DEPARTMENT OF MINES AND ENERGY

GEOLOGICAL SURVEY

SOUTH AUSTRALIA

REPORT BOOK 93/16

SOIL AIR CO₂/O₂ PROJECT PROGRESS REPORT V CURNAMONA AREA

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Soil Air CO₂/O₂ Project: Progress Report V Curnamona Area

Dr I G Watmuff and B J Morris

INTRODUCTION

Soil air carbon dioxide (CO₂) and oxygen (O₂) measurements as a guide to oxidising sulphide have been assessed by several researchers and government geological surveys in the United States, Ireland, Africa and Saudi Arabia (Lovell et al, 1983; Hinkle and Dilbert, 1984; Reid and Rasmussen, 1990; Ball et al, 1990 and McCarthy, Jr and Bigelow, 1990). The rationale is that sulphide oxidation in the presence of water and oxygen will produce sulphuric acid which in turn, will attack any carbonates present to produce CO₂. Oxygen is consumed in the process. Both CO₂ and O₂ are easily measured to an acceptable accuracy in the field with portable equipment.

The soil air CO_2/O_2 project is being conducted jointly between Dr I G Watmuff and the South Australian Department of Mines and Energy (SADME). The aim of the project is to test the technique over areas of known mineralisation in a variety of geological and geographical settings. Progress Reports I, II, III and IV detailed testing in the Mount Lofty Ranges (Watmuff, 1992), Moonta District (Watmuff and Morris, 1992a), Mt Gunson area (Watmuff and Morris, 1992b) and Wirrda Well Prospect, Stuart Shelf (Watmuff and Morris, 1992c). This report details trials in the Curnamona area.

The cooperation of Placer Exploration Ltd in

allowing access to mineralised areas is greatly appreciated.

CASE HISTORY

Curnamona Area

Prospecting in the Curnamona area is hampered by transported sandy and clayey sediments a few metres to over 100 m thick. Lead-zinc mineralisation has been sought in the area along what are possibly stratigraphic equivalents of the Broken Hill mineralised sequence. Two prospects, Ram Dam and Hunters Dam, held by Placer Exploration Ltd were tested to see if soil air CO_2/O_2 could define zones of known analysis mineralisation. The prospect localities are shown in Figure 1.

Ram Dam Prospect

Weak stratiform lead and zinc mineralisation has been found within the steeply dipping Bimba suite and hanging wall schist of the Early Proterozoic Willyama Supergroup. The Bimba suite is a complex sequence of schist, shale and siltstone with minor calc-silicate. One angled diamond drill hole along grid line 9000N had revealed two thin massive sulphide bands about 0.3m and 0.2m true thickness and comprising mostly pyrrhotite plus a few percent galena and sphalerite. Most of the sulphide mineralisation within the Bimba suite is low grade ($\leq 0.5\%$ zinc and lead sulphide) occurring in zones up to 16m wide.

The terrain is very flat with little vegetation. Most soil gas samples were taken under bare ground. A transported cover of clays and gravels about 15m thick rests on weathered bedrock. Oxidation extends 65 to 90 m below the ground surface.

Four soil gas traverses were made along grid lines 8400N, 8800N, 9000N and 9200N (Fig 1). The results are tabulated in Appendix A. No soil air CO_2/O_2 anomaly was detected and the CO_2 elevations and O_2 deficits were very low ($\leq 0.1\%$). One relatively high CO_2 value on line 9000N is probably due to drill site contamination.

The lack of positive response is probably related to the very weak character of the mineralisation. Also, clay layers within the transported cover may be acting as relatively impervious barriers to gas migration from depth. Below 20-30 cm, probe penetration became very difficult apparently due to a hard clayey horizon.

Hunters Dam Prospect

The Bimba suite has been traced from the Ram Dam prospect over 30 km to the northeast in the region of Hunters Dam where it strikes parallel to a portion of Mingary Creek and dips 70° or steeper to the northwest. The Bimba trend appears to control the direction of the creek channel and a tributary over a distance of 8 km. Cover thickness is generally 3 to 4 times greater here than at Ram Dam prospect and palaeochannels cut deeply into the weathered basement to at least 125m below the surface. These channels contain layers of coarse sand which carry water and in some cases, apparently secondary pyrite.

Soil air CO_2/O_2 measurements were taken along grid lines 3000N, 3200N and 4400 N across the mineralised Bimba suite. The data are tabulated in Appendix B.

Line 3000N (Fig. 2) crosses a zone of substantial sulphide in the Bimba suite between 15750E and 15900E (Fig. 2). Rotary drill holes HD 119, 131, 136 and 176 contain significant pyrite in fresh basement and diamond drill hole HDD02 intersected 2-5% pyrrhotite plus minor pyrite and sphalerite in Bimba suite shale beneath drill holes

HD 131, 136 and 176. Depth to basement is 85 to 125 m and much of the transported clay and sand cover is palaeochannel fill, including two major layers of water-bearing coarse sand. The lower sand unit carries 5-10% pyrite. Depth of oxidation is 85 to 100m and may coincide with the upper channel sand unit.

A CO₂ anomaly peak was detected at about 15,900E (Fig. 2). The oxygen deficit gives a less clear signal in the same area. The traverse was repeated 15 m north to see if the CO₂ anomaly peak could be A slightly displaced peak was duplicated. obtained, but in the same position with respect to the Mingary Creek channel (Fig. 2). The anomalous response is rendered ambiguous by the occurrence of dense vegetation along the creek channel margins (see Appendix B for detailed description) and since there is no evidence of oxidising sulphide at depth, it is considered likely that the peak relates to relatively high levels of biogenic soil CO₂ associated with this vegetation zone.

Line 3200N traverses weakly pyritic rock in basement east of about 15800E. The cover of transported clays and sands is about 45m thick and weathering extends a similar distance into bedrock (Fig. 3). Sulphides may occur in the weathered zone as observed in HD 73 between 68 and 70 m.

Soil air measurements along 3200N also detected a broad zone of relatively high CO_2 values, up to 0.27%, adjacent to the Mingary Creek channel (Fig. 3). This zone does not necessarily correlate with high vegetation density and, compared to line 3000N, extends further from the creek channel to the east and beyond the obvious limit of the flood plain. The oxygen deficit is low and is considered unlikely to be related to the higher CO_2 levels. No sulphide was observed in the rotary drill holes beneath the zone. Apparently identical terrain on line 3000N gave much lower CO_2 readings ($\leq 0.12\%$). The cause of these elevated CO_2 levels is therefore unclear.

No definite anomalous response was detected over the sulphide-bearing zone east of 15800E.

Along line 4400N the transported clay/sand cover is 60 to 70m thick. The bedrock below is weathered for a further 25 to 40 m (Fig. 3). Although $\geq 1\%$ sulphide was intersected by deep diamond drilling

between 15780E and 15820E, over 180 m below the surface, no sulphide or iron oxide after sulphide was recognised in any of the rotary drill holes.

No anomalous soil air CO_2/O_2 levels were detected along line 4400N.

CONCLUSIONS

The lack of a clear anomalous soil air CO_2/O_2 response in the Ram Dam and Hunters Dam areas may reflect either the weak nature of the mineralisation coupled with the considerable depth of oxidation (eg. Ram Dam and line 3200N at Hunters Dam) or the absence of oxidising sulphide within or at the base of oxidation (eg. Hunters Dam lines 3000N and 4400N). Also the thick clayey cover may be reducing any near-surface CO_2 flux to insignificant levels. Sampling of gas from capped bedrock drill holes may prove more useful than soil air sampling in these areas and could be contemplated later when soil moisture levels reach something like the permanent wilting point.

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APPENDIX A

SOIL AIR CO₂/O₂ DATA

RAM DAM PROSPECT

Soil air CO2/O2 data, Ram Dam prospect, Curnamona 1:250,000 sheet, S.A.

Coordinates	CO 2%	02%	Depth(cm)	Comments
8400N,8380E	0.05	20.8	75	Bare ground.
90	0.08	20.8	11	" •
8400	0.08	20.8	ά.	"•
10	0.06	20.8	11	"•
20	0.05	20.8	et	"
30	0.06	20.8	11	"•
40	0.04	20.8	68	n .
50	0.02	20.8	75	".
60	0.05	20.8	0	u .
70	0.09	20.8	u	" . Sparse blue bush to 0.5m high.
80	0.06	20.85	¥1	"•
90	0.04	20.9	11	" . Sparse salt bush to 0.3m high.
8500	0.06	20.75	11	и "
10	0.05	20.8	11	• 11.
20	0.06	20.8	11	
8530E	0.06	20.75	17	".
8800N,8380E	0.06	20.8	75	Bare ground6m from stand of mulga.
90	0.09	20.8	11	" . 4m from above stand of mulga.
8400	0.06	20.8	.	" . 1.5m from 0.5m high blue bush.
10	0.11	20.8	Ħ	" . Sparse blue bush to 0.3m high.
20	0.03	20.8	11	11
30	0.05	20.8	Ħ	17
40	0.05	20.8	11	".
50	0.04	20.8	11	и <u>.</u>
60	0.04	20.8	11	IT .
70	0.04	20.8	.11	H .
80	0.05	20.8	81	II
90 a s	0.09	20.8	11	10% new blue bush germ. to 6cm high.
8500	0.08	20.8		Bare ground. Drainage.
10	0.05	20.8	77	. ч.
20	0.04	20.8	11	".
8530E	0.04	20.8	ÌŦ	1 ¹ •

Traverse lines 8400N and 8800N.

Atmospheric oxygen = 20.9%

23-9-92

Soil air CO2/O2 data, Ram Dam prospect, Curnamona 1:250,000 sheet, S.A.

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Traverse line 9000N.

-----CO % Depth(om) 0,% Coordinates Comments 9000N,8250E 0.03 20.8 75 Bare ground. 60 0.03 20.8 11 11 70 0.03 20.85 11 11 0.03 80 20.9 IJ 90 0.03 20.9 11 8300 0.03 20.8 11 10 0.03 20.9 91 20 0.03. 20.8 ŤŤ 0.04 30 20.8 11 40 0.04 20.8 11 50 0.04 20.8 11 60 0.04 20.8 11 70 0.04 20.8 11 80 0.04 20.8 11 90 0.04 20.8 11 8400 0.04 20.8 12 10 0.05 20.8 11 20 0.03 20.9 11 30 0.03 20.85 11 40 0.03 20.8 11 50 0.04 20.9 ŧŧ 60 0.04 20.8 11 70 0.04 20.85 Ħ 80 0.03 20.8 11 90 0.03 20.8 11 8500 0.04 20.8 11 10 0.06 20.8 11 11 0.08 20 20.8 11 5% green oover in drainage bed. 30 0.05 20.8 11 Bare ground. 40 0.03 20.9 11 IJ 50 0.04 20.8 11 11 8560E 0.06 20.8 11 **1**7

Atmospherio oxygen = 20.9%

Soil air CO2/O2 data, Ram Dam prospect, Curnamona 1:250,000 sheet, S.A.

9000N,8570E 0.04 20.9 75 Bare ground. 80 0.04 20.8 " ". 90 0.07 20.9 " ". 8600 0.05 20.9 " ".	•
80 0.04 20.8 " ". 90 0.07 20.9 " ". 8600 0.05 20.9 " ".	
90 0.07 20.9 " ". 8600 0.05 20.9 " ".	
8600 0.05 20.9 "	
10 0.06 20.8 " ".	
20 0.17 20.8 " ". Underneath dr	cill cuttings.
Diesel spills	nearby.
30 0.06 20.8 " Bare ground.	
40 0.05 20.8 " ".	
50 0.04 20.85 " ".	
60 0.05 20.9 " ".	
70 0.06 20.8 " ".	
8 0 0.05 20.9 " ".	
90 0.05 20.9 " ".	
8700E 0.06 20.9 " ".	
9200N,8350E 0.04 20.9 75 Bare ground.	
60 0.03 20.9 " ".	
70 0.05 20.8 " ".	
80 0.04 20.9 " ".	•
90 0.04 20.9 " ".	
8400 0.05 20.8 " ".	· · · · ·
10 0.05 20.8 " ".	
20 0.05 20.8 " ".	
30 0.04 20.8 " ".	· .
40 0.04 20.8 " ".	
50 0.04 20.8 " ".	
60 0.03 20.9 " ".	
70 0.04 20.9 " •	
80 0.04 20.9 ".	
90 0.05 20.9 " ".	•
8500E 0.04 20.9 " ".	

Traverse lines 9000N and 9200N.

Atmospheric oxygen = 20.9%

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APPENDIX B

SOIL AIR CO₂/O₂ DATA

HUNTERS DAM PROSPECT

Soil air CO2/O2 data, Hunters Dam prospect, Curnamona 1:250,000 sheet, S.A.

Traverse line 3000N

23,25-9-92

Coord	inates	CO 2%	02%	Depth(cm)	Comments
,	15750E	0.07	20.8	65	<0.5% Burr clover to lcm high.
	65	0.07	20.8	75	11 •
	75	009	20.7	65	n .
	85	0.13	20.7	70	и <u>.</u>
	95	0.10	20.8	70	¹¹ •
	800	0.14	20.7	75	¹¹ •
	05	0.13	20.7	75	" •
	10	0.13	20.8	68	11 .
	15	0.12	20.5	75	" +broadleaf to 2cm high.
	20	0.14	20.65	75	" burr clover to 1cm high.
	30	0.21	20.7	11	2% " .+turnip to 3cm high.
	40	0.18	20.65	11	2% " + " 5cm " •
144	50	0.13	20.8	11	2% " + " 2cm " •
	60	0.15	20.6	11	0.5%",+bdlf to lcm. Salt b 1.2m/3m.
	70	0.21	20.6	**	1% burr clover+ bdlf to 2cm high.
	80	0.22	20.6	11	1% bdlf to 8cm high. Creek bed
	90	0.57	20.55	**	2% burr clover to lcm. Creek bank.
	900	0.40	20.5	11	2% " + vetch to 6cm. Euc t 5m/7m.
	10	0.34	20.5	11	1% burr clover to lcm. Salt b $1.2m/3m$
	20	0.09	20.7	65	1% burr clover to 1cm high.
	30	0.06	20.7	75	2% " .
	40	0.06	20.8	75	2% "•
	50	0.07	20.8	70	1% " •
	60	0.08	20.7	68	Bare ground.
	70	0.08	20.7	75	2% burr clover to 2cm high.
	80	0.11	20.6	.11	10% bdlf to 8cm high.
	90	0.06	20.75		Bare ground.
	16000	0.09	20•9	11	11 . •
	10	0.12	20.9	11	" . Sparse blue+salt bush to 0.3m.
	20	0.11	20.8		11 • 17 •
	16030E	0.12	20.8	89	H . H .

Abbreviations: bdlf (broadleaf), b (bush), t (tree), Euc (eucalypt),

1.2m/3m (1.2m high bush/ 3m from sample site).

Atmospheric oxygen = 20.9%

Soil air CO₂ O₂ data, Hunters Dam prospect, Curnamona 1:250,000 sheet, S.A.

Traverse line	es 30001	N and 30	D1 5N •	23,25-9-92		
Coordinates	co ₂ %	02%	Depth(cm)	Comments		
3000N,			n, da n,	23-9-92		
16040E	0.11	20.8	75	2% broadleaf cover to 8cm high.		
50	0.09	20.8	11	Bare ground. Mulga t 4m/4m.		
60	0.11	20.8		2% bdlf to 6cm. Sparse blue b to 0.3m.		
70	0.09	20.8	81	Bare ground.		
80	0.09	20.8	8.0	1% bdlf+new blue b to 6cm high.		
				Sparse blue bush to 0.3m high.		
90	0.09	20.8	68	As above.		
16100E	0.10	20.7	50	Bare ground. Sparse blue&salt b to 0.5m.		
3015N,				25–9–92		
15825E	0.19	20.7	75	<0.5% burr clover+turnip to 2cm high.		
34	0.07	20.8	68	<0.5% burr clover+vetch to 1cm & 6cm.		
44	0.19	20.7	75	1% burr clover+turnip to 3cm, vetch		
		-		to 6cm. Salt b lm/2m.		
53	0.24	20•4	65	Shallow sand on hard creek bottom.		
63	0.53	20.3	75	Hard creek bottom. 0.5% vetch.		
				Eucalypt 6m/10m.		
73	0.47	20.3	ŧ	2% bdlf+burr clover to 3cm.Salt b lm/3m.		
82	0.32	20.25	11	1% bdlf+burr clover. Salt, 1.2m/3.5m.		
92	0.19	20.7	11	Bare ground.		
902	0.21	20.4	11	1% bdlf+burr clover. Salt b lm/2m.		
11	0.06	20.7	65	1% bdlf+burr clover.		
21	0.08	20.8	68	II .		
31	0.11	20.6	75	Bare ground with veneer of drill cuttings.		

1% bdlf+burr clover.

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Abbreviations: bdlf (broadleaf), b (bush), t (tree), 6m/10m (6m high tree/ 10m distance between sample and tree butt).

Atmospheric oxygen = 20.9%.

0.08

0.06

20.8

20.8

11

**

40

15950E

Soil air CO2/O2 data, Hunters Dam prospect, Curnamona 1:250,000 sheet, S.A.

Traverse line 3200N.

26-9-92

 t^{\dagger}

Coordinates	co ₂ %	0 ₂ %	Depth(cm)	Comments
3200N,				
15710E	0.26	20.7	75	<0.5% bdlf+burr clover to lcm.
				Salt bush 1.2m/3m, 1.2m/6m.
20	ð . 27	20.7	11	<0.5% bdlf+burr clover to lcm.
30	0.25	20.6	11	" •
40	0.24	20.6	17	11 .e
50	0.21	20.65	65	2% " to 2cm. Salt b 0.75m/2m,1.5m/4m.
60	0.13	20.7	75	0.5% " .
70	0.13	20.6	11	2% bdlf+turnip+new blue b+burr clover
				to 4cm high.
80	0.09	20•7	*1	∠0.5% bdlf+burr clover to 6cm.
90	0.10	20.8	70	1% grass+bdlf+new blue b. Sparse blue
×**				bush to 0.2m high.
800	0.09	20.75	70	<0.5% grass+bdlf+new blue b to 6cm.
				Sparse blue bush to 0.25m high.
20	0.07	20.8	75	5% broadleaf+grass to 6cm high.
40	0.13	20.8	*1	1% bdlf+other+new blue b to 6cm high.
				Sparse salt b to 0.3m high.
60	0.13	20•7	75	1% bdlf+burr clover to 6cm. Mulga 5m/5m
				Sparse blue, salt b to 0.3m high.
80	0.10	20.7	75	1% bdlf+burr clover to 6cm high.
				Sparse blue, salt b to 0.3m high.
15900E	0.13	20.8	75	trace grass+onion weed to 5cm high.
				Mulga (mostly dead) 6m/5m.

Abbreviations: bdlf (broadleaf), b (bush), 5m/5m (5m high tree/5m from butt to sample site).

Atmospheric oxygen = 20.9%.

Soil air CO2/O2 data, Hunters Dam prospect, Curnamona 1:250,000 sheet, S.A.

Supplementary samples

25,26-9-92

Coordinates	co ₂ %	0 ₂ % D	epth(cm)	Comments
3195N,	0.27	20.7	75	5% broadleaf. Salt bush $1.2m/2-3m$
3220N,	0.21	20.		
15700E	0.23	20.7	70	1% broadleaf.
3200N, 15670E	• 0.25	20.7	75	5m from creek. Salt bush 1.2m high.
3213N, 15720E	0.21	20.5	75	1% broadleaf cover.
3220N , 15735E	0.17	20.75	75	1% " .
3225N , 15690E	0.23	20.5	75	1% " •
3200N , 15890E	0.12	20.7	75	
3400N , 15900E	0.08	20.6	75	1 Acts
3400N , 15880E	0.08	20.65	75	
3000N, 15950E	0.09	20.8	75	Repeat
3000N, 15940E	0.08	20.8	75	Repeat
Atmospheric	oxygen :	= 20.9%		

Soil air CO_2/O_2 data, Hunters Dam prospect, Curnamona 1:250,000 sheet, S.A.

Traverse line 4400N

25-9-92

Coordinates	CO 2%	0 ₂ %	Depth(cm)	Comments
15550E	0.06	20.6	70	3% bdlf, new blue b to 6cm high.
60	0.07	20.7	75	5% "•
70	0.07	20.6	75	2% ".
80	0.07	20.7		5% "+burr clover, grass to 6cm high.
80	0.19	20.3	75	く0.5% grass to lOcm high. Drill site.
90	0.08	20.6	75	" " 3cm " .
600	0.08	20.7	60	Bareground.
10	0.08	20.7	75	< 0.5% grass, bdlf, onion weed to 6cm.
20	0.06	20.7	75	Bareground.
30	0.07	20.6	75	1% onion weed, bdlf to 6cm high.
40	0.09	20.5	65	Bare ground.
50	0.11	20.6	75	1% bdlf to 6cm. Sparse blue,salt b to 0.3m.
60	0.08	20.5	55	Bare ground.
70	0.09	20.6	75	20% bdlf, new blue b to 6cm high.
80	0.09	20.6	75	1% new blue b to 6cm.
90)	0.08	20.6	75	5% new blue b to 6cm+ tr grass, bdlf.
700	0.06	20.75	65	Bare ground.
10	0.05	20.7	75	ч. .
20	0.06	20.7	65	и .
30	0.06	20.75	75	5% new blue bush+ tr grass to 6cm.
40	0.08	20.5	75	trace bdlf+grass to 6cm high.
50	0.10	20.7	75	" to 2cm. Sparse salt bush.
60	0.09	20•5	75	5% new blue b+bdlf to 6cm high.
70	0.11	20.5	75	Π.
80	0.04	20.7	75	trace onion weed to 8cm high.
90	0.07	20.6	75	tr new blue b,grass,bdlf, burr clover
				to 2cm high.
800	0.06	20.6	75	Bare ground. Sparse salt bush to $O.3m.$
10	0.06	20.6	75	trace bdlf to 4cm.
. 20	0.09	20.6	75	10% bdlf, new blue bush to 6cm high.
				Sparse salt bush to 0.3m.

Abbreviations: bdlf (broadleaf), b (bush).

Atmospheric oxygen = 20.9%.

Soil air CO_2/O_2 data, Hunters Dam prospect, Curnamona 1:250,000 sheet, S.A.

Traverse line 4400N.

25-9-92

Coordinates	CO ₂ %	0 ₂ %	Depth(cm)	Comments
15830E	0.07	20.7	70	10% bdlf, burr clover to 6cm high.
			- · ·	Sparse salt b to 0.3m.
40	0.08	20.6	75	2% bdlf to 8cm high.Sparse salt b
	*			to 0.3m.
50	0.07	20.6	75	trace bdlf, new blue b to 6cm high.
				Sparse salt bush to $0.3m$ high.
60	0.06	20.7	65	trace grass. Sparse salt b to 0.3m.
70	80,00	20.7	75	Bare ground.
80	0.06	20.7	75	tr bdlf to 3cm. Sparse salt b to 0.3m
90	0.05	20.7	70	Bare ground.
900	0.05	20.7	75	tr bdlf, blue b to 3cm high.
10	0.06	20.6	75	Bare ground. Sparse salt b to 0.25m.
20	0.08	20.5	75	tr bdlf, new blue bush to 4cm high.
30	0.07	20.6	75	5% broadleaf, grass.
40	0.08	20.6	60	tr broadleaf. Sparse salt bush.
50	na	20.7	75	tr new blue bush, broadleaf to 3cm.

Abbreviations: bdlf (broadleaf), b (bush).

Atmospheric oxygen = 20.9%



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SADME 93-174

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TRAVERSES 3200N & 4400N