DEPARTMENT OF MINES

SOUTH AUSTRALIA

THE BOUCAUT VOLCANICS

by

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REGIONAL SURVEYS SECTION

Rept.Bk.No. 77/113
G.S. No.5932
D.M. No.1302/71

CONTENTS

ILLUSTRATIONS

DEPARTMENT OF MINES
SOUTH AUSTRALIA

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ABSTRACT

The type section of the Boucaut Volcanics is 60 km south of Olary and contains regionally metamorphosed rhyolite, dacite, andesite and basalt with minor metasediments: outcrop width here is 760 m. Nearby outcrops, between Sisters and Division Dams, northeast of "Lilydale", contain mainly acid volcanics and quartz-muscovite schist. Similar volcanics, also considered to be Boucaut Volcanics, are known on a ridge 7 km south of "Mutooroo", 60 km northeast of the type section.

Rb/Sr analysis suggests a Cambrian age for the type Boucaut Volcanics, but field relationships near Mutooroo indicate an early Adelaidean or older age.

INTRODUCTION

The aim of this report is to define and briefly describe the volcanics of the Anabama region which are to be shown on the forthcoming OLARY 1:250 000 geological map. Outcrops on low ridges near Boucauts West Dam (see Fig. 1) appear to be the first in the region to be identified as volcanic, as a result of reconnaissance in 1958, by M.N. Hiern and B.P. Thomson and petrological work done under A.W. Whittle (personal communication, B.P. Thomson). Asarco (Australia) Pty. Ltd. mapped some of the volcanics and suggested a possible relationship with the Anabama Granite (Hosking, 1969) and A.L. Currie of the Geological Survey in 1970 mapped the volcanics as part of the OLARY regional mapping programme. More recent work has been done by petrologists of the Australian Mineral Development Laboratoreis (Amdel), (Simpson, 1970; Whitehead, 1971; Steveson, 1976, 1977), geologists of Mines Administration Pty. Ltd., and Longreach Metals N.L., 1971-1972 (e.g. Edwards, 1971), G. Arnold (on Mutooroo ridge, B. Sc. Hons. thesis, 1971) and B.J. Morris (Geological Survey, 1973-1977).

I am grateful for critical comments from Drs. A.W. Webb and B.G. Steveson of Amdel and B.P. Thomson (Supervising Geologist). Dr. Gary Arnold (Geological Survey, Papua New Guinea) gave permission for use of his Thesis material.

DEFINITION

The Boucaut Volcanics are named after Boucauts West Dam, 62 km south of Olary. Their main outcrop area is on the Anabama 1:100 000 map area between Sisters Dam and Division Dam, but very similar volcanics, also considered to be Boucaut Volcanics, occur on Mutooroo ridge (Fig. 1 locality 12) southwest of Flood Dam (northeast Oakvale). The most widely occurring rock-type is a pale pink to grey rhyolite (Figs. 6-8) but green and grey amygdaloidal andesite and basalt are also present (Fig. 5). These rocks have suffered more than one phase of deformation and have been metamorphosed to the biotite grade.

A type section is described from low hills (Fig. 1, locality 10) 1.5 km southwest of Division Dam.

In the type section the beds are steeply dipping from about 60 degrees to vertical, and strike northeasterly. No evidence of folding was seen and there are no known indications of facing. Thicknesses of units f to h were determined by tape and the remainder by air photo measurement.

Petrographic details have been provided by Dr. B.G. Steveson, Amdel (1976, 1977). Unit a is at the northwest end of the traverse, which extends southeasterly.

Unit	Notes	Outcrop width (m)
a.	Northwesterly limit of outcrop. Rhyolite, grey and pink, streaky, spotted. Vertical lamination in places, strikes 040 degrees. P456/76: mainly fine-grained potassium feldspar and quartz; some potassium feldspar phenocrysts.	40
b.	Quartz-muscovite rock (?metavolcanic), pale greenish-grey, laminated. Complex minor folds - possibly a disturbed flow structure. P457/76: 60 percent quartz, 40 percent muscovite.	150
c.	Covered interval: in part rhyolite,grey and pink, similar to a.	
d.	Mainly metavolcanics, greenish, greyish, amygdaloidal, containing chlorite and epidote, partly soil-covered. Dacite, near northwest limit, P605/76: dark grey, porphyritic, 70 percent plagioclase, 15 percent quartz (69 percent SiO_2).	

Tourmalinized biotite schist, P604/76: dark greenish grey, laminated, fine-grained, containing plagioclase, epidote.

Basalt, P603/76: medium greenish-grey; quartzose fragments up to 10 mm, 55 percent plagioclase, 30 percent biotite (48 percent SiO_2).

Andesite, P458/76: pale grey, 40 percent plagioclase, 10 percent clinopyroxene; amygdales contain tourmaline, quartz, calcite, epidote.

Epidote rock.

Andesite, P459/76: amygdaloidal, with plagioclase, epidote.

Andesite, P460/76, near southeast limit of unit: greenish grey, amygdaloidal, porphyritic; 40 percent plagioclase, 35-40 percent biotite, 10 percent epidote (55 percent SiO_2) 330

e. Rhyolites and phyllitic rocks, dark to light grey, pinkish, greenish, brownish,; partly laminated, amygdaloidal, medium-bedded and soil covered.

Rhyolite, P461/76, near northwest limit: dark, massive, fine-grained, potassium feldspar, quartz.

Rhyolite, P462/76: pale grey, altered; biotite, potassium feldspar, quartz.

Rhyolite, P463/76: dark grey, laminated; potassium feldspar and quartz.

Trachyte, P464/76: black, amygdaloidal; potassium feldspar; trachytic texture.

Dacite, P466/76: black, potassium feldspar (64 percent SiO_2).

Quartz-biotite schist, P602/76, near southeast edge of unit: dark grey. 110

f. Rhyolite, rhyodacite, medium and dark grey, layered, partly amygdaloidal; beds 0.3 to 1 m thick, layers 1-3 mm, prominent ridge, northwest side.

?Welded tuff P467/76: dark, layered; pale grey streaks and patches up to 20 mm; potassium feldspar, quartz (72 percent SiO_2).

Rhyolite breccia, P465/76: lenticular; grey, angular fragments up to 50 mm; 60 percent potassium feldspar, 30 percent quartz.

Unit f thins out southwest of the line of traverse. 12

g. Rhyolite, light grey: small pink patches in places, partly laminated, fine-grained; moderately well cleaved in part; prominent ridge.

P468/76: potassium feldspar and quartz. 34

h. Schist, rhyolitic, light grey, weathering light brownish grey, partly laminated, moderately well cleaved.

P469/76: 50 percent potassium feldspar, 30 percent quartz, 15 percent biotite. 6

(Total outcrop width 762 m).

Unit b (Figs. 3, 4) of the type section is recognisable also at localities 9 and 5 (Fig. 1) and resembles parts of quartz-muscovite schists west of Cronje Dam. Grey or pink rhyolite, partly fragmental and similar to units a and g, is present at localities 6, 7, 8 and 11.

AGE DETERMINATION

Three rhyolites from near Division Dam (P233/70, P105/73) and Boucauts West Dam (P358/75) were analysed for Rb/Sr by A.W. Webb of Amdel (1976a). Webb reports "The relationship between these analyses when plotted on an isochron diagram is very poor ... However, the samples have fairly high Rb/Sr ratios and errors associated with uncertainties in initial Sr^{87}/Sr^{86} ratios have a relatively small effect on the calculated ages".

Calculated ages for initial Sr^{87}/Sr^{86} ratios of 0.700 and 0.710 range between 507 and 601 million years (Cambrian). Webb (pers. comm.) considers that, if the rocks have remained closed systems with respect to Sr and Rb since their formation, they are unlikely to be older than Cambrian.

The structural relationships between similar volcanics at Mutooroo ridge and Adelaidean sediments suggest that the volcanics are Precambrian (early or pre-Adelaidean). If the Boucaut Volcanics are as old as suggested by this evidence, they must have lost radiogenic Sr^{87} in the early Palaeozoic, presumably during the Delamerian Orogeny.

REGIONAL RELATIONSHIPS

The Boucaut Volcanics of Mutooroo ridge (locality 12) include acid and basic volcanics which are very similar in nearly all aspects to the Boucaut Volcanics in the type section. Suites of specimens from this area have been

examined by Amdel petrologists and regional mapping has been carried out by A.F. Williams and B.G. Forbes (Geological Survey), but the most detailed work has been done by G. Arnold, (1971, see Fig. 1a). The lowermost volcanics are grey and greenish amygdaloidal basalt and andesite interlayered with chloritic schist (Fig. 10). These are overlain by pink and grey partly laminated rhyolites (Figs. 11, 12) which are strongly sheared in places to give quartz-muscovite schist.

The boundary between the volcanics and the folded sequence of conglomerate, phyllite and dolomite rock to the north is partly faulted, but structural relationships and cross bedding indicate that the volcanics underlie the Burra Group sediments. Assuming that these volcanics are in fact Boucaut Volcanics, this casts doubt on the Cambrian age of the Boucaut Volcanics.

Near Cronje Dam (localities 1 to 4, Fig. 1) there are quartz-muscovite schists which have been assigned tentatively by earlier workers to the crystalline basement, the Umberatana Group or the volcanics. In view of the resemblance of some of these rocks to rhyolitic schist of Mutooroo ridge and quartz-muscovite rock of the type section (Figs. 3, 4), they are thought to be a highly deformed part of the Boucaut Volcanics. Immediately west of locality 2, where quartz-muscovite (?rhyolitic) schist is flanked by chloritic schist, there is poorly outcropping schistose tillite.

Minor copper mineralization occurs in grey and greenish schist, localities 2 and 3, and is associated with green, schistose metavolcanics, resembling unit d of the type section, at locality 12 (Mutooroo ridge). Arnold (1971) considers the copper of Mutooroo ridge to be derived from metavolcanics and associated rocks and to have been mobilized during ~~his~~ a second period of metamorphism.

However, if the radiometric age is correct, other volcanic rocks of possibly the same age as the Boucaut Volcanics are the Lower Cambrian Truro Volcanics, which are mainly amygdaloidal green and grey basic volcanics and are interbedded with sedimentary rocks. Sodic rhyolite or dacite of the Keith region (Mawson and Dallwitz, 1944) differs in composition from the Boucaut Volcanics and is of Ordovician age (Webb, 1976b).

PETROLOGY

As a result of regional metamorphism of Delamerian age, the Boucaut Volcanics have been recrystallized and muscovite and biotite have developed in rocks of suitable composition. Evidence from thin sections indicates that some quartz and tourmaline has been introduced. Nevertheless, volcanic features, such as amygdales, phenocrysts, trachytic texture, flow banding and devitrification textures (radial and snowflake texture) have survived in some rocks (Steveson, 1976, 1977).

The pink-grey acid volcanics are rich in potassium feldspar which commonly forms a fine-grained aggregate with quartz. Some rhyolitic rocks contain angular blocks of rhyolite forming a breccia, while others have a streaky lenticular fabric probably indicative of an origin as a welded tuff. Recrystallization appears to have removed evidence of this that may have otherwise been seen in thin sections. Accessory minerals include hematite, tourmaline, rutile, zircon and sphene.

The basaltic and andesitic rocks are commonly amygdaloidal and contain plagioclase with quartz, biotite, chlorite, epidote and opaques. Associated chloritic and biotitic schists may be partly of tuffaceous or sedimentary origin, but some contain compressed remnant amygdales and are metamorphosed lavas. Quartz is commonly the main component of amygdales, but tourmaline, epidote, calcite, and chlorite may also be present.

Three specimens from each of the andesitic and rhyolitic sequences were chosen for chemical analysis (Amdel report AN 1/13/4/0-2509/77). In view of possible metasomatism, the results (Table 1) may only approximate the original composition of the volcanics.

In Figure 2 the six analyses are compared with metavolcanics from the Mutooroo ridge analysed by Arnold (1971): the Division Dam rocks appear to be more alkaline. The rocks near Division Dam are on average more alkaline and more zirconium-rich than the Wooltana Volcanics, or possible equivalents, of the Wooltana, Denison and Roopena areas, but less calcic, less copper-rich and less

strontium-rich than these (personal communication, G.J. Ambrose: collected analyses of Wooltana lavas and possible equivalents).

CONCLUSION

The Boucaut Volcanics are composed of regionally metamorphosed rhyolitic and andesitic rocks with minor metasediments. Their possible Cambrian age, indicated by Rb/Sr analysis, is consistent with their alteration during the Ordovician Delamerian Orogeny. However, structural relationships at Mutooroo ridge suggest a Precambrian, rather than Cambrian age. Unlike known Lower Cambrian volcanic rocks, such as the Truro Volcanics and the volcanics west of Mount Wright, N.S.W. (Packham, 1970), the Boucaut Volcanics are not associated with Cambrian sedimentary rocks. If the Volcanics are of Precambrian age they may be tentatively correlated with the Wooltana Volcanics, but only the andesitic members bear any resemblance to the Wooltana.

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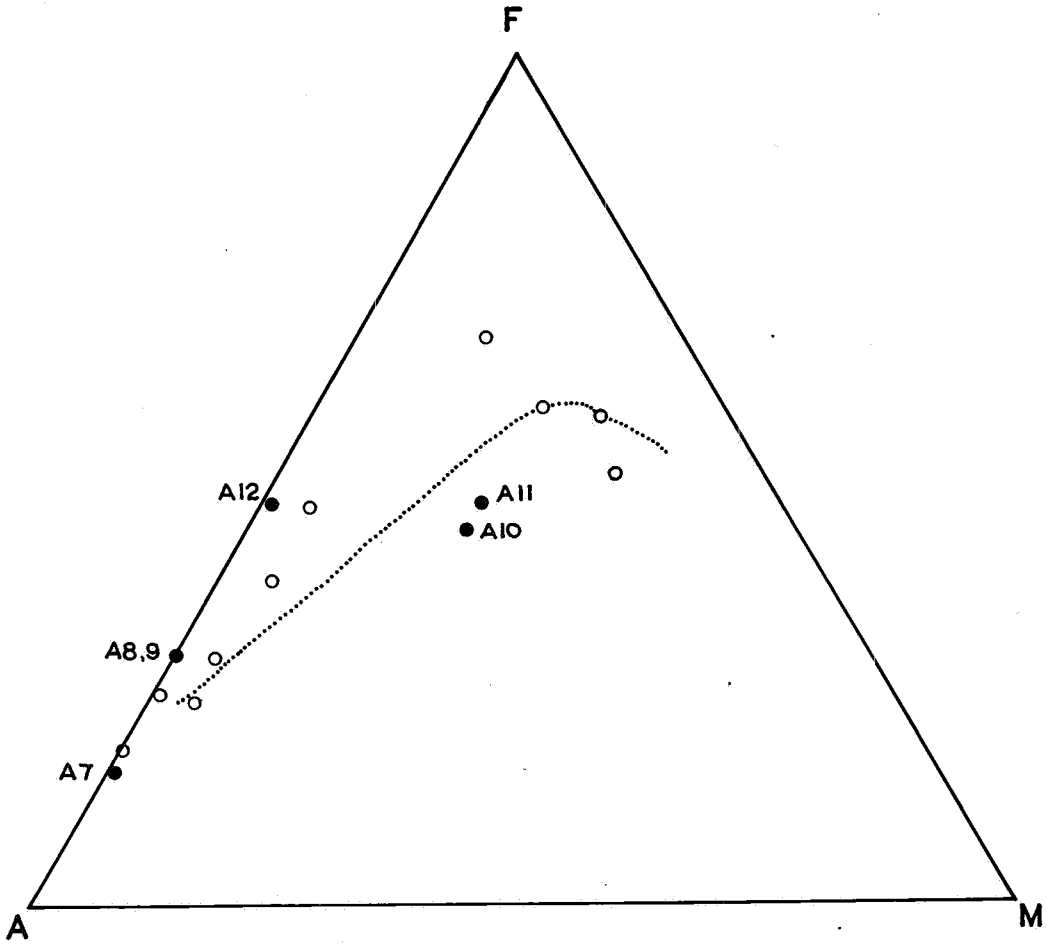
AFM variation diagram,
after Arnold, 1971.



o Mutooroo Ridge specimens (Arnold, 1971).

● Division Dam specimens (values based on computer print-out from systems section, Department of Mines).

A: alkalis F: iron oxides M: magnesia

Dotted line is the "Pigeonite Series" – "Hypersthene Series" boundary from Kuno (1968, fig. 14).

FIG.2

	DEPARTMENT OF MINES – SOUTH AUSTRALIA	SCALE.
COMPILED: B.G.FORBES	AFM VARIATION DIAGRAM OF MUTOOROO RIDGE & DIVISION DAM SPECIMENS	DATE: 27-9-77
DRN: J.W. CKD.		PLAN NUMBER: S13039
REGIONAL SURVEY SECTION		

6933, 7033

TABLE 1: Silicate analyses of Boucaut Volcanics

(by Amdel - mainly X-ray fluorescence techniques)

	A7/77	A8/77	A9/77	A10/77	A11/77	A12/77
SiO_2	75.24	64.10	72.93	55.06	48.91	69.01
TiO_2	.20	1.06	.32	1.76	1.50	.83
Al_2O_3	12.45	14.67	11.59	14.84	16.23	13.24
Fe_2O_3	1.61	5.91	4.30	7.29	9.83	6.98
FeO	.20	.45	.35	3.25	4.60	.60
MnO	.01	.01	.01	.13	.16	.01
MgO	.07	.03	.03	5.14	6.30	.14
CaO	.03	.39	.20	2.50	.93	.56
Na_2O	.15	.62	.32	4.20	4.27	6.64
K_2O	8.11	12.32	9.78	3.06	3.73	.58
P_2O_5	.03	.28	.04	.43	.40	.20
H_2O+	.20	.11	.07	1.40	2.29	.32
H_2O-	.12	.07	.07	.18	.19	.20
Total	98.42	100.02	100.01	99.24	99.34	99.31
P.p.m.						
Rb	120	75	100	50	95	12
Sr	2	16	2	55	18	18
Zr	300	610	660	510	300	540
Cu	30	5	4	3	8	4
Pb	15	10	2	5	7	4

Notes:

A7/77, P456/76, 6932 RS 203; porphyritic rhyolite, Division Dam, unit a.

A8/77, P466/76, 6932 RS 213, dacite, Division Dam, unit c.

A9/77, P467/76, 6932 RS 214; rhyodacite, ? welded tuff, Division Dam, unit f.

A10/77, P460/76, 6932 RS 207; altered andesite, Division Dam, unit d.

A11/77, P603/76, 6932 RS 218; altered basalt, Division Dam, unit d.

A12/77, P605/76, 6932 RS 220; altered dacite, Division Dam unit d.

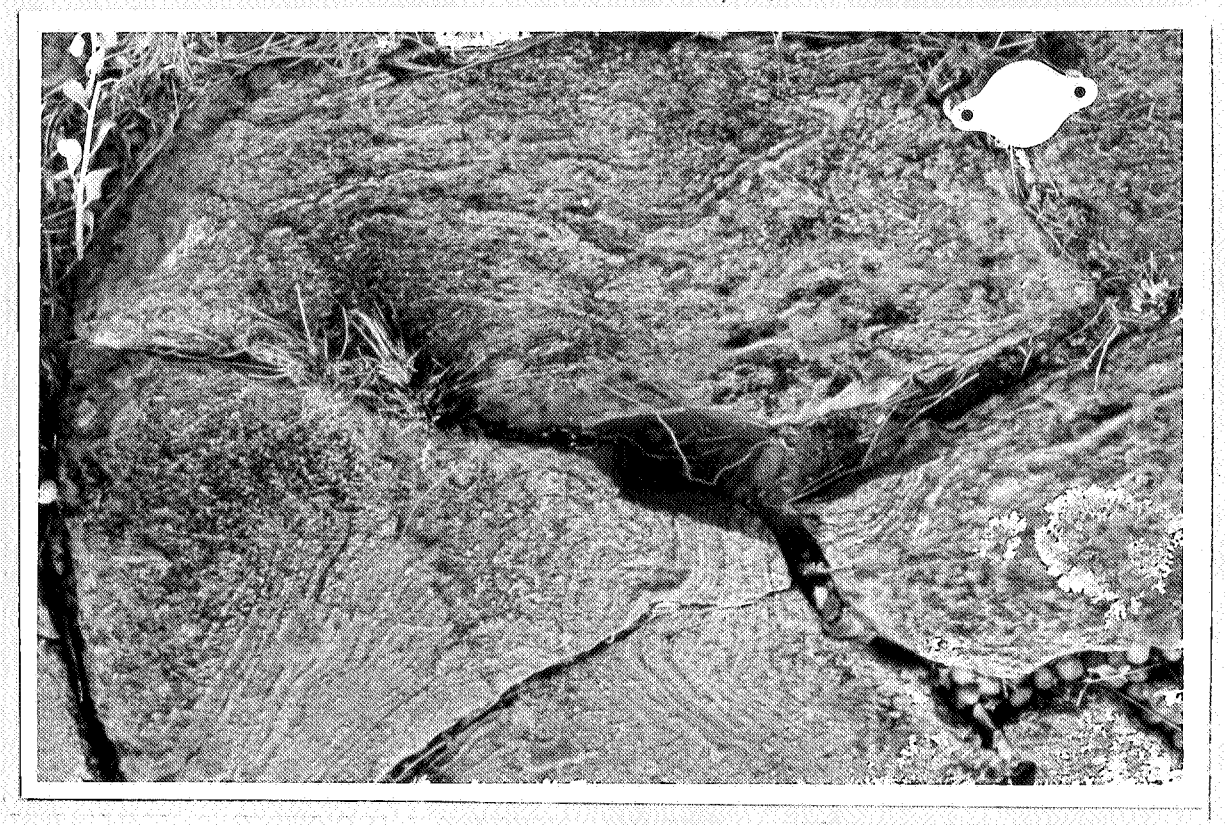


Figure 3 12608

Boucaut Volcanics, type section, unit b, Contorted layering (?flow structure) in quartz-muscovite rock, P457/76 (Hand lens is 50 mm long).

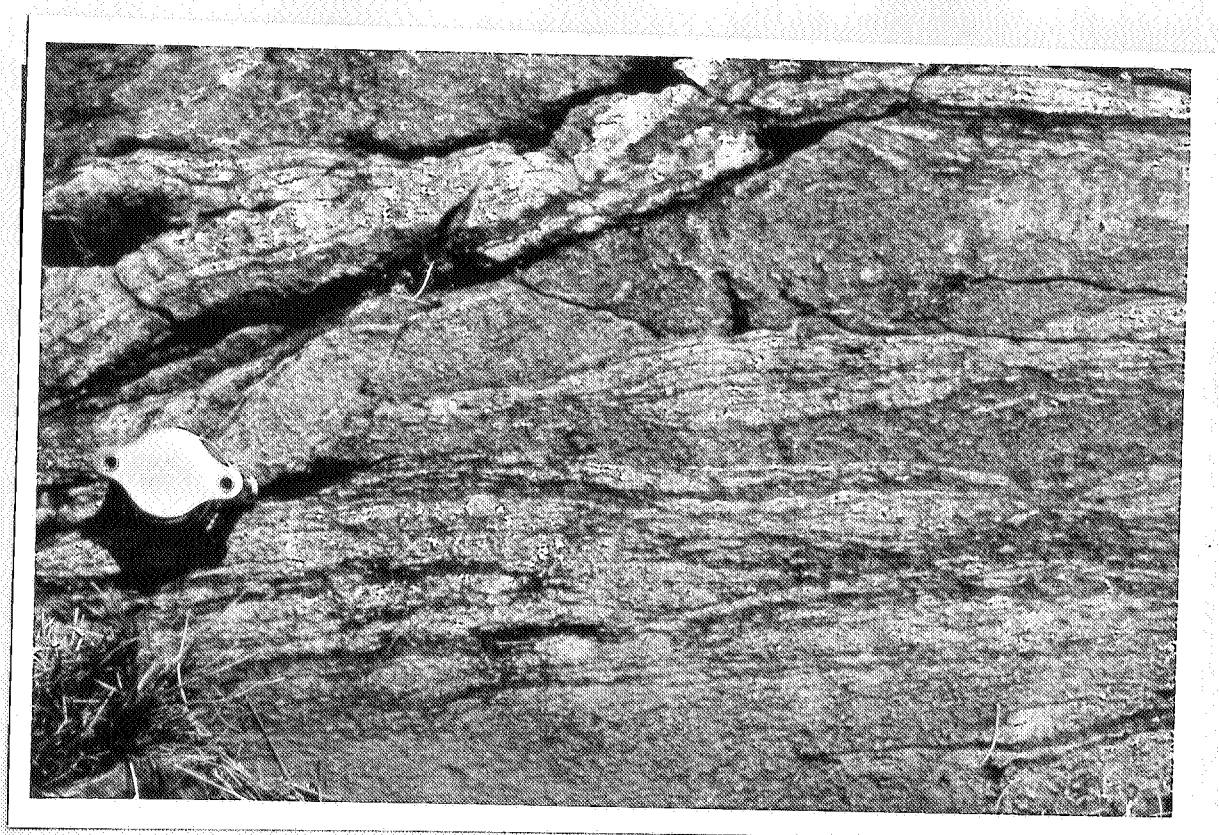


Figure 4 12744

Boucaut Volcanics, type section, unit b. Lenticular layering in quartz-muscovite rock.

Figure 5 12614

- Boucaut Volcanics, type section unit d. Greenish grey amygdaloidal andesite, P460/76, containing plagioclase, biotite and epidote.

Figure 6 12609

Boucaut Volcanics, type section, unit f, Fragmental grey rhyodacite (?welded tuff; P467/76). (Hand lens 22 mm high).

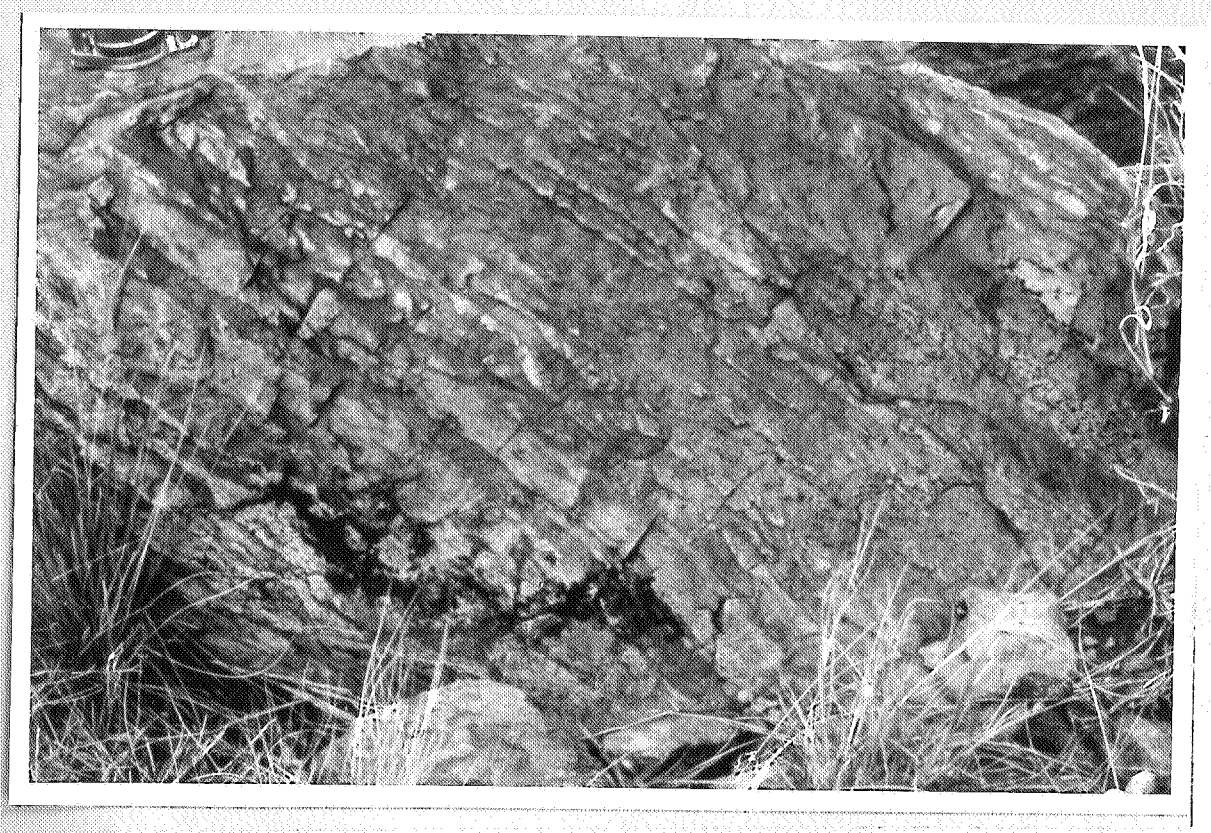


Figure 7 12613

Boucaut Volcanics, type section, unit f. Layering in rhyolite (Hand lens 50 mm long).

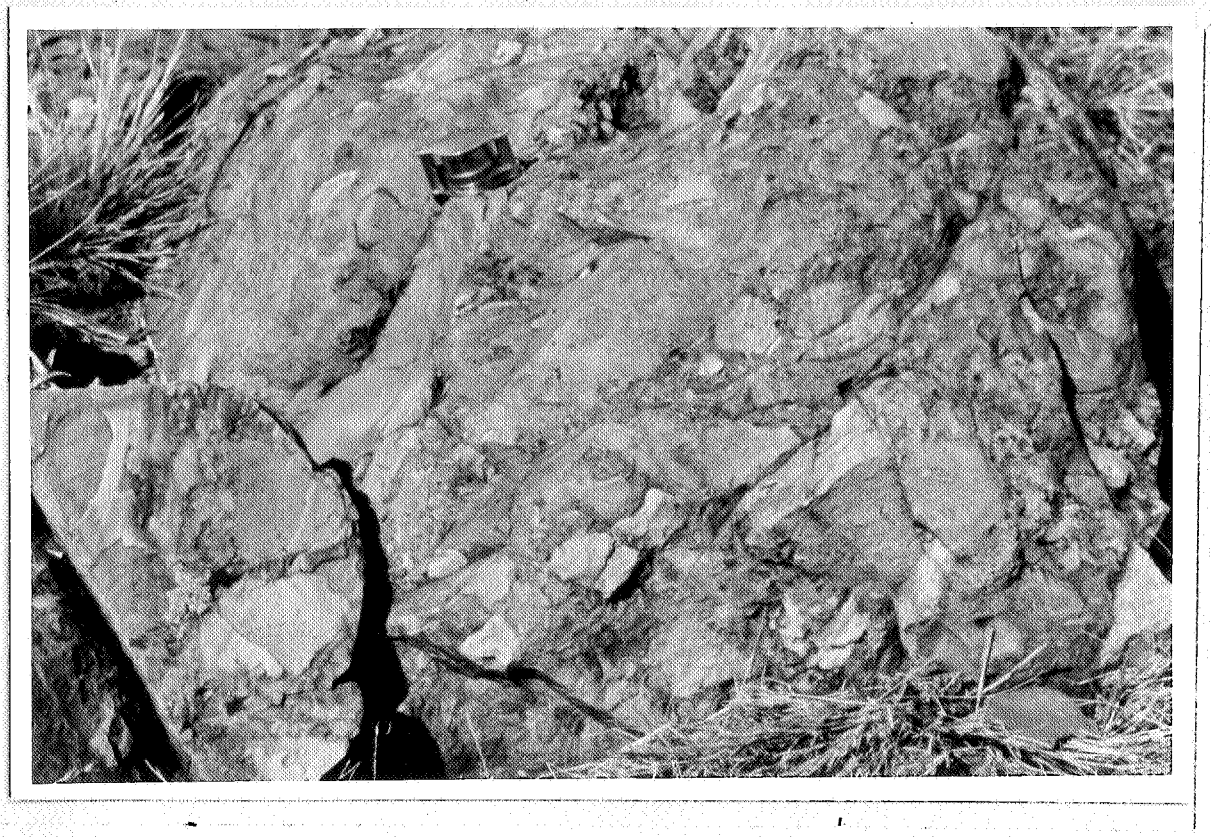


Figure 8 12610

Boucaut Volcanics, type section, unit f. Rhyolitic breccia, P465/76. Blocks up to 50 mm in length are composed of a fine-grained potassium feldspar-rich, porphyritic rock and set in a rhyolitic groundmass.

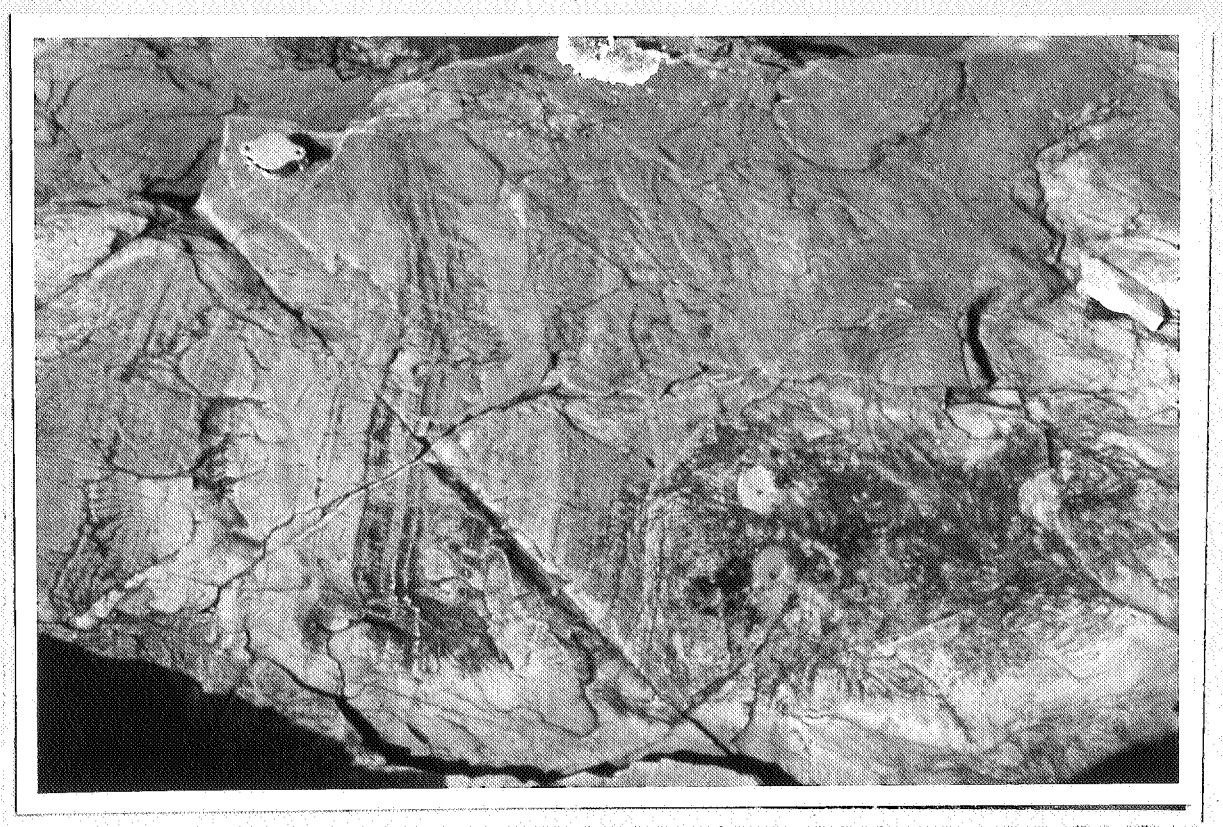


Figure 9 12611

Boucaut Volcanics, type section, unit h, subvertical layering in rhyolitic schist, P469/76 (50% potassium feldspar, 30% quartz, 15% biotite).

Figure 10 12099

Greenish, pebbly, sandy schist in lower volcanic beds, Mutooroo ridge. The rock is stained with malachite and contains pebbles of pegmatite, quartzite, quartz and volcanic rock. P175/76 contains quartz, plagioclase, calcite, chlorite and biotite as its main constituents. (Hand lens is 50 mm wide).

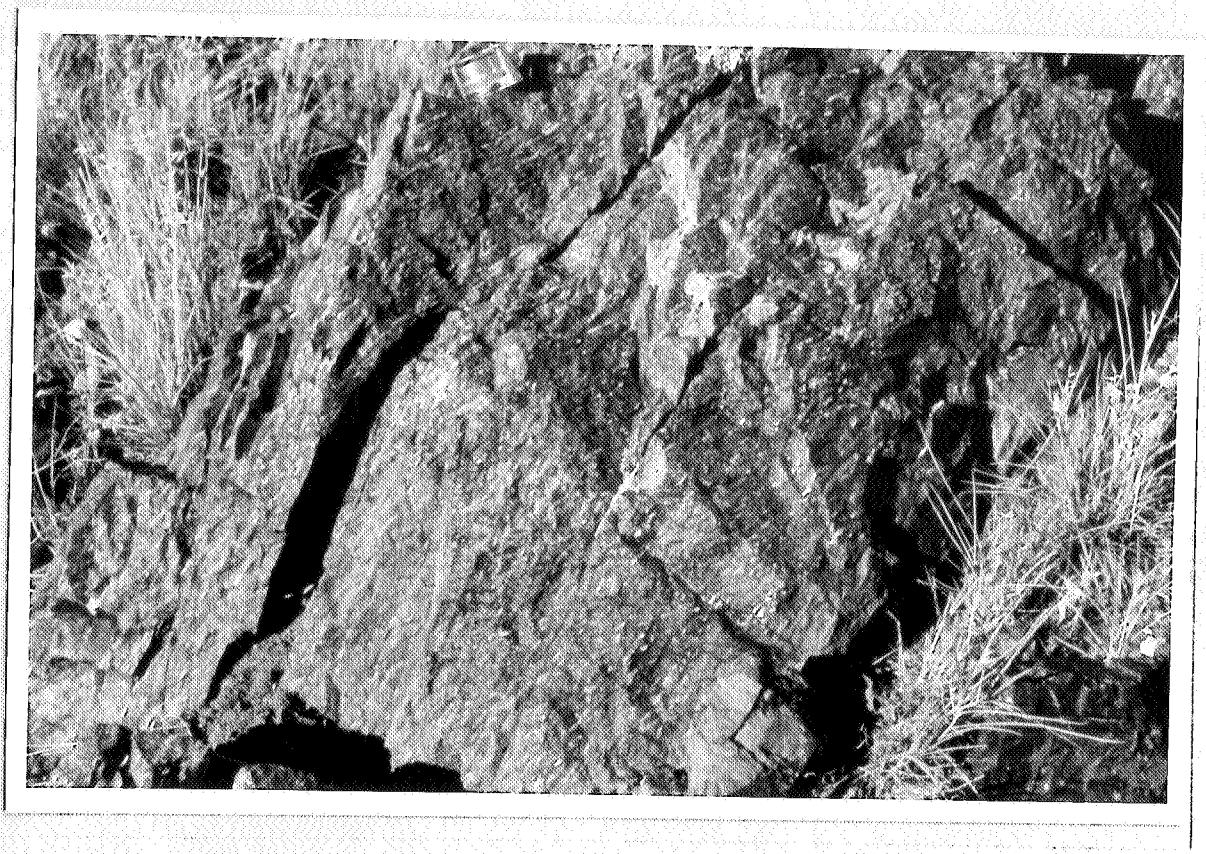


Figure 11 12102

Dark potassic volcanic rock, P179/76, upper volcanic beds, Mutooroo. White flecks are quartz-filled amygdales extended in the schistosity. (Lens is 22 mm high).

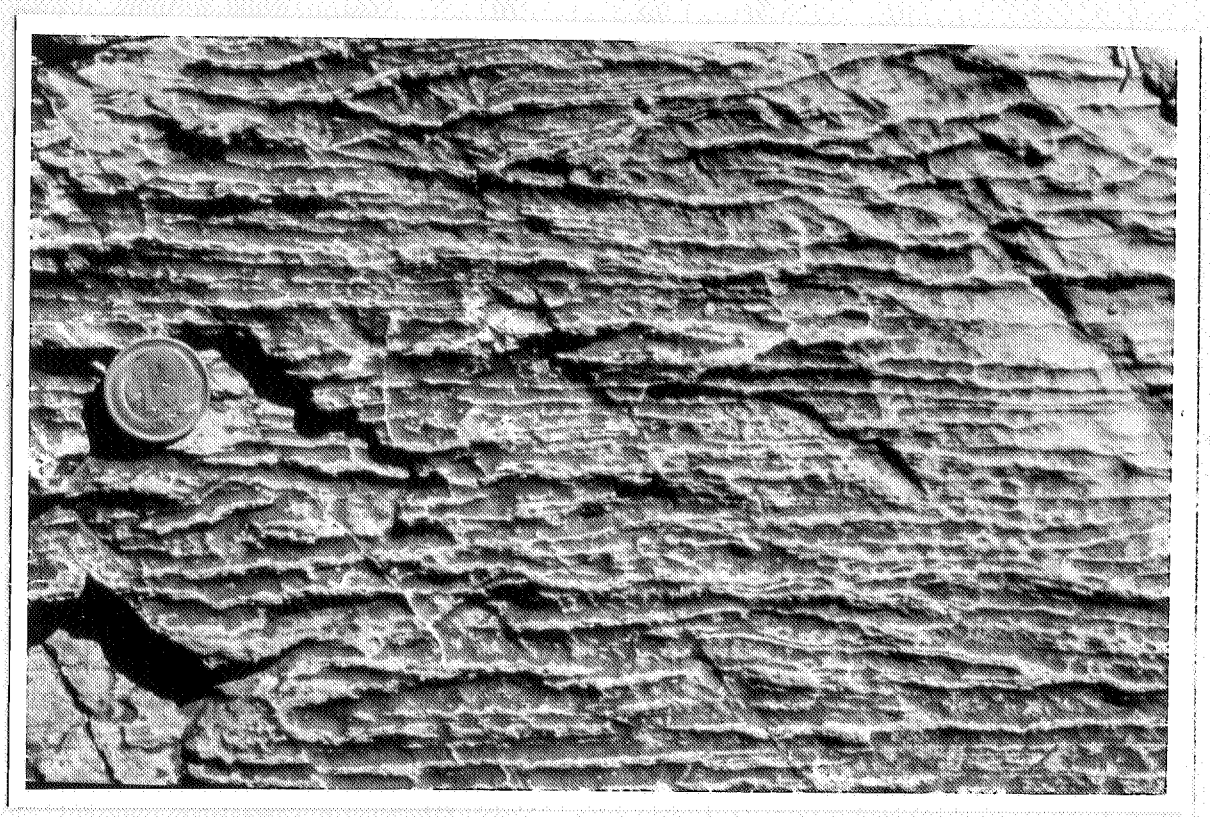


Figure 12

12092

Layering in recrystallized acid volcanic, upper volcanic beds, Mutooroo ridge, P171/76. The paler lines are ridges, possibly richer in quartz. Main constituents are potassium feldspar and quartz. (Coin is 17 mm wide).

Key to some rock specimen numbers

P456/76	6932	RS	203	A7/77
457			204	
458			205	
459			206	
460			207	A10/77
461			208	
462			209	
463			210	
464			211	
465			212	
466			213	A8/77
467			214	A9/77
468			215	
469			216	
P602/76			217	
603			218	A11/77
604			219	
605			220	A12/77
P171/76	7032	RS	001	
172			002	
175			005	
176			006	
177			007	
178			008	
179			009	
180			010	

Appendix: precis for Quarterly Note

The Boucaut Volcanics

Bryan G. Forbes

The suite of volcanic rocks defined here has its type section near Division Dam (Fig.1) in the Anabama 1:100 000 area, eastern South Australia and is named after Boucauts West Dam, 62 km south of Olary (Forbes, 1977). The volcanics form isolated low ridges at the edge of the Murray Basin and were first noted by B.P. Thomson in 1958. They have also been mentioned or described by Asarco (Australia) Pty. Ltd. (Hosking, 1969), A.L. Currie (1970, unpublished Geological Survey mapping), petrologists of Amdel (Simpson, 1970; Whitehead, 1971; Steveson, 1976, 1977), Mine Administration Pty. Ltd., Longreach Metals NL (Edwards, 1971) and B.J. Morris (1973-1977).

The most widely occurring rock-type is a pale pink to grey rhyolite, but green and grey amygdaloidal andesite and basalt are also present. These rocks have suffered more than one phase of deformation and have been metamorphosed to the biotite grade.

Similar volcanic rocks at Mutooroo ridge (locality 12, Fig.1) have been described in detail by G. Arnold (1971, unpublished) and I consider these also to be Boucaut Volcanics.

In the type section described below the continuous variation of rock types and the apparent absence of fold hinges suggests that it is a continuous sequence, but this is uncertain, hence possible thickness is registered as "outcrop width". No evidence of facing was seen. Analytical results are from Amdel (AN 2509/77) and petrology is by Steveson (1976, 1977).
(Type section as in this report).

RELATIONSHIPS

A probable Cambrian age has been assigned the Boucaut Volcancis on the basis of Rb/Sr analysis of three specimens from the type area (Webb, 1976a). However, field relationships of the probable Boucaut Volcanics at Mutooroo ridge suggest an early Adelaidean or pre-Adelaidean age.

Copper mineralisation is associated with schistose volcanic rocks on Mutooroo ridge and near Cronje Dam (locality 12 and 3, Fig. 1). Arnold (1971) suggests the copper at Mutooroo ridge to have been released during the metamorphism of chlorite.

(References, figures, table as in this report).

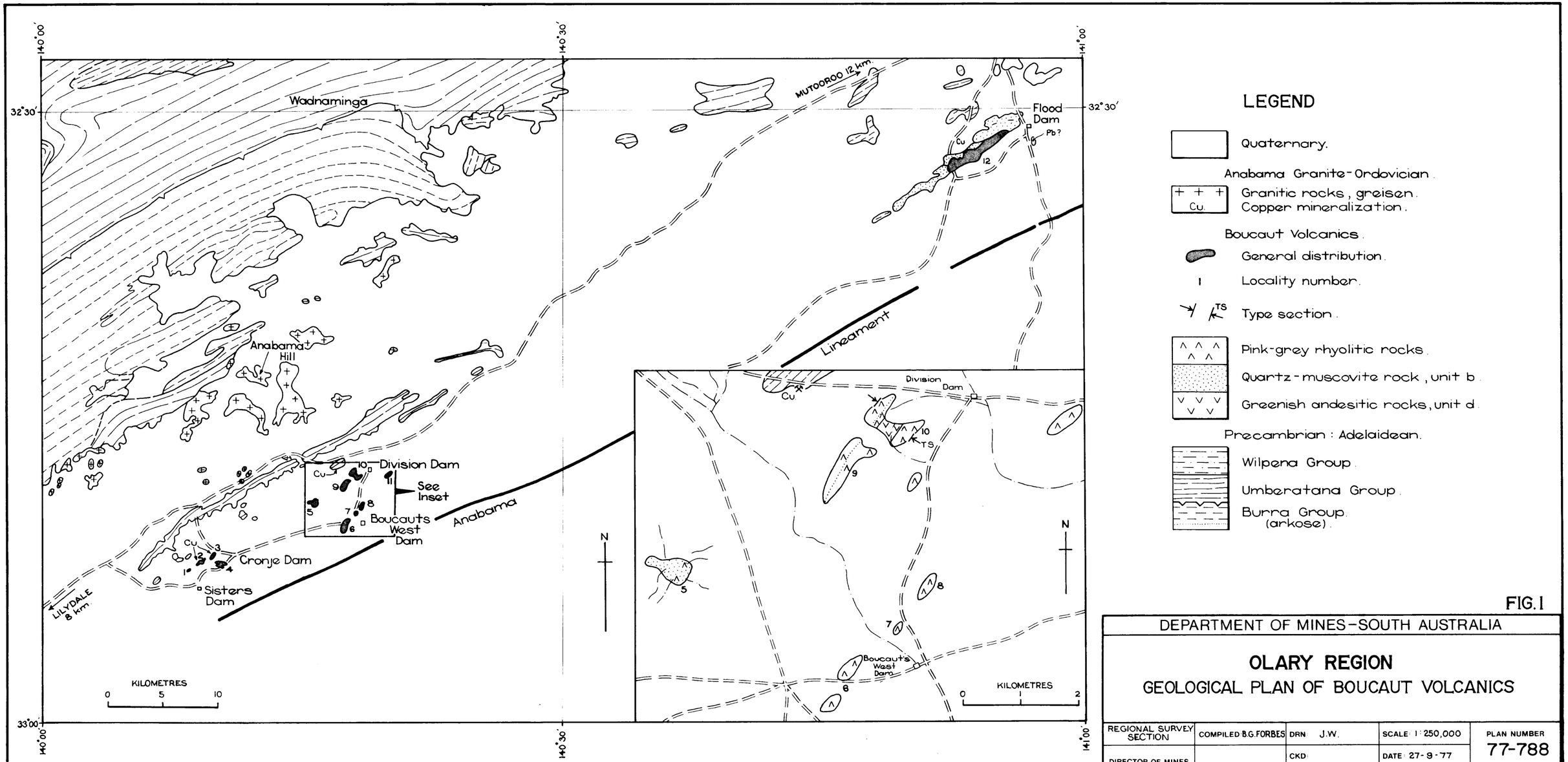


FIG. 1

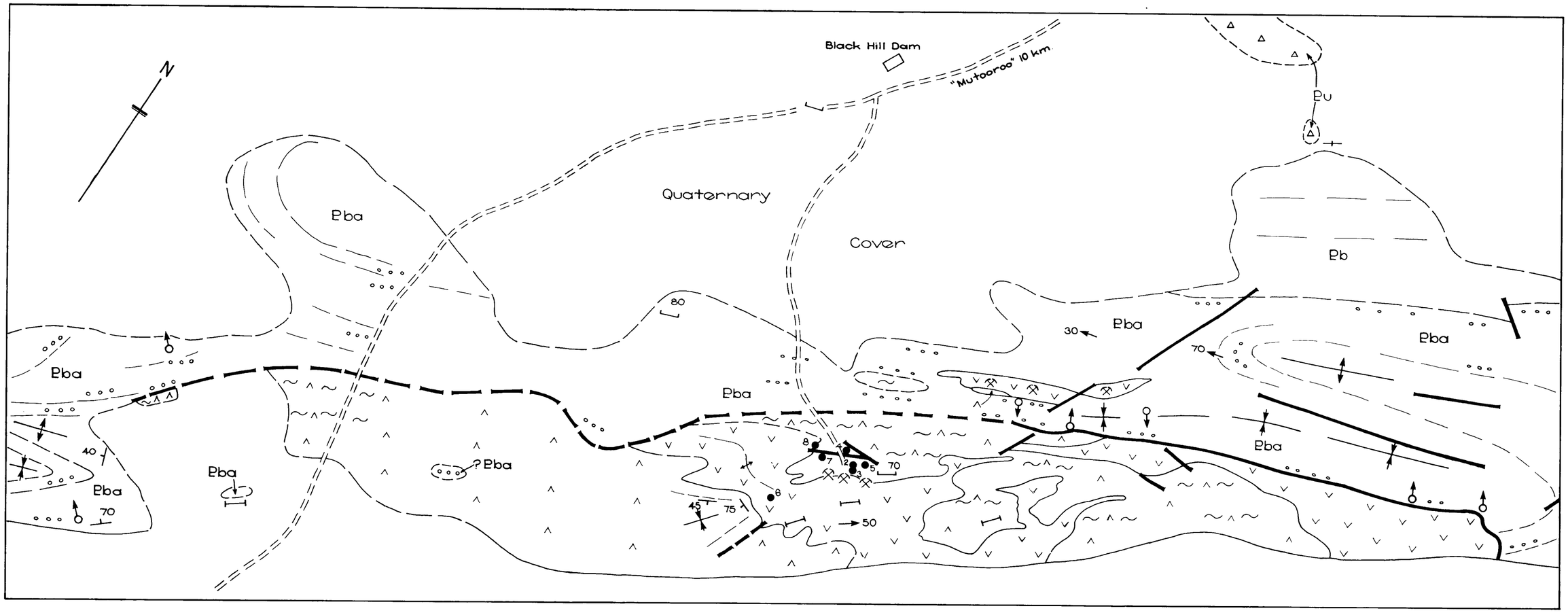
DEPARTMENT OF MINES-SOUTH AUSTRALIA

OLARY REGION

GEOLOGICAL PLAN OF BOUCAUT VOLCANICS

REGIONAL SURVEY SECTION	COMPILED B.G. FORBES	DRN: J.W.	SCALE: 1:250,000	PLAN NUMBER 77-788
DIRECTOR OF MINES		CKD:	DATE: 27-9-77	

6933, 7033.



LEGEND

ADELAIDEAN
UMBERATANA GROUP.
Pu — Pebbly siltstone.

Pb — BURRA GROUP.

Pba — Conglomerate, sandstone siltstone ?Aldgate sandstone equivalent.

BOUCAUT VOLCANICS.
- Rhyolitic schist.
- Rhyolite.
- Basic volcanics, chloritic schist.

- Copper prospecting pits
- Sedimentary facing
- 50 — Plunge of minor fold.
- Anticlinal axis.
- Synclinal axis.
- Schistosity attitude.
- Bedding attitude
- Fault.
- Diamond drill hole Longreach Metals N.L.

Partly after G. Arnold, 1971.

METRES
0 500 1000

FIG. 1a

DEPARTMENT OF MINES - SOUTH AUSTRALIA

MUTOOROO RIDGE AREA

GEOLOGICAL PLAN

REGIONAL SURVEYS SECTION	COMPILED B.G. FORBES	DRN. J.W	SCALE: 1:16,000	PLAN NUMBER 77-787
DIRECTOR OF MINES		CKD	DATE: 27-9-77	

6933, 7033