DEPARTMENT OF MINES AND ENERGY

GEOLOGICAL SURVEY

SOUTH AUSTRALIA

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SOIL AIR $CO_2/0_2$ PROJECT: PROGRESS REPORT VIII WHEAL HUGHES MINE, MOONTA

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DEPARTMENT OF MINES AND ENERGY
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INTRODUCTION

The soil air $C0_2$/0_2 project is being conducted jointly between Dr I G Watmuff and the Department of Mines and Energy, South Australia (MESA). The aim of the project is to test the technique over areas of known mineralization in a variety of geological and geographical settings. Progress Reports I-VII detailed testing in the Mount Lofty Ranges (Watmuff, 1992a), Moonta District (Watmuff and Morris, 1992a), Mt Gunson area (Watmuff and Morris, 1992b), Wirrda Well Prospect, Stuart Shelf (Watmuff and Morris, 1992c), Curnamona area (Watmuff and Morris, 1993a), Olary area (Watmuff and Morris, 1993b) and Menninnie Dam Prospect (Watmuff and Morris, 1993c).

Soil air carbon dioxide and oxygen measurements were made around the south-western end of Wheal Hughes mine pit to try to determine the true cause of the $C0_2$ and 0_2 anomalies detected over mineralization during the previous 18 months (Watmuff and Morris, 1992a). This examination was prompted by an apparent association between elevated $C0_2$ levels and the occurrence of particularly massive calcrete or deeply disturbed ground, noted during a recent soil air survey of the Moonta district (Watmuff, 1993). The original anomaly at the south-western end of the Wheal Hughes pit coincided with the site of an old railway line and roadway as well as oxidising mineralization at depth.

The cooperation of Moonta Mining NL in allowing access to mineralized areas is greatly appreciated.

METHOD

Samples of air were taken from drill holes, undisturbed and disturbed soil, decomposed rock and the transported overburden using the method described in earlier reports (Lovell et al, 1983; Watmuff and Morris, 1992a). The drill holes (all open to the air) were each capped with a large soil-filled plastic bag 48 hours before sampling. The sampling tube was inserted through this sealing cap to a depth of 1.5 m below surface. Several traverses of soil air measurements were made across the now filled railway cutting to see if a consistent contrast between disturbed and undisturbed soil could be detected (traverses A, B and C, Fig 2). A few soil air samples were also taken from the top of the earth mound (bund) enclosing the pit. Samples of air were taken from the transported overburden and decomposed bedrock in the wall above the mine pit entry ramp. All sample locations are shown in figure 2 and the data are tabled in the appendix.

RESULTS

Pit Wall air

Decomposed Ore Zone Bedrock.

Probe penetration of the decomposed rock wall was difficult and ranged from 30 to about 70 cm. The rock tended to be fractured and it is probable the samples were heavily contaminated with atmospheric air. Carbon dioxide values were only a trace above atmospheric levels, but the oxygen deficits (atmospheric 0_2 - sample 0_2), though small, were much larger than their corresponding $C0_2$ levels (figure 3 and appendix page 1). The two samples clustered near 1990 m east appear to occur in the vicinity of weak oxidised hanging wall mineralization. Minor quartz veining occurs here with abundant fine white gypsum impregnating the weathered wall rock. The quartz tourmaline veining in weathered porphyry at about 2020 m east is probably the up dip extension of the western Wheal Hughes lode. The highest $C0_2$ value of 0.07% was recorded in weathered porphyry in what appears to be a small zone of oxidised footwall mineralization at about 2035 m east.

All samples were taken about 20 m above oxidising sulphide. The absence of plant growth in the pit wall precludes vegetative respiration as a cause of oxygen depletion. A bacterial cause cannot be ruled out however and sulphide oxidation below may also be causing the depleted oxygen values.

Further up the entry ramp and 70 m west of oxidising sulphide, a sample taken at the interface between sandstone channel fill and overlying transported clay, yielded atmospheric $C0_2$ and 0_2 levels only. The channel fill has been deposited in depressions in the sub outcropping Moonta porphyry surface (Watmuff and Morris, 1992a).

Calcrete and Transported Clay Overburden

A 2 to 3 m thick transported overburden of clay rests on weathered bedrock (Watmuff and Morris, 1992a). This is capped by a 1 m thick horizon of calcrete and grey brown calcareous topsoil. Sampling of the wall near the ramp entrance (approximately mine grid 10 100 m north) yielded near atmospheric values for $C0_2$ and 0_2 in the clay, but higher $C0_2$ values were detected in the calcrete horizon above (appendix page 1 and figure 4).

Atmospheric air contamination is suspected here because the clay now exposed in the wall of the entry ramp has dried, producing abundant vertical shrinkage cracks about 1 cm apart. The dried surfaces are smooth and shiny giving the impression the clay has little porosity when wetted sufficiently to close the shrinkage cracks. One air sample could not be drawn at full probe depth (75 cm), apparently due to lack of porosity. However air could be drawn here at a probe depth of 65 cm.

In contrast to the clay, the calcrete has an open structure consisting of loosely packed carbonate nodules the order of 1 cm diameter in a fine grained friable lime matrix. A discontinuous, solid, 20 cm thick layer, of lime-cemented carbonate nodules occurs about 20 cm above the base of the calcrete horizon. Carbon dioxide values above this hard layer were more than the value measured below (figure 4), possibly reflecting higher biological activity and organic carbon levels near surface.

The $C0_2$ and oxygen deficit levels fall as the edge of the entry ramp is approached, probably indicating considerable lateral gas exchange with the atmosphere.

Surface Soil Air

Pit Rim Above Mineralization

Several soil air samples were taken between the pit rim and the bund above mineralization (figure 2). The results are plotted in figure 3 for comparison with pit wall bedrock samples below. The $C0_2$ levels in the soil are an order of magnitude higher than in the pit wall. No anomalous response was detected vertically above mineralization and samples taken nearer the pit rim yielded generally lower $C0_2$ values than those further away. Exceptionally high $C0_2$ values coincided with a railway cutting which had been filled during mine site preparations about three years ago. The fill material appears to be mostly calcrete horizon material previously heaped at the edge of the cutting during its construction.

Bund

A few samples were taken along the top of the bund around the Wheal Hughes pit, both over mineralized and unmineralized bedrock (figure 2). The bund appears to consist of material from the upper 1.5 cm of the soil profile (sandy loam mixed with calcrete). All values were high to very high (appendix page 2). The highest values were obtained where the bund had been recently (2-3 months) extended northwards beyond grid line 10 300 m N.

Traverses A, B and C

The original $C0_2$ anomaly on line 9 960 m north was suspected as being due to the railway cutting fill and adjacent old roadway site immediately west of the railway. Traverses A, B and C (figure 2) crossed railway cutting fill, but no convincing elevation of $C0_2$ values was observed within the fill (figure 5). Traverse B lies only 20 m south of

9 960 m north. Neither the old bitumen road site nor the present dirt track on traverse C, yielded markedly high values (figure 5). Sampling nearby on line 9 900 m north in April 1993 yielded a similar result, but the $C0_2$ values were about 20% less than the October 1993 values.

Drill Hole Air

Unfortunately several of the original surface drill holes are open to the stopes below and these yielded $C0_2$ and 0_2 values near atmospheric levels (figure 6). The highest levels were found in drill holes through railway cutting fill on 9 960 m north and the top of the bund on 9 980 m north (appendix page 4). However, all of these also happen to penetrate oxidising ore.

DISCUSSION

The causal relationship between oxidising sulphide at depth and soil air $C0_2/0_2$ at Wheal Hughes now appears tenuous. None of the traverse data gathered during this sampling programme gave an anomalous response directly over mineralization. The only $C0_2$ anomaly observed vertically above mineralization is on mine grid line 9 960 m north and this also corresponds to railway cutting fill and shallow fill on the flank of the bund immediately west of the railway cutting. There is no unambiguous evidence that the old roadway site running parallel to the railway on its western side is causing the extension of the anomaly west of the railway cutting.

The drill hole air data are ambiguous - the high $C0_2$ values correspond with disturbed near surface ground (bund, railway cutting fill) as well as oxidising sulphide mineralisation below. However, even among the high $C0_2$ values, there is a correlation between the degree of ground disturbance and the $C0_2$ level. The highest values (1.1, 1.85% $C0_2$) occur in the bund which has been raised 2-3 m above the natural ground level -i e the probe tip at 1.5 m below surface is surrounded above and below by disturbed ground. A lower $C0_2$ value (0.68% $C0_2$) was obtained under 1 m of railway fill and the lowest values (0.19 - 0.465 CO_2) occur in drill holes through undisturbed ground.

The relationship between soil air $C0_2$ and disturbed ground is inconsistent. Traverses A, B, C and pit rim all run across railway cutting fill but, elevated $C0_2$ values occurred only on the pit rim traverse. Notably though, all high $C0_2$ values occur in disturbed ground.

The cause of higher $C0_2$ values in disturbed ground is probably a combination of a lack of normal macropore development in the soil structure restricting gas exchange with the atmosphere and incorporated near-surface organic matter undergoing rapid decay.

CONCLUSIONS

Although $C0_2$ generation related to oxidising sulphide at Wheal Hughes cannot be ruled out, the balance of evidence appears to favour near surface causes for the original anomaly response on line 9 960 m N.

REFERENCES

Ball, T K, Crow, M J, Laffoley, N, Piper, D and Ridgway, J, 1990. Application of soil-gas geochemistry to mineral exploration in Africa. *In*: S E Kesler (Ed) Soil and Rock gas Geochemistry. J. Geochem. Explore, 38:103-115.

Beeson, R, 1990. The Geochemical environment of the Wilcherry Hill Base Metal Mineralization, South Australia. Mineralium Deposita 25:179-189.

Fridman, A I, 1990. Application of Naturally Occurring Gases As Geochemical Pathfinders in Prospecting for endogenetic Deposits. *In*: S E Kesler (Ed), Soil and Rock Gas Geochemistry. J Geochemical. Exploration, 38:1-11.

Lovell, J S, Hale, M and Webb, J S, 1983. Soil air carbon dioxide and oxygen measurements as a guide to concealed mineralization in semi-arid and arid regions. *In*: G R Parslow (Ed), Geochemical Exploration 1982. J Geochem. Explore, 19:305-317.

McCarthy, Jr. J H and Bigelow, R C, 1990. Multiple gas analyses using a mobile spectrometer. *In*: S E Kesler (Ed), Soil and Rock Gas Geochemistry. J Geochem. Explore, 38:233-245.

Reid, A R and Rasmussen, J D, 1990. The use of soil-gas $C0_2$ in the exploration for sulphide-bearing breccia pipes in northern Arizona. *In*: S E Kesler (Ed), Soil and Rock Gas Geochemistry. J Geochem. Explore, 38:87-101.

Hinkle, M E and Dilbert, G A, 1984. Gases and trace elements in soils at the North Silver Bell deposit, Pima County, Arizona. J Geochem. Explore, 20:323-336.

Watmuff, I G, 1992. Soil Air $C0_2/0_2$ Project, Progress Report I, Mount Lofty Ranges. *South Australian Department of Mines and Energy Report* 92/50 (unpubl).

Watmuff, I G, 1993. Soil Air $C0_2/0_2$ Survey: EL 1753, Moonta District, South Australia. April/May 1993 (unpublished company report).

Watmuff, I G and Morris, B J, 1992a. Soil Air $C0_2/0_2$ Project, Progress Report II, Moonta District. *South Australian Department of Mines and Energy Report* 92/60 (unpubl).

Watmuff, I G and Morris, B J, 1992b. Soil Air $C0_2/0_2$ Project, Progress Report III, Mt Gunson Area. *South Australian Department of Mines and Energy Report* 92/61 (unpubl).

Watmuff, I G and Morris, B J, 1992c. Soil Air $C0_2/0_2$ Project, Progress Report IV, Wirrda Well Prospect Stuart Shelf. *South Australian Department of Mines and Energy Report* 92/73 (unpubl).

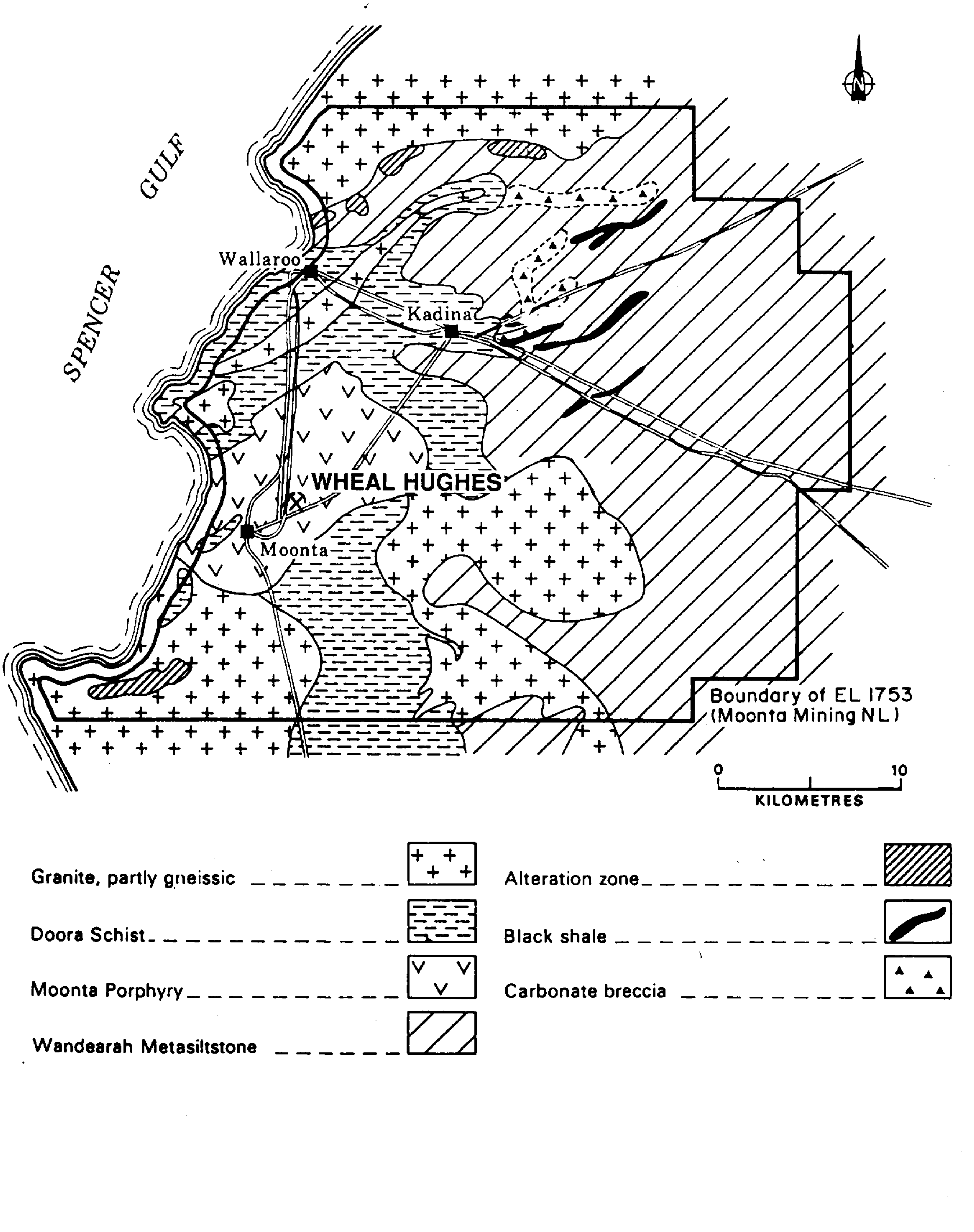
Watmuff, I.G., and Morris, B J, 1993a. Soil Air $C0_2/0_2$ Project, Progress Report V, Curnamona Area. *South Australian Department of Mines and Energy Report* 93/16 (unpubl).

Watmuff, I.G., and Morris, B J, 1993b. Soil Air $C0_2/0_2$ Project, Progress Report VI, Olary Area. *South Australian Department of Mines and Energy Report* 93/15 (unpubl).

Watmuff, I G and Morris, B J, 1993c. Soil Air $C0_2/0_2$ Project, Progress Report VII, Menninnie Dam, Eyre Peninsula. *South Australian Department of Mines and Energy Report* 93/39 (unpubl.).

APPENDIX

Field Data Sheets



Soil, Air, CO_2 and O_2 Project - Wheal Hughes Mine, Moonta

Regional Locality and Geological Plan

Figure 1
DME_SA 93-2001

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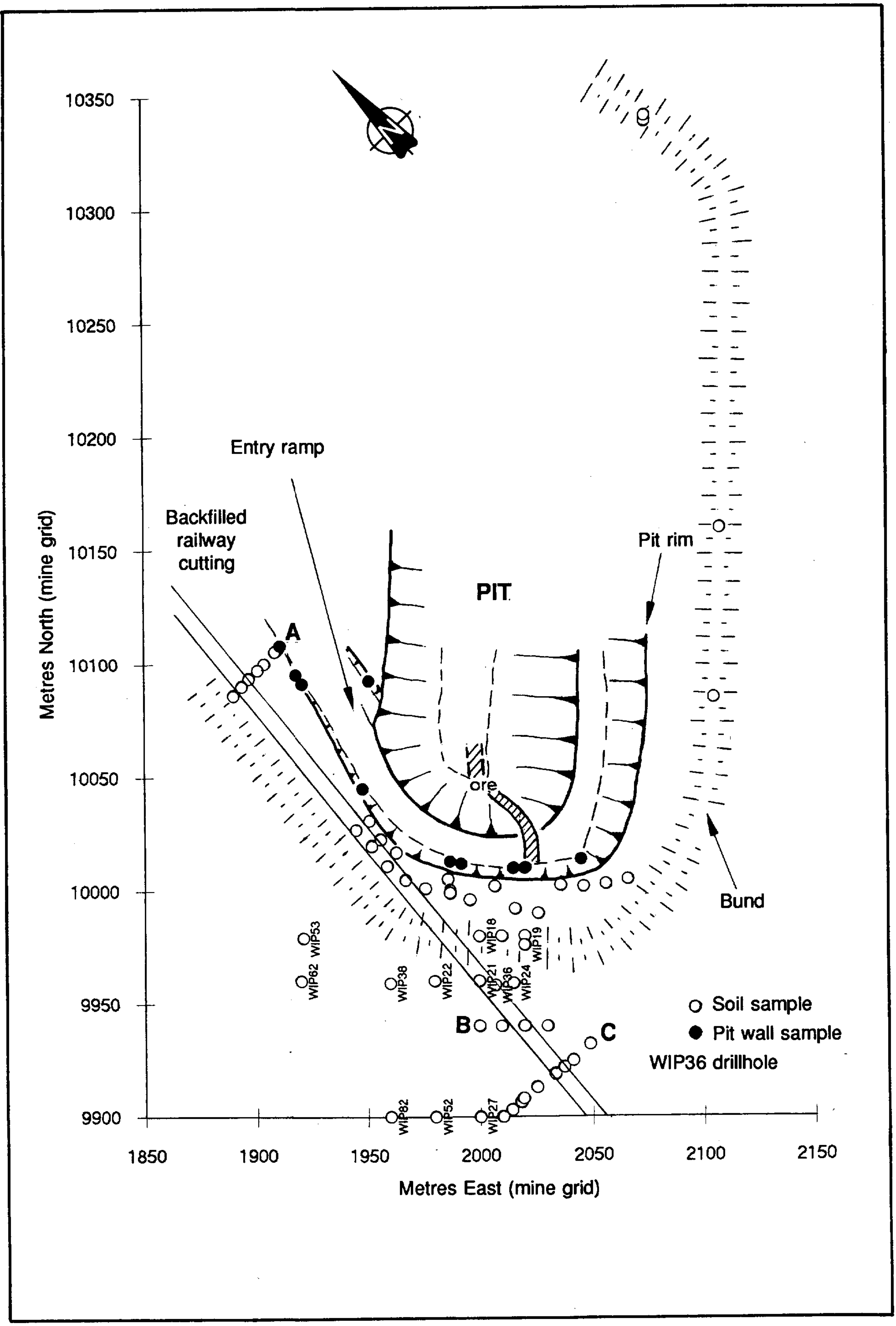

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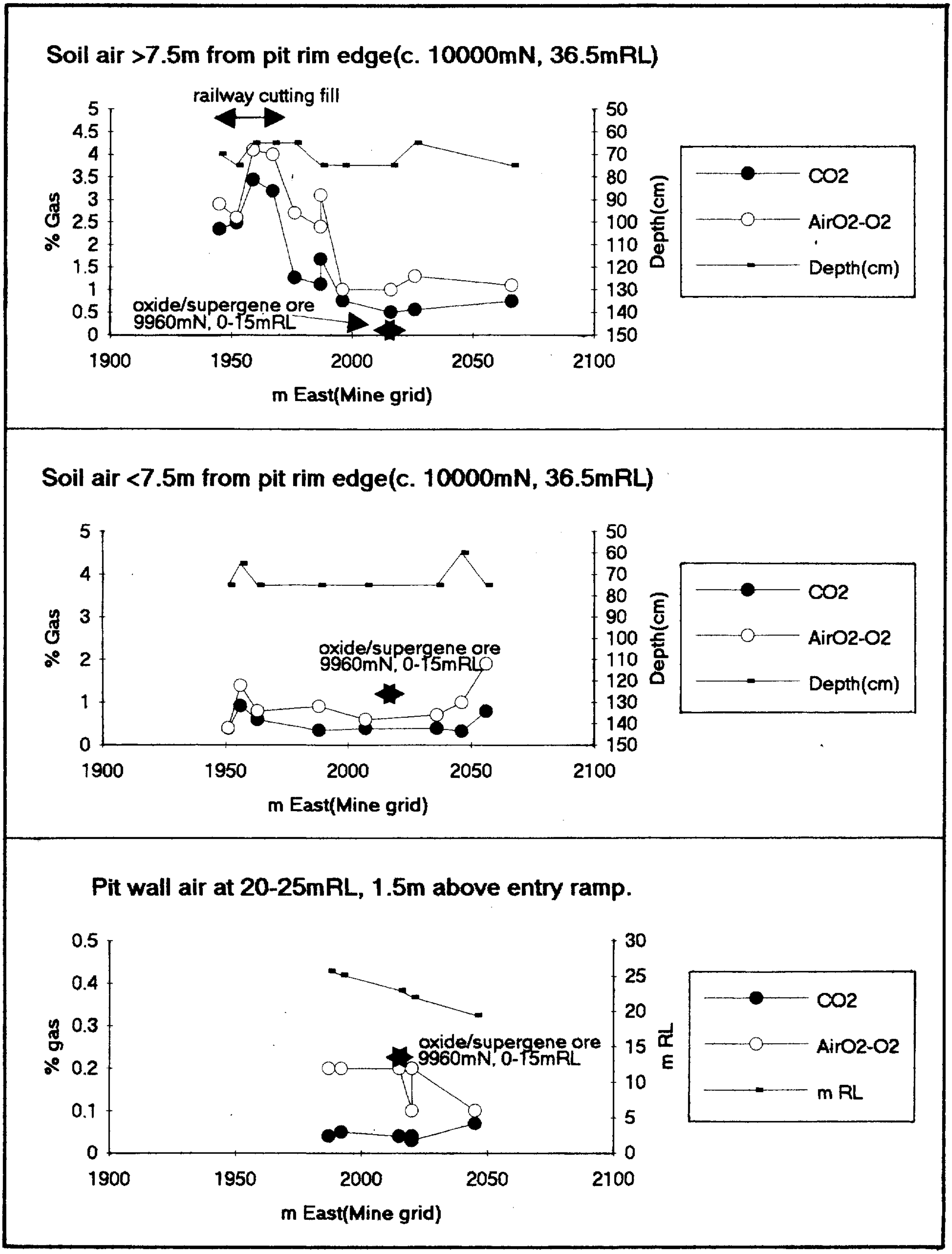
Soil, Air, CO_2 and O_2 Project - Wheal Hughes Mine, Moonta
Sample Location Map

Figure 2
DME_SA 93-2002



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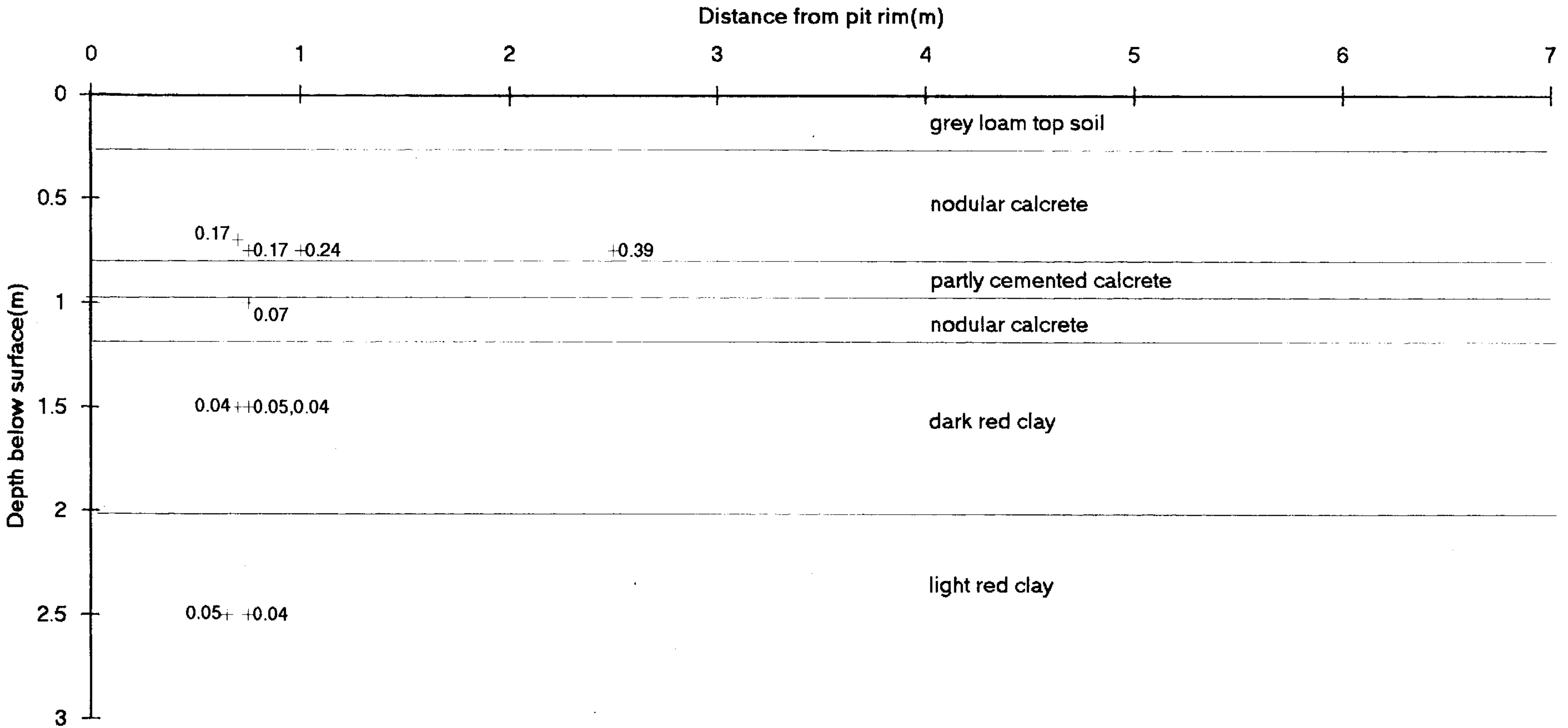
Soil, Air, CO_2 and O_2 Project - Wheal Hughes Mine, Moonta
Sample Results - Pit Wall and SW Pit Rim

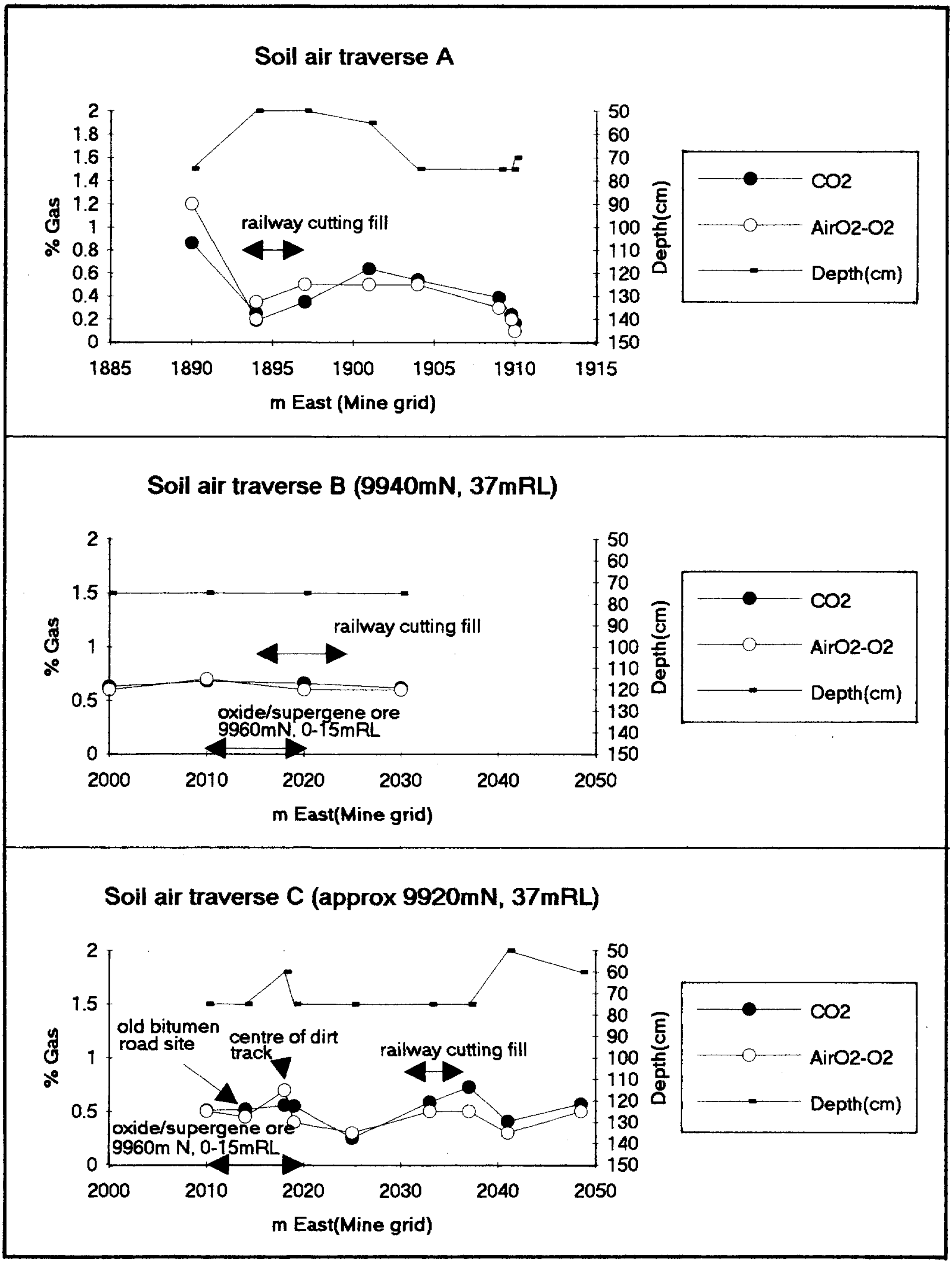
Figure 3
DME_SA 93-2003

Calcrete and transported clay overburden



Soil, Air, CO_2 and O_2 Project - Wheal Hughes Mine, Moonta
Sample Results - Pit Entry Ramp Wall

Figure 4
DME_SA 93-2004



Soil, Air, CO_2 and O_2 Project - Wheal Hughes Mine, Moonta

Sample Results - Traverses A, B and C

Figure 5
DME_SA 93-2005

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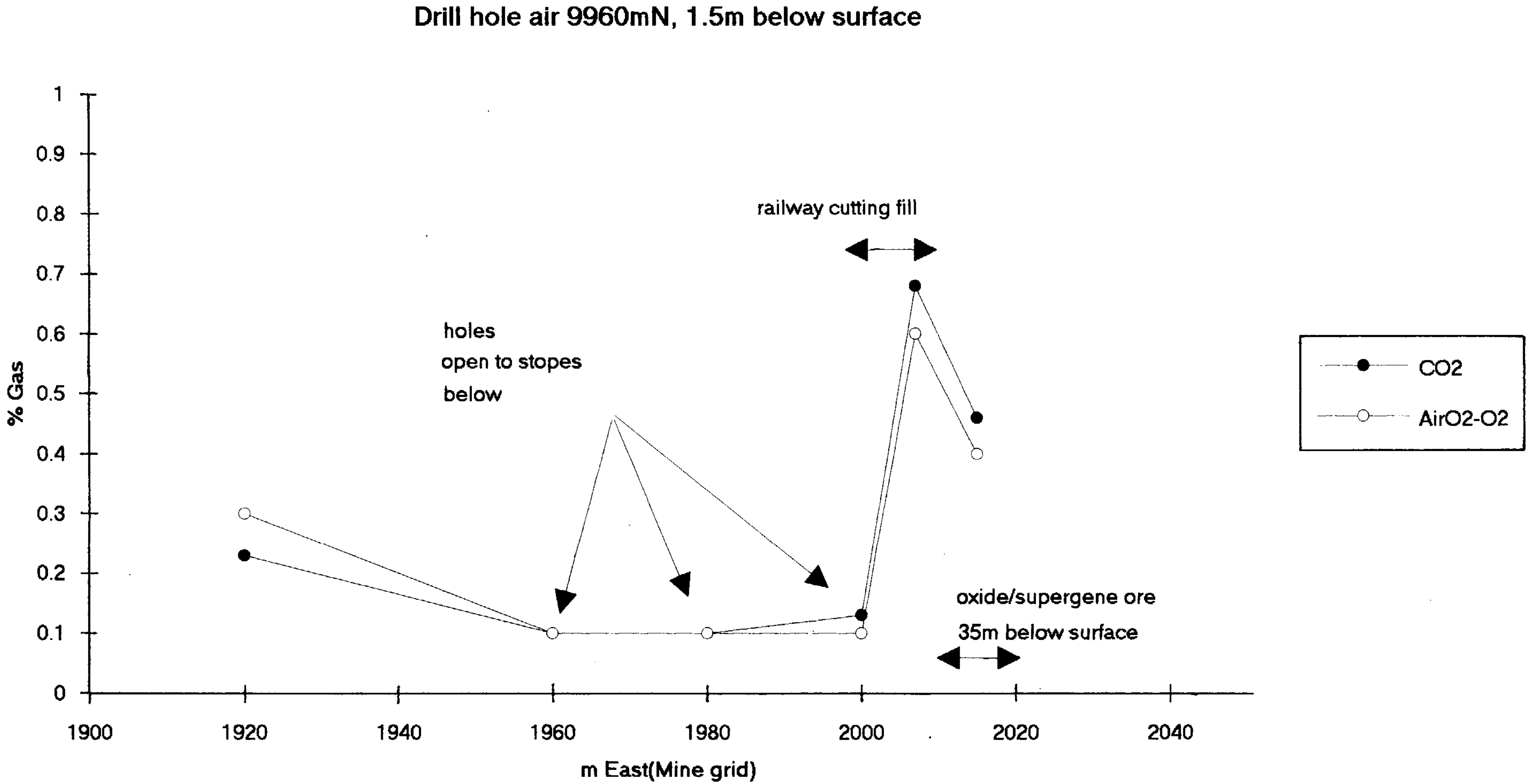

Soil, Air, CO_2 and O_2 Project - Wheal Hughes Mine, Moonta
Sample Results from Drillholes, 9960 N

Figure 6
DME_SA 93-2005