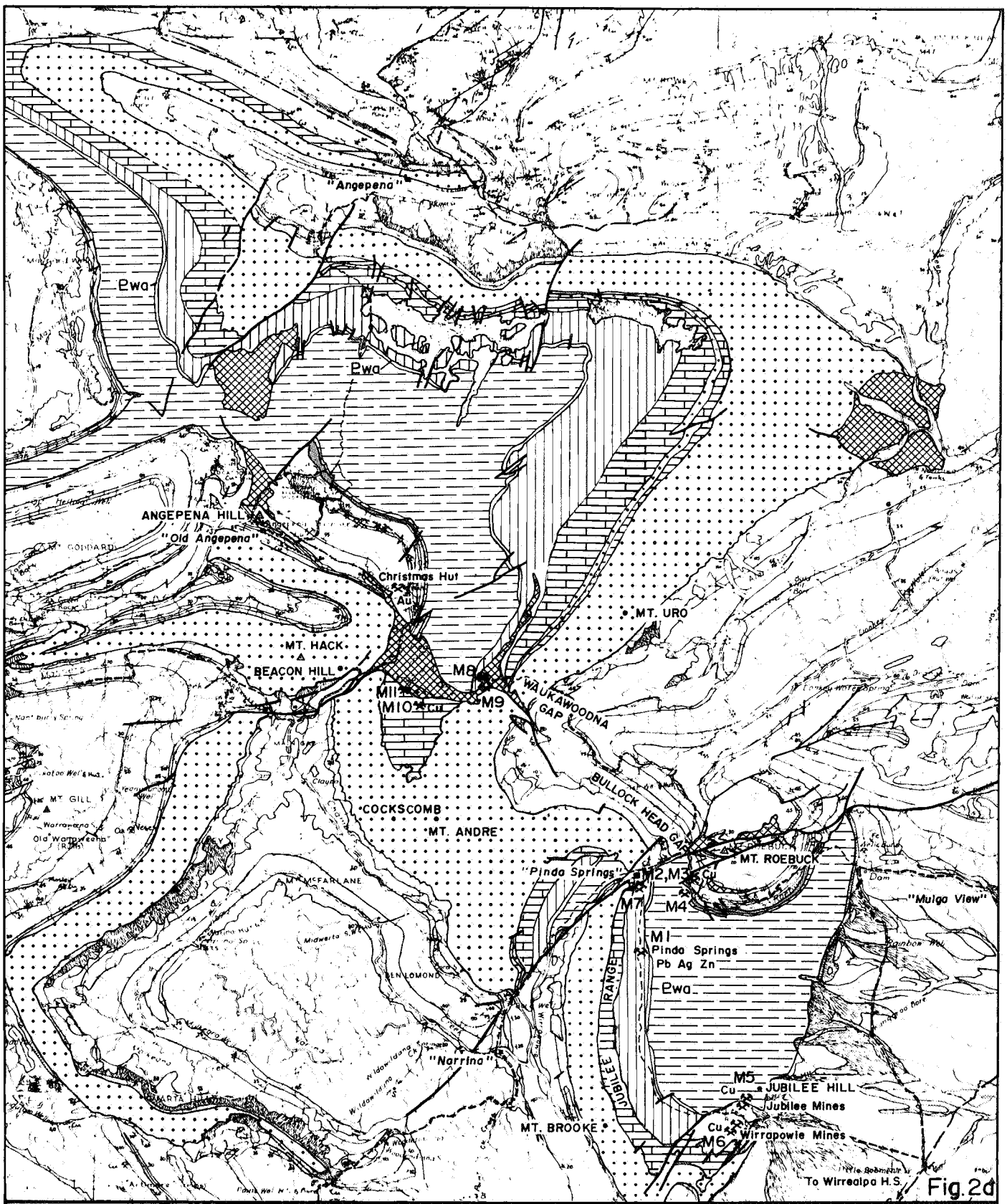
ENVIRONMENTAL AREAS

- Class A
- Class B
- Class C

- Country Township
- Special Township
- Main road
- Secondary road

Fig. 1

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. R.	C D O DATE
PINDA SPRINGS AND WAUKAWOODNA CREEK DEPOSITS	DRAWN M. B.	SCALE 1 : 2 000 000
LOCALITY PLAN	DATE 3-7-80	PLAN NUMBER S14709
	CHECKED	



	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE: 1:250 000
COMPILED: ROBERTSON. S	PINDA SPRINGS AND WAUKAWOODNA CREEK DEPOSITS	DATE: 10-12-79
DRN: M. B. CKD:	REGIONAL GEOLOGY	PLAN NUMBER S14552

1714

WILPENA GROUP

Ewp — Pound Quartzite: Resistant white feldspathic quartzites and sandstones above red feldspathic sandstones and siltstones.

Eww — Wonoka Formation: Grey-green shales, grey sandy limestones, minor red-brown and purple calcareous shales, siltstones and dolomite.

Ewb — Bunyeroo Formation: Red-brown or purple shale, minor red limestone, minor carbonaceous shale, lenticular cream dolomites.

Ewa — ABC Range Quartzite: Cross-bedded feldspathic sandstone and quartzite.

Ewr-u — Brachina Formation: Ulupa Siltstone undifferentiated. Olive green and purple siltstones, red-brown, olive green and purple shales.

Ewn — Nuccaleena Formation: Finely-laminated purple dolomitic shales with cream dolomite nodules, basal cream-weathering pink dolomite bands.

UMBERATANA GROUP

Ehl — Elatina Formation: Well bedded pink sandstone or massive feldspathic granule greywacke, minor fine grained purplish sandstone.

Diapiric breccia with carbonate matrix.

Fault.

Mineral Occurrences, with workings.

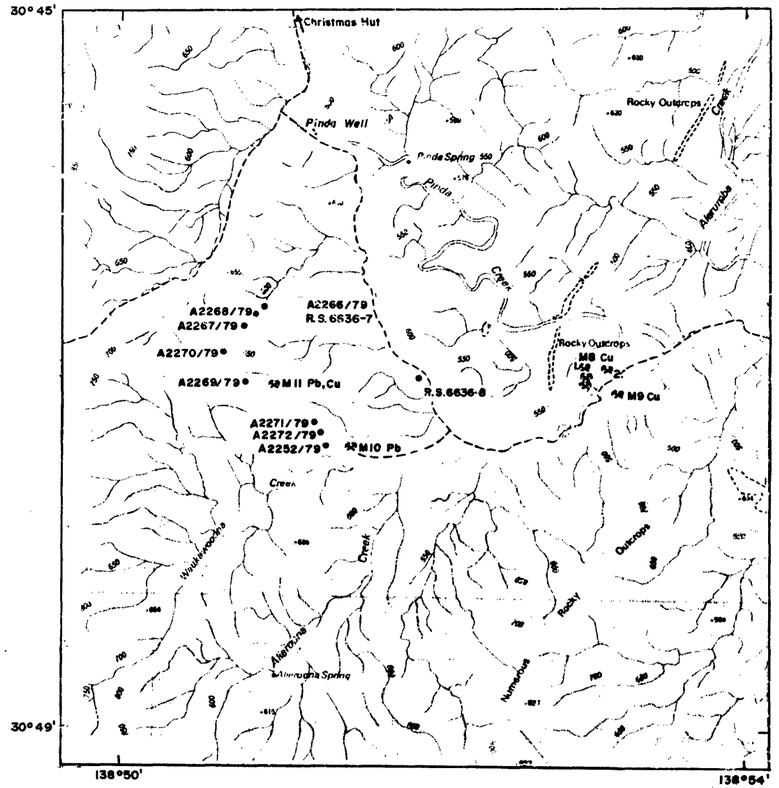
Mineral Occurrences, without workings.

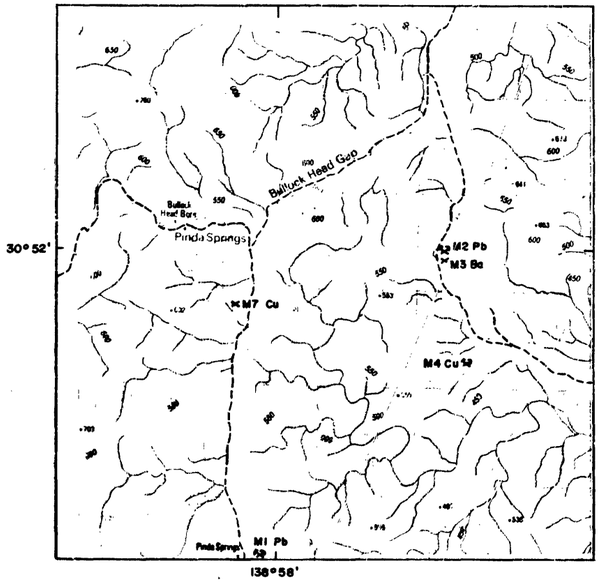
Adapted from COPLEY 1:250 000 Geological Sheet
Coats et al 1973

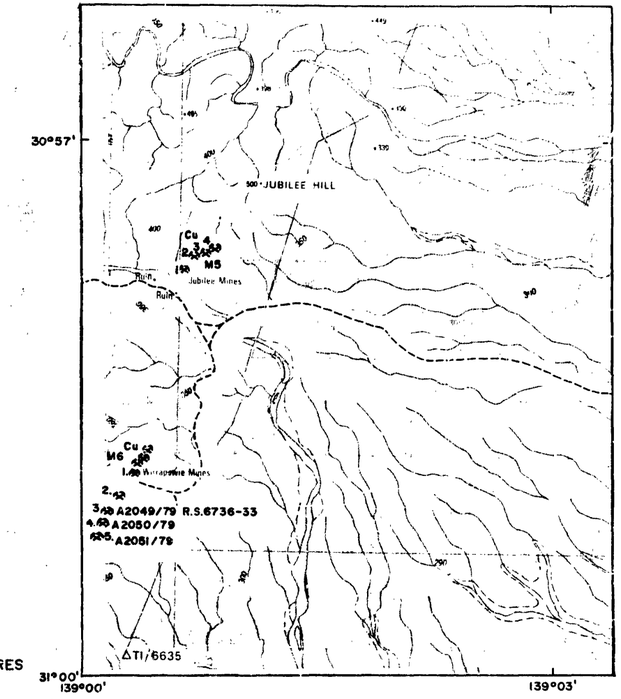
Fig.2b

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE
COMPILED ROBERTSON.S	PINDA SPRINGS AND WAUKAWOODNA CREEK DEPOSITS	DATE 13-12-78
DRN M.B. CKD	GEOLOGICAL LEGEND	PLAN NUMBER S14553

1714







LEGEND

Cu ✻ M9	Mineral Occurrence, with workings.
Ba × M3	Mineral Occurrence, without workings.
A2272/79 •	Sample locality.

SCALE 1:50 000

METRES 1000 0 1 2 3 4 5 KILOMETRES

Fig. 3

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE 1:50000
COMPILED ROBERTSON	PINDA SPRINGS AND WAUKAWOODNA CREEK DEPOSITS	DATE 19-12-79
DRN M.B. CKD 28.8.80	LOCALITY PLANS	PLAN NUMBER 79-882

1714

PINDA SPRINGS MINE (M1)

SKETCH PLAN

M.N.

LEGEND

Geological Boundary.....

Dip, dip direction of bedding... 45° to 100°

Excavation.....

Survey Station..... +⑤

Peg ◻ M.C. 844

Corner Peg ◻ M.C. 844

Peg ◻ M.C. 860

Peg ◻ M.C. ?

Peg ◻ M.C. 844

Peg ◻ M.C. ?

Peg ◻ M.C. ?

Claim Peg ◻ M.C. 860

Peg ◻ M.C. 860

+ Sample A1440/79 (position approximate)

To Pinda Springs H.S., Bullock Head Gap, Nantawarrina H.S.

CAMP AREA

Track

Gate

Road

To Jubilee Mines, Wirrealpa–Wertaloona Rd.

BUNYEROO FORMATION

BRACHINA FORMATION

25° to 274°

Shallow Bulldozer Cuts 0·5m – 1·0m depth.

Minor galena. Thin coating on joint surface in siltstone

45° to 288°

Bulldozer cut

5° to 100°

No mineralisation

Collapse.

③ Shaft, depth 6m.

30° to 100°

Drive 10m to 040°

25° to 285°

28° to 255°

22° to 205°

10° to 190°

15° to 140°

25° to 190°

Bulldozer cut, depth 1·0m

35° to 265°

Vein exposed at base of eastern wall of cut and at bottom of shaft. Galena in gangue of ferruginous quartz and some carbonate. Average width 0·1m. Exposed strike length 30m. Dips about 35° to 090°. Some thin veinlets also present. Samples A3200/78, A3201/78, A3202/78, A3203/78.

Country rock grey to bleached white siltstone. Dips as shown.

15° to 245°

SCALE 1:1000

0 20 40 60 80 100 Metres

MOUNT ROEBUCK LEAD WORKINGS (M2) AND BARITE OCCURRENCE (M3)

SKETCH PLAN

M.N.

LEGEND

Geological Boundary.....

Dip, dip direction of bedding..... 45° to 100°

Cleavage.....

Joint.....

Excavation.....

Survey Station, elevation (relative to creek bed Stn. 12)..... ⑤ + 10·2m

50° to 215° Dolomitic siltstone and medium sandstone.

⑦ + 27·8m

⑧ 42·5m Pit 2m depth. Pinkish brown medium to coarse sandstone. Ferruginous veins 41° to 085° 35° to 200° Fragment of galena in spoil.

Prominent Outcrop ⑩ + 68·5m Gritty sandstone ± Fe and Mn staining

⑥ 26·3m Fine silty sandstone Adit ± thin ferruginous veins. No mineralisation observed. 55° to 075° 25° to 270°

42·5m + ⑨ Sandstone ± Fe and Mn staining.

⑤ + 27·0m

Cut maximum depth 2·5m. Galena in ferruginous quartz veins 1–4cm wide A 2039/79. 43° to 075° (Cleavage and veins). In dolomitic? silty sandstone. ④ 32·0m

③ + 23·5m

37° to 220° Sandy Dolomite ② Sample R.S. 6636–1 14·8m

Fence

Gate

Dolomitic sandstone + ① 10·2m

Cut contains several Barite veins 0·01–0·05m width. Dark cerussite along joint plane R.S. 6636–2 ± speck of malachite.

Cut Max. depth 4m. Medium to coarse sandstone. Vein 3–8 cm width. Galena in quartz and earthy limonite A 2040/79 Cleavage and vein orientation 80 to 155° Joint 60° to 123° ± slickensides. Bedding 33° to 230°

⑯ + Brown dolomitic ⑮ sandstone 3·1m + ⑰ Barite vein 0·05–0·15m wide. Sample A3025/79 taken along vein.

⑪ + 0·9m

0·0m +

⑫ 25° to 230° Pink brown dolomite

Purple shale

TOP OF CLIFF 6·2m

? BOUNDARY – ELATINA FORMATION – NUCCALEENA FORMATION

Dolomite Band

+ ⑭

Creek

32° to 240°

Shallow scrape

Sample A3024/79 taken along vein. Dolomitic silty sandstone. ⑱ 35° to 240°

Barite vein 0·10–0·15m width

Barite veins 0·15–0·30m wide

⑲ Barite vein 0·05–0·15m width.

Barite vein 0·02–0·10m width.

Vermin Proof Fence

Track

SCALE 1:500

Metres 0 10 20 30 40 50 Metres

⑳ Massive dolomitic sandstone

Barite vein 0·05–0·15m width

30° to 215°

Pink dolomitic sandstone

Purple shale

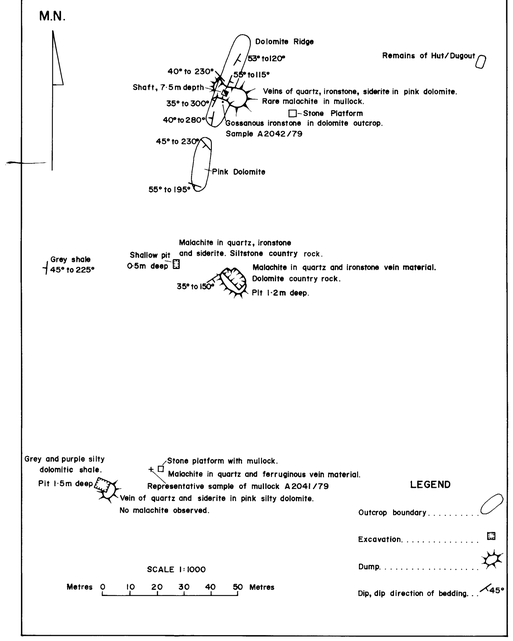
30° to 220°

Fig. 4

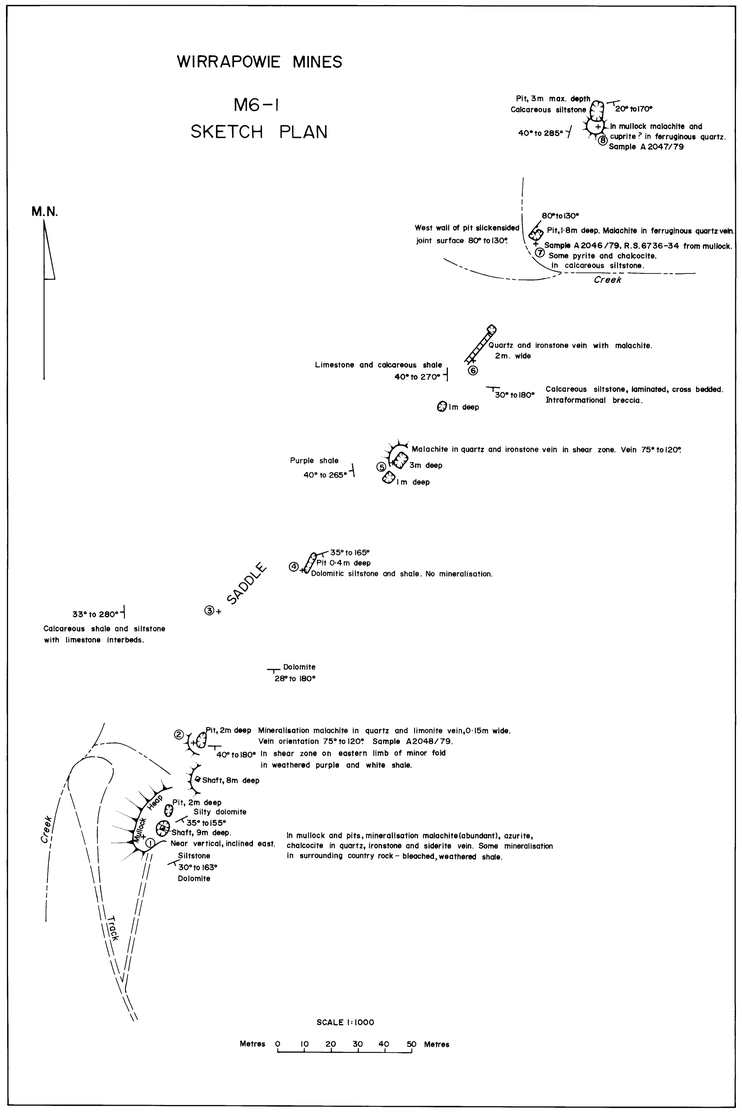
	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE AS SHOWN
COMPILED S. ROBERTSON	MINERAL DEPOSITS M1, M2 AND M3 PINDA SPRINGS	DATE 27-11-79
DRN M.B. CKD 28·8·80		PLAN NUMBER 79-845

1/14

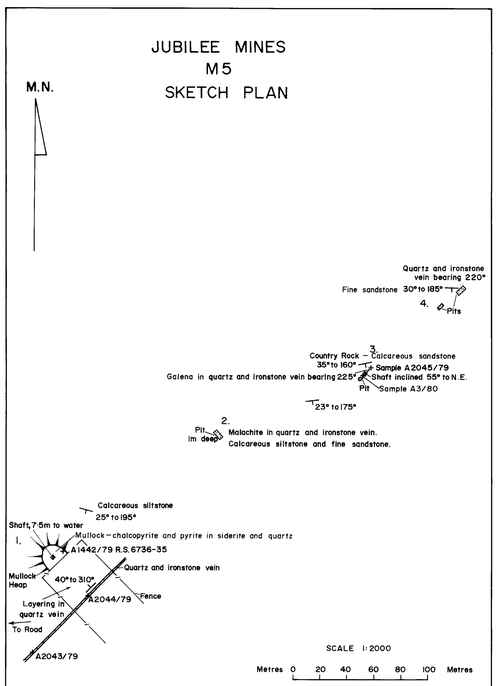
SOUTH MOUNT ROEBUCK COPPER WORKINGS
M4
SKETCH PLAN



WIRRAPOWIE MINES
M6-1
SKETCH PLAN



JUBILEE MINES
M5
SKETCH PLAN



MOUNT EURO MINE (M8)
SKETCH PLAN

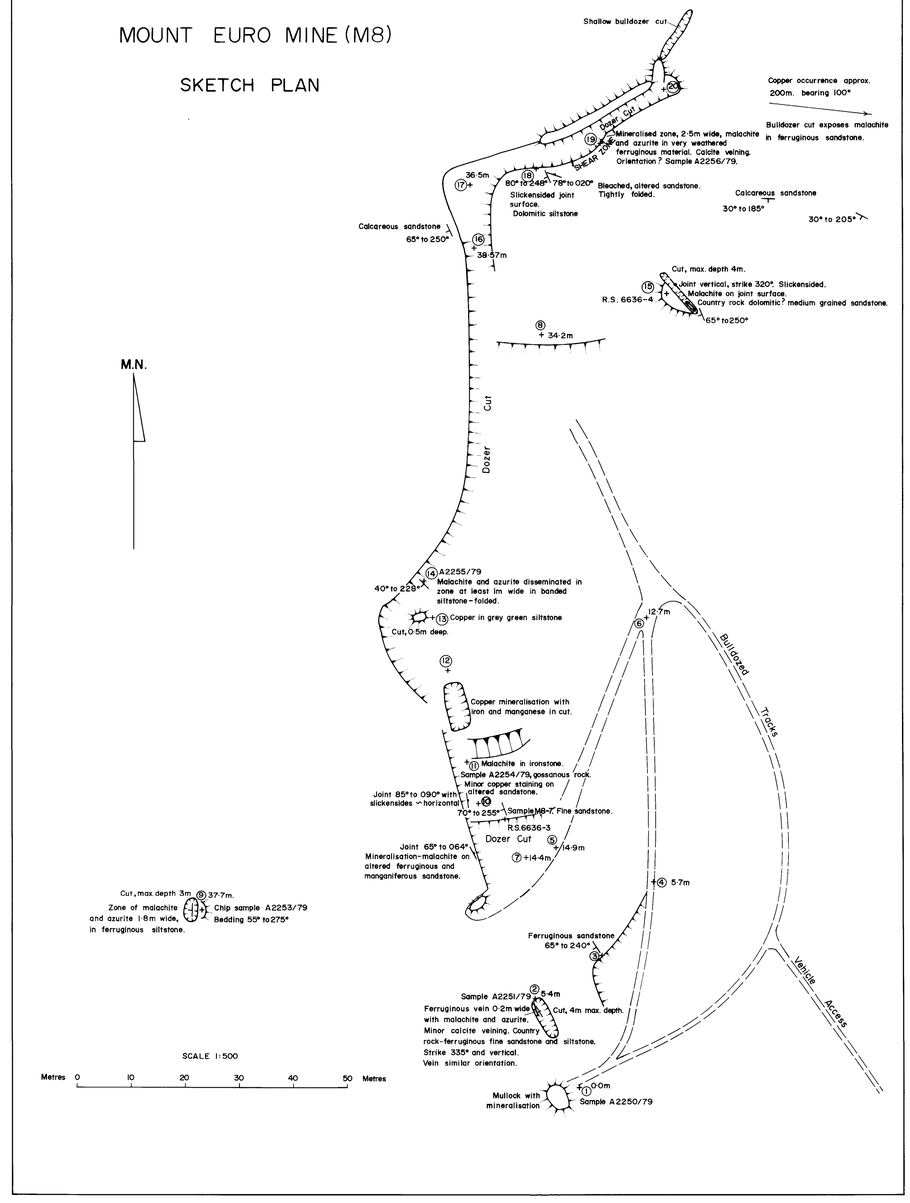


Fig. 5

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

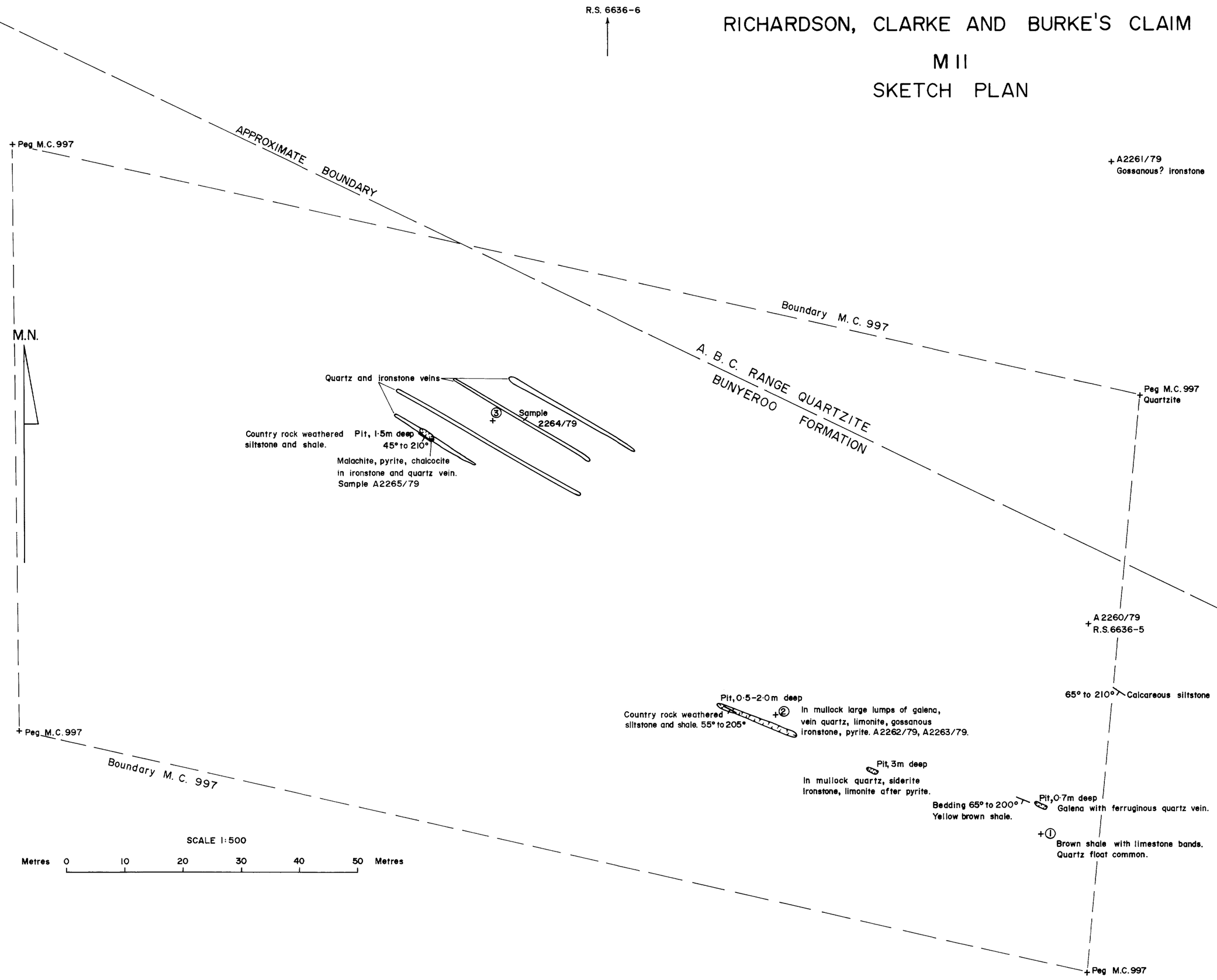
MINERAL DEPOSITS - M4, M5, M6 AND M8
PINDA SPRINGS AND WAUKAWOODNA CREEK

	COMPILED ROBERTSON	DRN M.B.	SCALE AS SHOWN	PLAN NUMBER
DIRECTOR GENERAL	28.8.80	CKD	DATE 5-12-79	79-855

RICHARDSON, CLARKE AND BURKE'S CLAIM

M II

SKETCH PLAN



WAUKAWOODNA CREEK WORKING

M IO

SKETCH PLAN

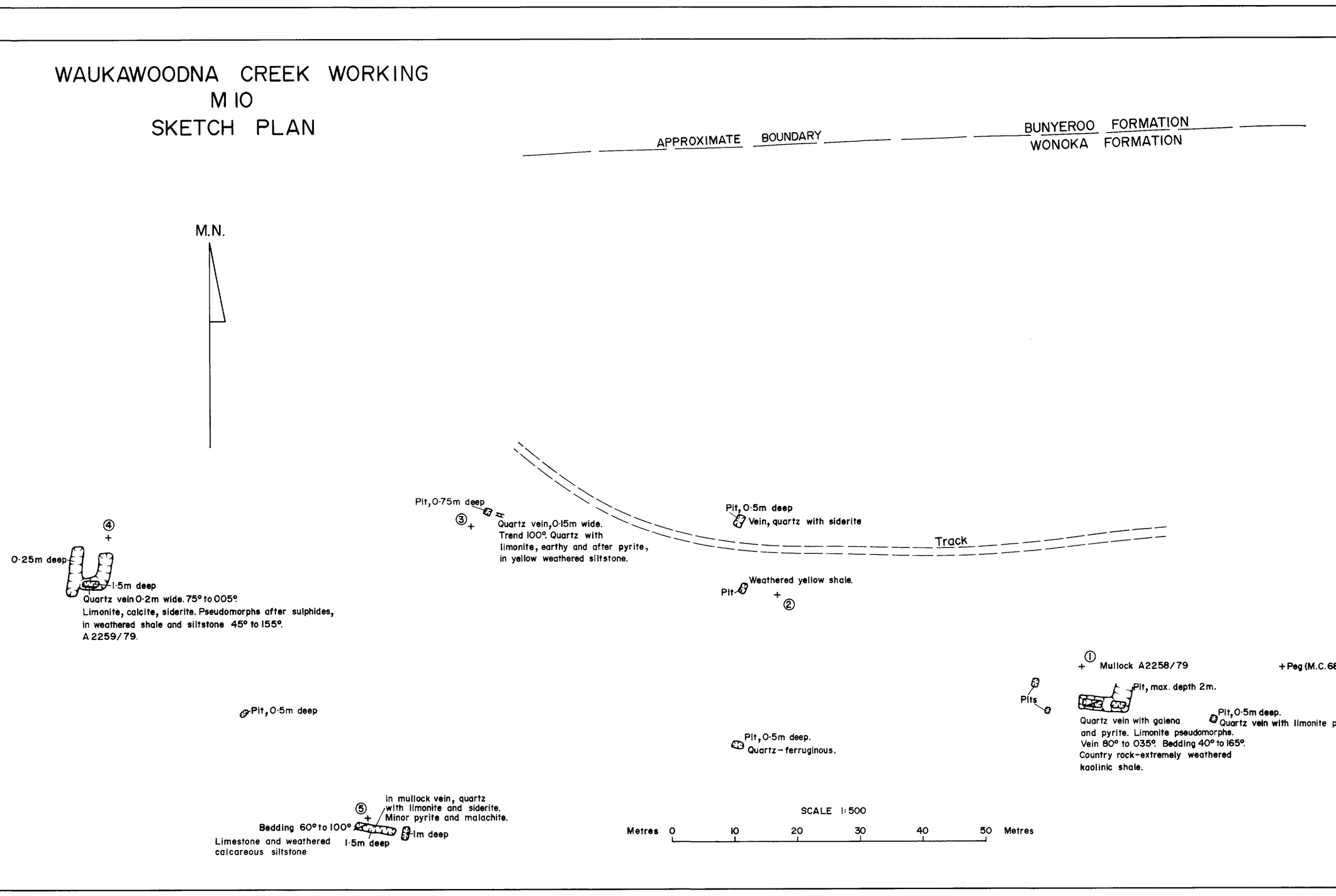


Fig. 6

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA				
MINERAL DEPOSITS – M10, M11 WAUKAWOODNA CREEK				
	COMPILED ROBERTSON	DRN M.B.	SCALE AS SHOWN	PLAN NUMBER
DIRECTOR GENERAL	28·8·80	CKD	DATE 7-12-79	79-858

1714