NORTHPARKES Cu-Au MINES, CENTRAL NSW

M.C. Arundell

Arundell Geoscience, PO Box 170, Belmont, WA, 6984.

LOCATION

The Northparkes Cu-Au Mines are located 27 km NW of Parkes and 300 km W of Sydney at 32º55'S; 148º00'E; Narromine 1:250 000 map sheet (SI55-03).

DISCOVERY HISTORY

Copper mineralization in the Parkes district has been known since the late 19th century, although the occurrences were generally small oxide shows within the Goonumbla Volcanics (Jones, 1985). However, in 1976, Cu-Au mineralization was discovered in the Goonumbla area by Geopeko Ltd when a 1 km spaced roadside traverse drilling program, designed to delineate regional geology below extensive cover, intersected the E22 mineralization under about 30 m of cover (Jones, 1985). The E27 orebody was discovered by following up weak Cu anomalies to the E of the E22 discovery hole. The E26 orebody (originally the E26N prospect) was discovered when an extension of the E28 RAB grid intersected anomalous Cu in 1980. A decision was made by the board of North Ltd to develop the Northparkes resources in 1992. Subsequent to this decision, the E48 orebody, close to the site of the planned operations (Figure 1), was discovered (Hooper *et al.*, 1996). A small Au resource was initially mined from the E22 and E27 open cuts in 1994/1995 before Cu-Au production commenced from E22, E27 and the underground E26 deposit in late 1995. The viability of the E48 deposit is currently being assessed. Following the takeover of North Ltd in 2000, Northparkes Mines is now part of the Rio Tinto group.

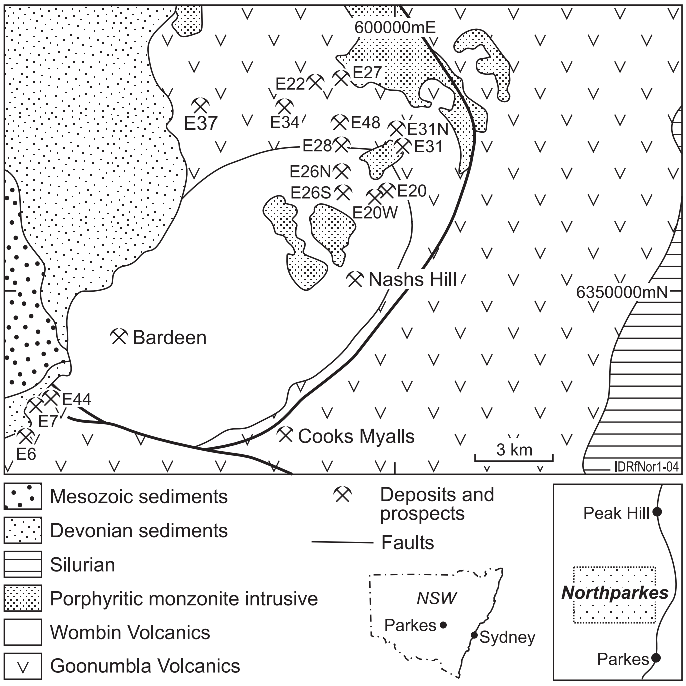

Figure 1. Regional geology of the Northparkes Area (after Arundell, 1997).

PHYSICAL FEATURES AND ENVIRONMENT

The Goonumbla deposits occur within flat to gently undulating agricultural land at the headwaters of the Bogan River. Minor remnant woodlands occur adjacent to the E48 deposit as the Limestone National Forest.

The Goonumbla area has a temperate climate with cool winters and hot summers. The average annual rainfall of 590 mm is spread between heavy summer thunderstorms and winter showers and rain. The average temperature ranges are 4-14°C in July and 18-32°C in January.

GEOLOGICAL SETTING

Copper-Au mineralization at Northparkes occurs within a 20 km diameter volcanic complex within the Late Ordovician - Early Silurian Goonumbla Volcanics (Sherwin, 1996). The volcanics are dominantly andesitic to trachyandesitic lavas, sills and volcanoclastics. These units are intruded by sub-vertical porphyritic monzonite intrusions. The mineralization at E22, E26, E27 and E48 occurs in and around the intrusions. Mesozoic sediments unconformably overlie the volcanic succession S of the Northparkes Mines.

REGOLITH

The southern third to half of the Goonumbla region is deeply weathered and is either a plain or has very low relief with low, rounded hills of Palaeozoic sediments (Sherwin, 1996). The hills are slightly weathered saprolite, surrounded by thin, residual soils (<1 m). Further N, there are low, rubbly rises and residual soil is poorly developed. Weathering in the northern part of the area is considerably deeper than in the S. In the vicinity of the Northparkes deposits, transported material dominates. Even under thin transported cover, the saprolite is thick (<50 m). The thickness of transported cover varies from very shallow in the S to about 70 m in the N.

The depth of weathering varies considerably but is generally <60 m in the area of the main mineralization (Tonui *et al.*, 2002). Sulphides, ferromagnesian minerals and some plagioclase of the greenish-grey saprock are weathered to Fe oxides and clays (including nontronite) leaving remnant quartz, muscovite and K-feldspar. The soft, greenish-grey saprolite (Figure 2) contains nontronite and remnants of quartz veins and is a weathered trachyandesite. The friable orange-pink saprolite consists of kaolinite and Fe oxides. The upper saprolite is mottled. Saprolite, developed on the Goonumbla Volcanics and intrusions, is generally about 20-30 m thick (Tonui *et al.*, 2002).

The thickness of transported cover in the Goonumbla area varies from very shallow, in the S, to about 70 m, in the N. The saprolite is overlain unconformably by both clay-filled palaeochannels and by colluvial-alluvial material (Figure 2). The palaeochannels are filled with mottled clays and with a nodular Fe-Mn oxide unit. The mottled clay sediments are pale-grey, green-grey or pink and smectitic and are strongly coloured by diffuse Fe oxides and contain round to subround nodules. Tonui *et al.*, (2002) identify three types of mottles with mini-mottles at the top, passing down into medium mottles (5-30 mm) and into mega mottles (50-300 mm) below.

The soil varies from 0.5-2.0 m on residual regolith and deepens to 0.5-3.5 m on transported regolith. The top 0.1 m (A horizon) is red to red-brown, contains rock detritus, quartz and minor coatings and aggregates of carbonate and is clay rich. The B horizon (0.1-3.5 m) is red to dark grey on residuum and red-brown to yellow on transported regolith, and contains gypsum. Coatings and powdery masses of carbonate are more abundant on transported regolith.

The regolith of the E31 Prospect has been determined from RAB and aircore drilling. Thus, the differentiation of individual regolith units is less precise as that around the main mineralization (Tonui *et al.*, 2002). Thin (<5 m) transported material (soil included) occurs above 5-25 m of upper saprolite which is mottled. The lower saprolite is truncated and is 0-40 m thick. A green-grey saprolite is developed over trachyandesite and profile truncation is common over monzonite.

MINERALIZATION

Economic mineralization is associated with four intrusive centres - E22, E26, E27 and E48. Ore grade Cu-Au mineralization occurs with K-feldspar alteration and is mostly hosted by stockwork and sheeted quartz veins. Bornite is the dominant Cu sulphide with chalcopyrite and minor chalcocite. Some of the Cu minerals are disseminated or associated with sulphide replacement of mafic minerals. Numerous other mineralized centres have been discovered in the area but none have yet proved economic (Arundell, 1997). Supergene Au mineralization was mined from the E22 and E27 open cuts. The lower part of the supergene zone has an increased Cu content associated with chalcocite, Cu oxides and sulphates.

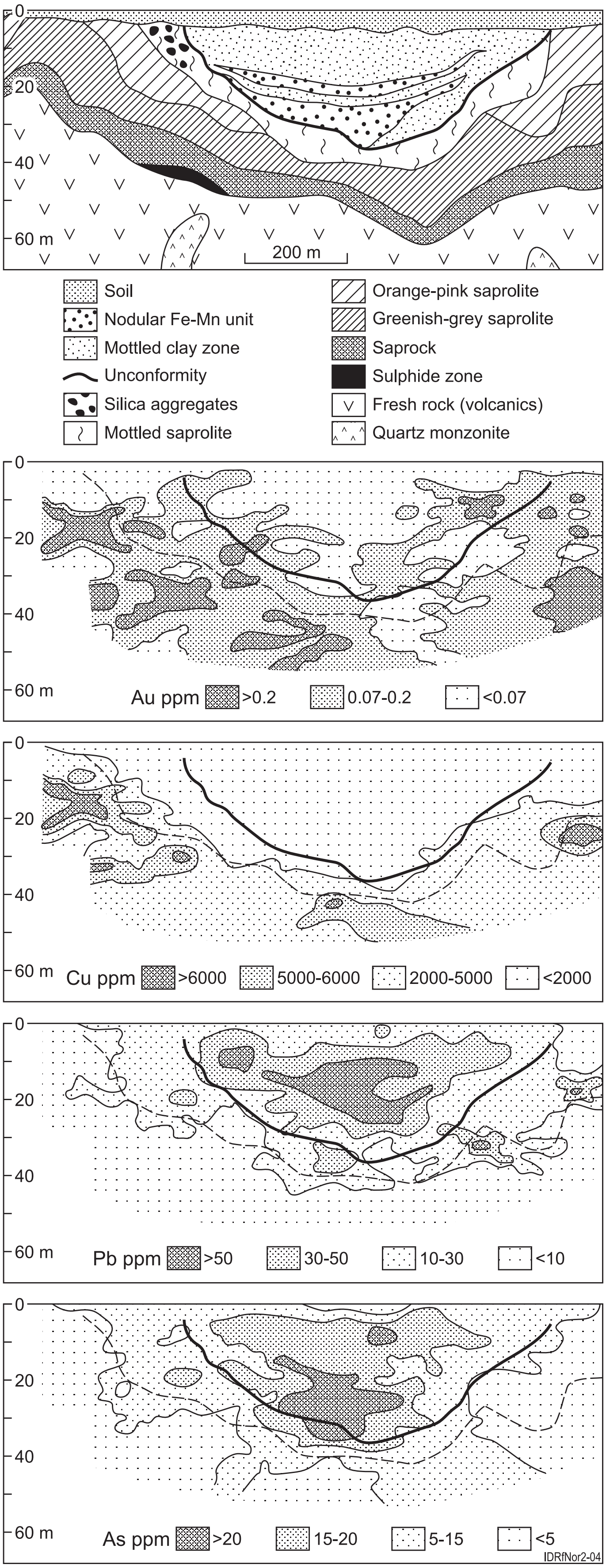

Figure 2. E27 Regolith stratigraphy and geochemistry cross section (after Tonui et al., 2002).

REGOLITH EXPRESSION

Primary mineralization at the Goonumbla deposits generally contains <5% sulphides. Detailed mapping of the E22 and E27 open pits revealed a complex regolith consisting of *in situ* weathered trachyandesite and weathered alluvial-colluvial material in a palaeovalley (Tonui *et al.*, 2002). The colluvial-alluvial material is thought to have been locally

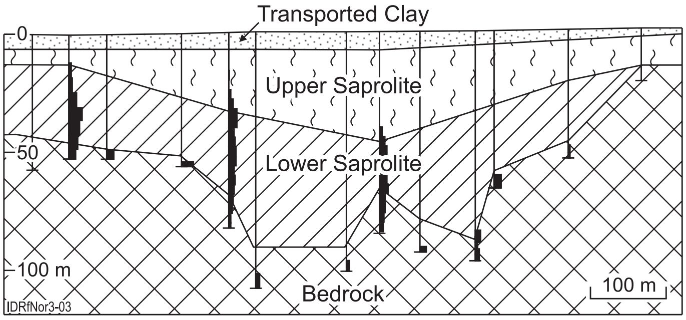

Figure 3. E31 Regolith stratigraphy Section 6356400N. Hole trace shows RHS histogram of Cu assays. Note increase in Cu through lower saprolite where analysed.

derived, with ferruginous nodules and mottles indicating intense post-depositional weathering. Anomalous Au, Cu and As in the regolith indicate primary mineralization; Pb and Zn show variable dispersion patterns. This was thought to be due to differences in their chemical mobility, provenance and sedimentary environment. Tonui *et al,* (2002) concluded that the widespread occurrence of saprock makes it a very good sampling medium even though it occurs at depth (30-50 m).

Analysis of aircore drilling in the E31 area, to the E of the E22 and E27 deposits (Figure 1), reveals much about Cu mobility in the weathering environment. Transported material has low Cu contents relative to the basement but they are sufficiently elevated to indicate a proximal source and that the material is largely colluvial. The upper saprolite seems to have been slightly depleted in Cu with no distinct increase or decrease with drilling depth. This is not the case within the lower saprolite, where Cu appears to be slightly enriched, particularly near the saprock - primary rock interface (Figure 3). Copper in primary rock is either near background or slightly enriched near intrusions. These observations support the conclusions of Tonui *et al,* (2002) that hydromorphic dispersion of Cu down the profile, from the upper to the lower saprolite, seems to have occurred. There are significant concentrations of both Pb and As in the palaeochannel sediments (Figure 3) compared to the residual regolith. Despite the presence of carbonate in the soils, there is no Au-carbonate relationship at Northparkes (Tonui *et al.*, 2002).

Much historic RAB drilling did not penetrate the lower saprolite and, thus, can be misleading. Single bottom-of-the-hole samples could represent lower or upper saprolite or basement. High Cu values (>1000

SAMPLE MEDIA – SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection limits (ppm)	Background (ppm)	Maximum (ppm)	Dispersion distance (m)
Residual regolith						
Primary mineralization	Cu	ICP-OES[1]	5	NA	187000	0
	Au	FA	0.01	NA	149	0
Alteration zone	Cu	ICP-OES[1]	5	NA	2000	Up to 100
	Au	FA	0.01	NA	0.1	Up to 25
Saprock/saprolite	Cu	ICP-OES[1]	5	800 (85^{th})	27300	Up to 250
	Au	FA	0.001	0.05 (80^{th})	119.47	Up to 200
White clay unit	Cu	ICP-OES[2]	2		1170	
	Au	GF-AAS	0.001		0.132	
	As	ICP-OES[2]	1		25	
	Pb	ICP-OES[2]	5		21	
	Zn	ICP-OES[2]	2		41	
Soil	Cu	ICP-OES[2]	5	100 (85^{th})	2500	Up to 150
	Au	GF-AAS	0.001	0.02 (97^{th})	2.3	Up to 200
	As	ICP-OES[2]	1		10	
	Pb	ICP-OES[2]	5		20	
	Zn	ICP-OES[2]	2		50	
Transported regolith						
Fe-Mn unit	Cu	ICP-OES[2]	2		1300	
	Au	GF-AAS	0.001		0.08	
	As	ICP-OES[2]	1		30	
	Pb	ICP-OES[2]	5		66	
	Zn	ICP-OES[2]	2		260	
Mottled clay	Cu	ICP-OES[2]	2		1420	
	Au	GF-AAS	0.001		0.78	
	As	ICP-OES[2]	1		65	
	Pb	ICP-OES[2]	5		63	
	Zn	ICP-OES[2]	2		130	
Soil	Cu	ICP-OES[2]	2		565	
	Au	GF-AAS	0.001		0.085	
	As	ICP-OES[2]	1		15	
	Pb	ICP-OES[2]	5		50	
	Zn	ICP-OES[2]	2		55	

FA Fire assay on 50 g aliquot GF-AAS Graphite furnace AAS
[1]After $HF/HClO_4/HNO_3/HCl$ digestion [2]After $HClO_4/HNO_3/HCl$ digestion

ppm) can be due to hydromorphic dispersion in the lower saprolite and may not be an indicator of significant mineralization. Profile sampling is necessary to assist in discriminating true anomalies from saprolitic enrichment.

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