FLYING DOCTOR Ag-Pb-Zn PROSPECT, NORTHERN LEASES, BROKEN HILL, NSW

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LOCATION

The Flying Doctor prospect is approximately 8 km E of Broken Hill at 31º55'S, 141º32'E; Broken Hill 1:250 000 map sheet (SH54-15) and lies within an area referred to as 'the Northern Leases'.

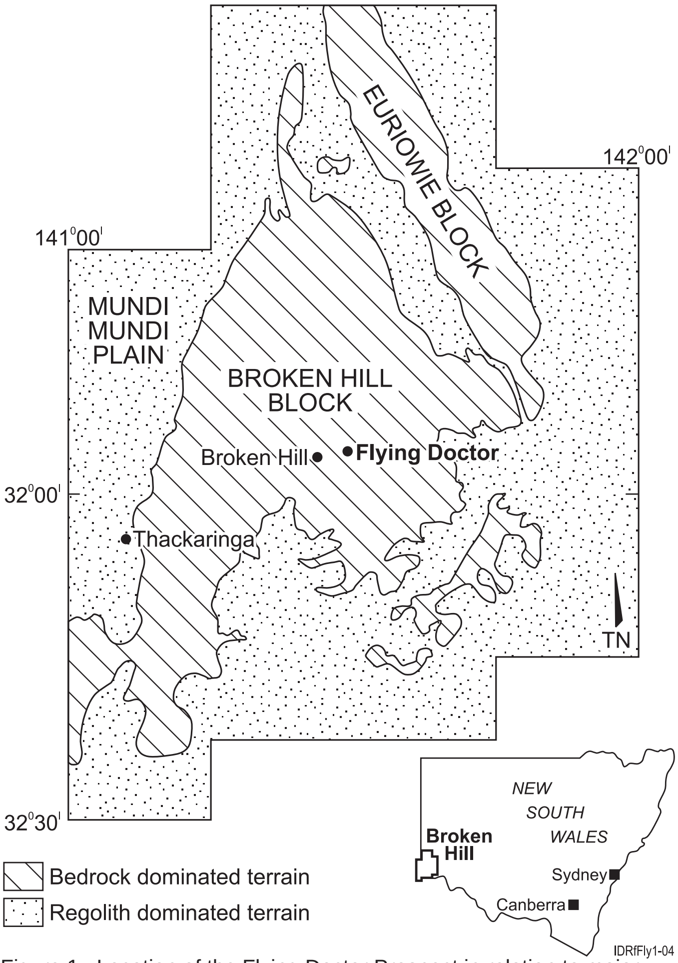

Figure 1. Location of the Flying Doctor Prospect in relation to major geomorphological units.

DISCOVERY HISTORY

The central part of the Broken Hill ore body was discovered in 1883 (Burton, 1994). Since the 1950s there has been extensive exploration for additional ore with very limited success. To the NE of Broken Hill, activity was intense along the line of lode and there are old workings, generally on surface gossans, such as at the Round Hill, Silver Peak and Potosi mines (Jaquet, 1894; Andrews, 1922; Morland and Leevers, 1998). More recently, Pasminco Mining were active explorers in the area until 2002. As well as exploring for large-tonnage underground targets, they also searched for small, near-surface ore-bodies that could supplement the reserves at Broken Hill. Work at the Flying Doctor Prospect and the Round Hill Mine was unsuccessful in providing a viable ore-body, however, exploration was successful at the nearby Potosi workings near Broken Hill (Morland and Leevers, 1998; Figure 1).

PHYSICAL FEATURES AND ENVIRONMENT

The prospect lies in the central-eastern part of the Barrier Ranges, and is centred on a tributary of Willa Willyong Creek, which is a part of the Stephens Creek catchment within the Murray-Darling drainage basin. The drainage has a well-developed trellis pattern reflecting strong bedrock lithological and structural controls (Hill, 2000; Thomas *et al.*, 2002; Lewis *et al.*, 2002; Hill, in press).

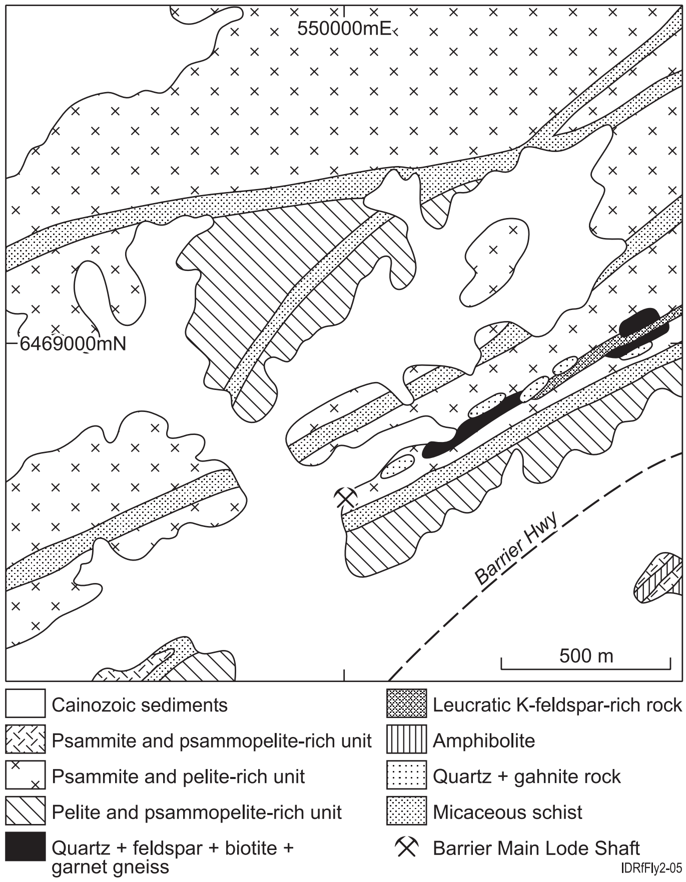

Figure 2. Bedrock geology of the Flying Doctor Prospect after Bradley (1984).

The Broken Hill region has a semi-arid climate with an erratic and generally low (220 mm) annual rainfall. Mean temperature ranges are 18-33ºC in January and 4-16ºC in July. The average annual evaporation rate is 2800-3200 mm (Brian Turner and Associates, 1983).

The vegetation is mostly an open woodland of mulga (*Acacia aneura*) on rocky hills and rises and prickly wattle (*A. victoriae*) along valleys. The understorey is mostly chenopod shrubland dominated by black bluebush (*Mairiana pyramidata*) along valleys and rock sida (*Sida petrofila*) on rocky rises and hills. The area is within the Broken Hill Common, public use land surrounding Broken Hill.

GEOLOGICAL SETTING

The bedrock includes the NE continuation of the Broken Hill lode rocks (Mt Gipps 1:25 000 Geological Sheet; Bradley, 1984). The major rock types include metapsammite, metapsammopelite, retrograde schists and quartzo-feldspathic gneisses (Figure 2). Most of the rocks show amphibolite or granulite facies mineral assemblages, partly overprinted by retrograde metamorphism (Bradley, 1984).

The Globe Vauxhall Shear Zone extends W across the central part of the area. The rocks are part of the Early Proterozoic Willyama Supergroup, with the metapsammites and metapelites forming part of the Sundown Group, and the other rocks belonging to undifferentiated Purnamoota Subgroup of the Broken Hill Group (Bradley, 1984; Haydon and McConachy, 1987).

REGOLITH

Saprock is exposed within low hills and rises, and is buried by up to 3 m of transported overburden along the axis of the drainage. Alluvial sediments mostly consist of red-brown to brown-grey, quartzose and

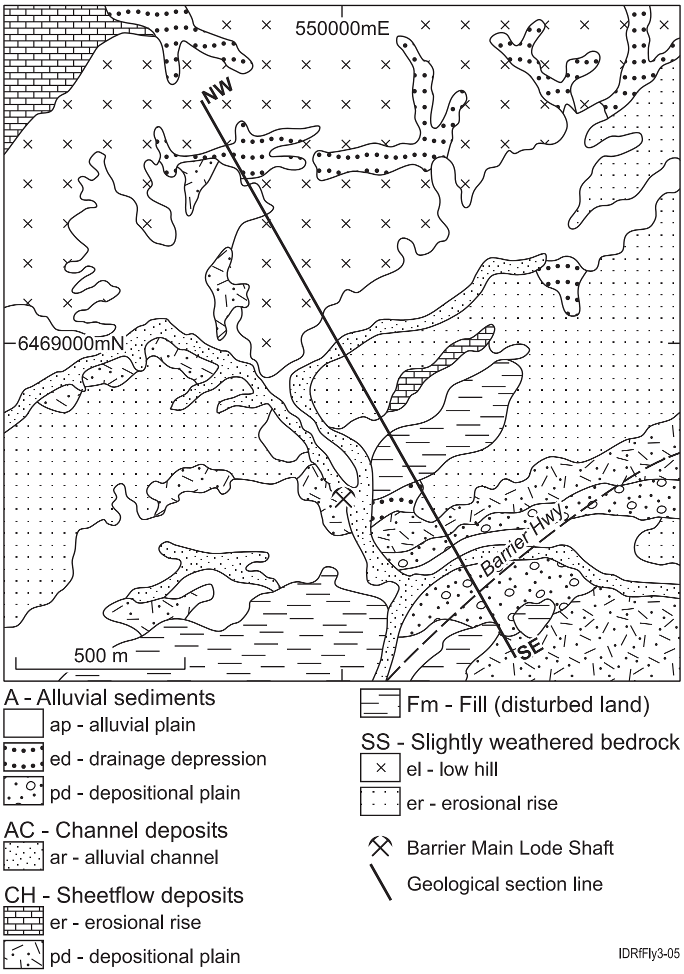

Figure 3. Regolith-landforms of the Flying Doctor Prospect after Thomas et al. (2002).

lithic silt, sand and gravel occurring within depositional plains, alluvial channels, and minor drainage depressions. Colluvial lithic and quartzose sheetflow silt, sand and gravel are widespread within depositional plains and erosional rises (Figure 3). Aeolian silt and fine sand are part of most regolith materials in the area and, locally, form sheets and hummocky dunes, particularly on the E slopes of many rises and low hills.

MINERALIZATION

Broken Hill type (Ag-Pb-Zn) deposits occur along a NE-trending linear zone with two main lodes, the Main Lode Horizon and the Upper Lode Horizon (Burton, 1994). In the Flying Doctor area, the Barrier Main Lode and the Flying Doctor mineralization are both part of the Upper Lode Horizon (blue quartz±gahnite±sulphide and minor garnet rocks). The mineralization is fine to coarse-grained galena and sphalerite, with minor chalcopyrite, pyrite and pyrrhotite, and occurs disseminated or as massive patches, irregular vein-like masses or reticular networks (Burton, 1994). Recorded production from the Barrier Main Lode is 351.24 t Ag and 57 t Pb (Burton, 1994). The Flying Doctor mineralization is not exposed, but lies within 100 m of the surface with a strike of 250 m (Burton, 1994). It contains 300 000 t at 7% Pb, 60 g/t Ag, and 2.4% Zn (NSW Department of Mineral Resources, 1981).

REGOLITH EXPRESSION

Saprock

Saprock contains anomalous Cd, Cu, Pb and Zn relative to surrounding sites (Figure 4). However, saprock is not consistently available and is buried beneath alluvium.

Soil

Soils were sieved into 80-130 and <80 µm fractions. However, these fractions contain only a relatively weak geochemical expression of mineralization (Figure 4) because of dilution by the aeolian component especially in the coarse fraction. A regolith-landform context is therefore critical for interpreting soil chemistry and helps to distinguish transported and redeposited metal contents from erosional settings more closely associated with mineralization. A notable exception is Pb in both soil fractions which is greatest in soils directly over the mineralization.

Plants

The biogeochemical results show variable expressions of mineralization. *Maireana pyramidata* leaves were widely available across the Flying Doctor area and show marked increases in Pb over mineralization relative to the remainder of the transect. *Acacia aneura* phyllodes had greater Cu and Pb contents over the mineralization compared to the remainder of the transect, however Zn contents were relatively high both over mineralization and within the alluvium down slope of mineralization. *Acacia victoriae* phyllodes were readily available across the area (particularly in regolith-dominated sites) and Cd, Cu, Pb and Zn effectively express underlying mineralization (Figure 4). *Sida petrophila* twigs could not be tested because this species was unavailable for sampling here. However, sampling this species from the Broken Hill Line of Lode suggests that metal contents are greatly elevated relative to the Flying Doctor prospect. These results suggest that, if precise species discrimination and systematic sampling techniques are used, biogeochemical methods may be better than some soil fractions in locally expressing mineralization, particularly in areas of shallow transported regolith. The reason for this could be that the plant roots penetrate shallow transported regolith and are, at least in part, chemically connected to the bedrock.

SAMPLING MEDIA – SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection Limits (ppm)	Background (ppm)	Max value (ppm)
Saprock (N=32)	Cd	ICP-MS	0.01	<0.1	0.60
	Cu	XRF	1	<1	88
	Pb	ICP-MS	0.1	<10	236
	Zn	XRF	1	<10	268
Soil <80 µm (N=84)	Ag	ICP-MS	0.01	<0.01	0.06
	Au	INAA	0.005	<0.005	0.0084
	Cd	ICP-MS	0.01	<0.15	1.33
	Cu	XRF	1	<15	105
	Pb	ICP-MS	0.1	<65	1966
	Zn	XRF	1	<125	1837
Soil 80-300 µm (N=84)	Ag	ICP-MS	0.01	<0.01	0.03
	Au	INAA	0.005	<0.005	0.007
	Cd	ICP-MS	0.01	<0.15	3.33
	Cu	XRF	1	<5	43
	Pb	ICP-MS	0.1	<46.5	1146
	Zn	XRF	1	<100	792
Mulga *(Acacia aneura)* phyllodes (N=33)	Cd	ICP-MS	0.01	<0.01	0.12
	Cu	XRF	1	<4	12
	Pb	XRF	1	<5	14
	Zn	XRF	1	<30	63
Prickly Wattle *(Acacia victoriae)* phyllodes (N=62)	Cd	ICP-MS	0.01	<0.01	4.28
	Cu	XRF	1	<2	9
	Pb	XRF	1	<2	49
	Zn	XRF	1	<25	221
Rock sida *(Sida petrofila)* twigs (N=38)	Cd	ICP-MS	0.01	<0.14	0.81
	Cu	XRF	1	<3	5
	Pb	XRF	1	<3	15
	Zn	XRF	1	<27	90
Black bluebush *(Maireana pyramidata)* leaves (N=71)	Cd	ICP-MS	0.01	<0.15	1.53
	Cu	XRF	1	<4	7
	Pb	XRF	1	<7	44
	Zn	XRF	1	<38	178

Soil and saprock were digested in $HF/HClO_4/HNO_3/HCl$ prior to ICP-MS analysis. Vegetation samples were dried for two days, pulped in a partially stabilized zirconia (PSZ) mill and digested in HNO_3

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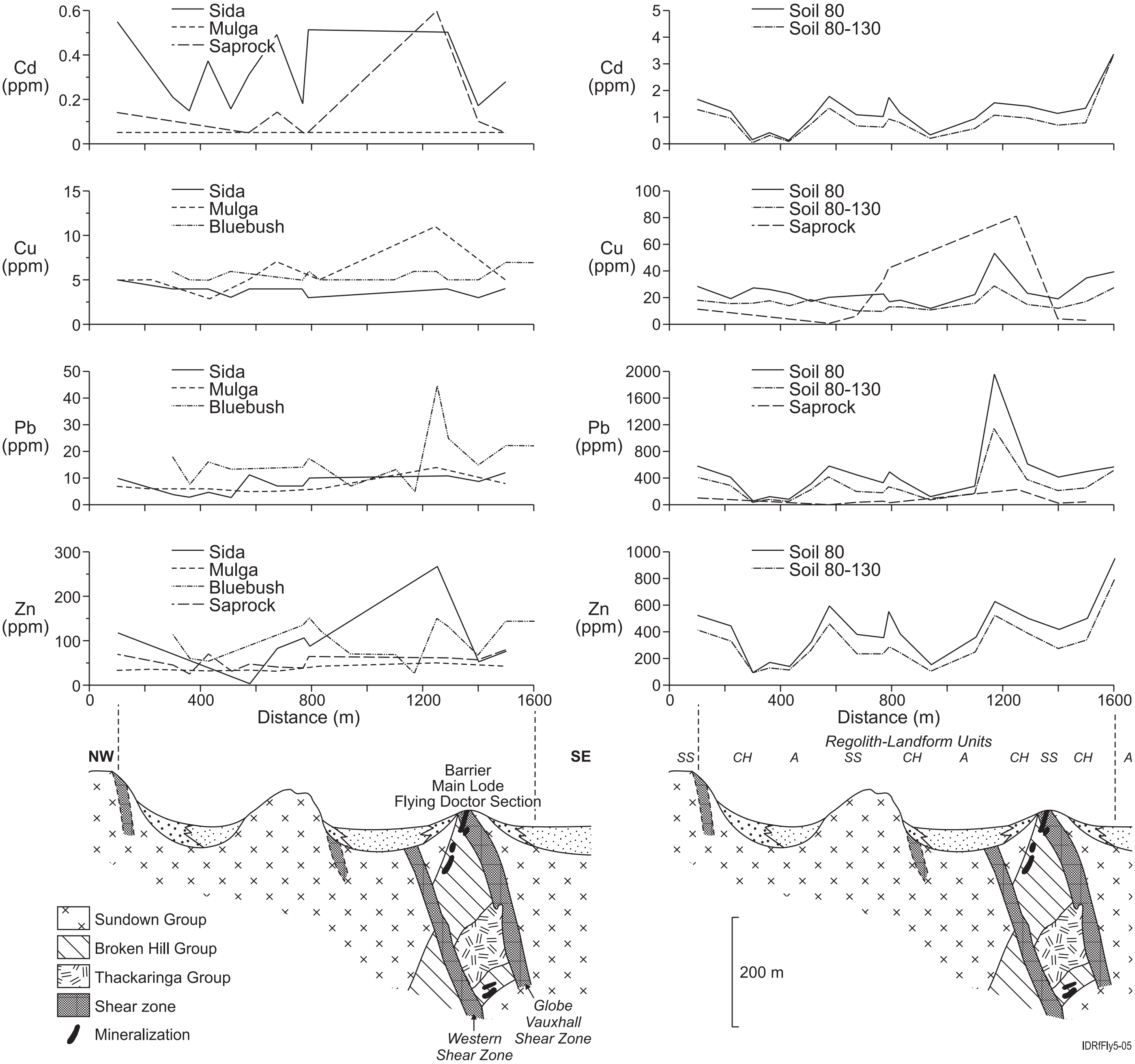

Figure 4. Section across the Flying Doctor area (as in Figure 3), and chemical variations in surface regolith sampling media. Geological section after Burton, 1994 and Bradley, 1984. Regolith-landform units (after Thomas et al., 2002). See Figure 3.

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