BOWDENS Ag-Pb-Zn DEPOSIT, LUE, NEW SOUTH WALES

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LOCATION

The Bowdens Ag-Pb-Zn deposit is located at 149°52'E, 32°39'S; Dubbo (SI 55-4) 1:250 000 and Mudgee (8832) 1:100 000 map sheets.

DISCOVERY HISTORY

The Bowdens deposit was discovered by CRA Exploration in 1989 during a regional reconnaissance stream sediment program in which anomalous Ag, Pb and Zn in the <180 µm fraction and anomalous bulk cyanide leachable Ag were detected up to 1.5 km from the deposit (McConachy *et al.,* 1992). Although mineralization is exposed at surface, there is little visible indication in the host volcanic rocks. CRA conducted a limited drilling program over the deposit. Silver Standard Australia Pty Ltd. subsequently conducted a more detailed geological and resource evaluation of the deposit through an extensive drilling program, establishing a reserve of 59 Mt at 49 g/t Ag equivalent for the deposit (Pringle and Elliot, 1998).

PHYSICAL ENVIRONMENT

The Bowdens deposit is on the E extremity of the Great Dividing Range. The northern part consists of moderately wooded spurs and knolls reaching 800 m asl. In the S part, ridges give way to less undulating cleared farm land (about 600 m asl). Small ephemeral streams drain the surrounding hills, feed into the main S-flowing creeks and thence into the Cudgegong River. The surrounding area is primarily grazing land with some crops along river flats. In the remnants of forest on most hills, the larger trees include black cypress pine (*Callitris endlicheri*), *Acacia* spp and a variety of eucalypts. The understorey has mostly been cleared for grazing. Mean minimum and maximum temperatures are 10-31ºC (January) and 1-14ºC (July). The average annual rainfall is 670 mm, with most falling in winter.

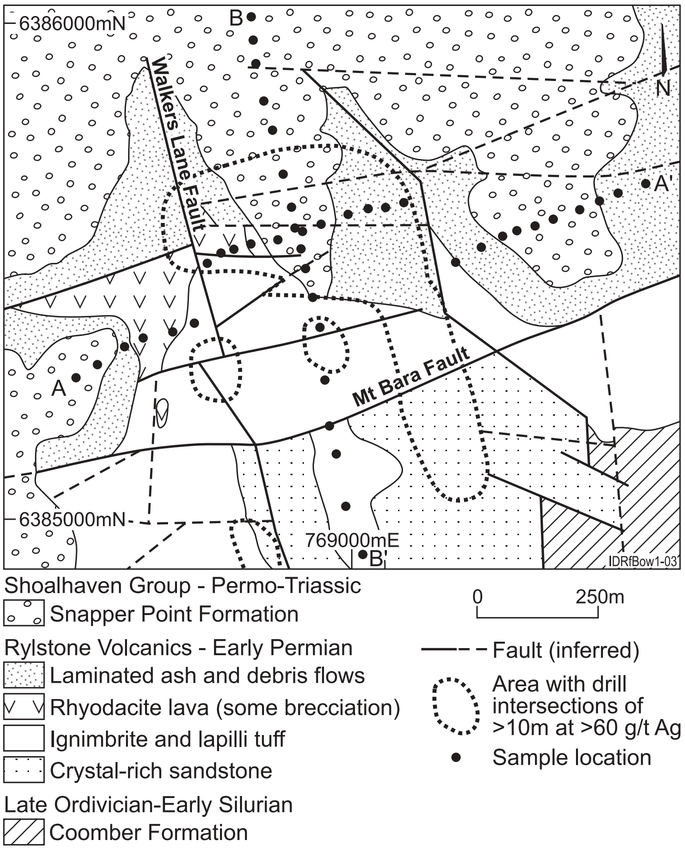

Figure 1. Local geology of the Bowdens Ag-Pb-Zn deposit.

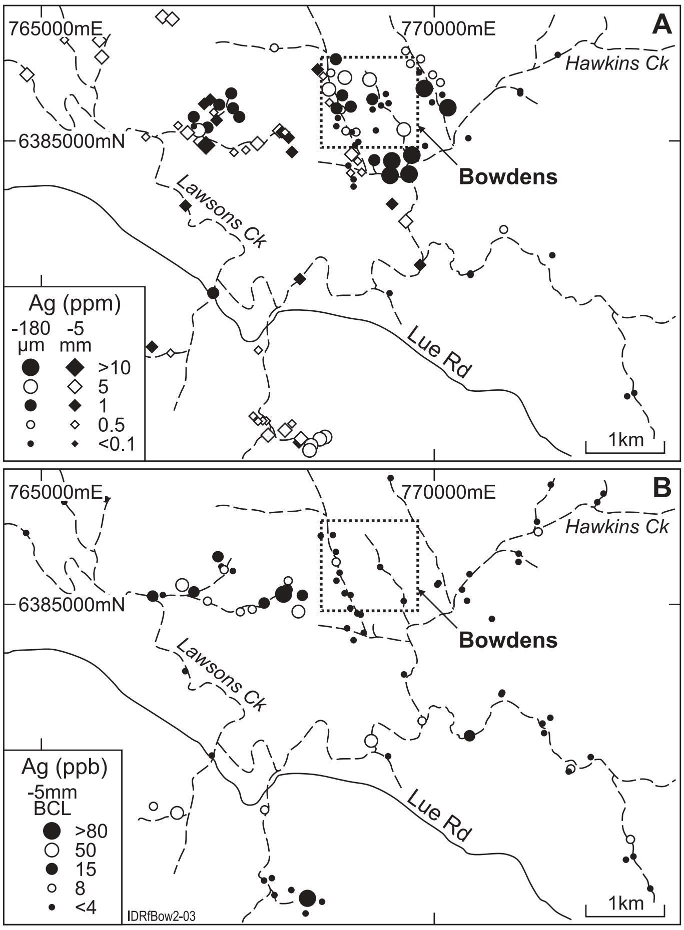

Figure 2. Regional stream sediment data in the Lue area for total Ag in the <180 mm and <5 mm fractions (A), and bulk cyanide leachable (BCL) Ag in the <5mm fraction (B). Square indicates position of Figure 1.

GEOLOGICAL SETTING

The deposit is hosted by the Early Permian Rylstone Volcanics. These unconformably overlie the eastern edge of the phyllites of the Late Ordovician–Early Silurian Coomber Formation (Colquhoun *et al.,* 1997) and are themselves overlain by Permo-Triassic shallow marine sandstones, conglomerates and shales of the Sydney Basin (Shoalhaven Group; Snapper Point Formation; Figure 1). The Rylstone Volcanics range from 10 to 200 m thick and are mainly dacitic and rhyolitic pyroclastics and epiclastics (including ignimbrites and crystal-rich epiclastics) with minor intrusions and lavas. There are no indications of sinter in any of the units. The Rylstone Volcanics have been dated at about 292 Ma by Rb-Sr isochron (Shaw *et al.*, 1989). The Snapper Point Formation contains basal conglomerates overlain by lithic and quartz sandstones and unconformably overlies the Rhylstone Volcanics (Figure 1).

The Bowdens deposit occurs adjacent to the Mt Bara and Walkers Lane Faults (Figure 1). The host rocks have had at least four periods of faulting (ENE and NNW normal and oblique) suggesting a collapsed caldera (Perry, 1998). To the N, the D_2 Mt Bara Fault is deformed into a prominent D_3 fold. This zone coincides with the northern projection of the Cudgegong Fault and associated structures.

REGOLITH

The thickness of residual regolith in the Rylstone Volcanics depends on the degree of hydrothermal alteration and/or silicification. Silicification in the ignimbritic units has restricted the depth of weathering to approximately 50 mm, whereas hydrothermally altered and mineralized zones have saprolite mantles up to 5 m thick. There are no mottled zones or duricrusts in the residual regolith. Similarly, the Snapper Point Formation in the area has none of the mottling or preserved ferruginous duricrusts that occur in other units of the Sydney Basin. The hills and ridges of Snapper Point Formation have less than 2 m of colluvium. The underlying Rylstone Volcanics and Coomber Formations are covered by up to 5 m of colluvium-alluvium with abundant clasts of acid volcanic epiclastics.

MINERALIZATION

Mineralization at Bowdens is approximately 500 x 300 m, bounded to the E by the central oblique fault and to the N by a major normal fault. The western extent has yet to be determined. The remnants of the hydrothermal stockwork and feeder veins are mineralized. Dominant minerals are pyrite, sphalerite, galena and arsenopyrite with lesser marcasite, chalcopyrite and enargite. Silver mineralization is in gently dipping, strata-bound zones of veins, disseminations and breccias, primarily within the silicified parts of the lower epiclastic and overlying units. Silver is generally associated with galena and occurs in polybastite-pearcite, proustite-pyargyrite, acanthite-argentite, freibergite and some secondary Ag minerals (Ramsden and Williams, 1998; Pringle and Elliot, 1998; Purvis, 1994). Clay-chlorite-hematite±carbonate±sericite alteration is strongly developed away from faults and intensely mineralized areas. The close relationship between mineralization, the pyroclastic deposits, crystal–rich sandstone and faults is shown in Figure 1.

In the centre of the deposit, ore grade intersections are commonly 30-100 g/t Ag equivalent. The main high grade zone is best developed just S of the main EW fault, where average grades are commonly >300 g/t Ag within intervals >45 m thick. This zone is approximately 100 x 80 m, with a strike parallel to the E side of the central ridge. The high-grade zone increases in depth from approximately 100 m at the main EW fault to over 200 m below the S limit of the Snapper Point Formation sandstone. There is no significant supergene mineralization. Corbett (1998) and Pringle and Elliot (1998) concluded that the deposit is a low sulphidation, epigenetic deposit within a pull-apart depression formed by strike-slip faulting, although Perry (1998) has suggested a silicic caldera setting.

REGOLITH EXPRESSION

Bedrock and saprolite

Rock chip samples from outcrops of Rylstone Volcanics around the main zone of mineralization are highly anomalous in Ag, Pb, Zn, As and Mn, and erratically anomalous in Au and Cu. Sandstones of the Snapper Point Formation just above the unconformity contain anomalous Ag, Pb and Zn. This may be related to either incorporation of mineralized fragments in the base of the sandstone or subsequent hydromorphic dispersion along the unconformity. Where the sandstone is thin (<20 m), there are slight increases in As, Pb, Zn and Ag concentrations towards the surface, suggesting some vertical hydromorphic or biologically-related transport mechanism. Where the sandstone is thicker, there is no anomalous metal accumulation in the upper profile. There is a strong correlation between Pb and Zn and a moderate correlation between Ag and Pb/Zn in the thin saprolite developed over mineralization. Variations in the Mn content of the saprolite are closely related to presumed primary carbonate abundance.

Stream sediments

Bulk cyanide leach Ag anomalies (>20 ppb over a background of <5 ppb in the <5 mm fraction) extend 1500 m in local drainages downstream of the deposit. Anomalous Pb, Sb, As and Ag concentrations also occur in the <180 µm fraction (McConachy et al., 1992). However, the stream sediments have no detectable regional dispersion trains extending from Bowdens into higher order streams such as Lawsons Creek (Figure 2).

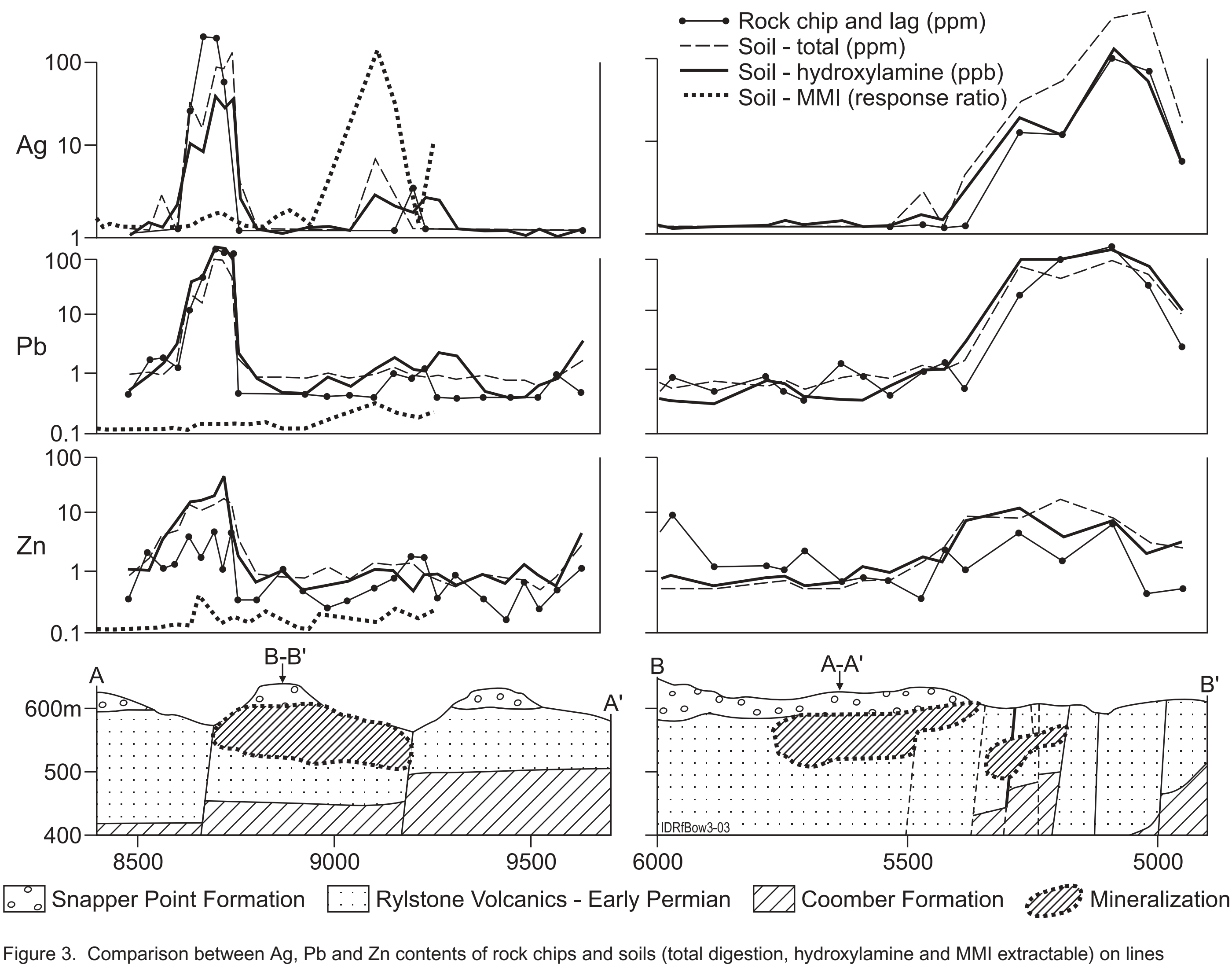

Figure 3. Comparison between Ag, Pb and Zn contents of rock chips and soils (total digestion, hydroxylamine and MMI extractable) on lines AA' and BB' (see Figure 1).

Soil and vegetation

The <180 µm fraction of the soil is strongly anomalous in Ag, Pb, Zn, As and Mn due to mineralization within the Rylstone Volcanics. Although soil creep has increased the surface extent of the soil geochemical anomalies for most elements, only Zn has been significantly dispersed hydromorphically. Preliminary analysis of various eucalypt species indicates anomalous Pb, As and Ag in the leaves above mineralized volcanics. Various selective extraction methods were compared with total analyses on soils collected at 200 mm depth to determine if mineralization could be detected beneath Snapper Point Formation sandstone. These methods included CHX (0.25 M hydroxylamine hydrochloride in 0.25 M HCl) designed to extract poorly crystalline Fe and Mn oxides and MMI for mobile metals. Over the subcropping mineralized Rylstone Volcanics, the areal extent of anomalous Ag, Zn and Pb values derived from total and selective extractions were greater in soils than the underlying rock (implying some lateral dispersion) but selective extractions did not provide a larger target than total analyses (Figure 3). Over mineralization covered by <5 m of Snapper Point Formation sandstone (or sandstone scree), weakly anomalous CHX and MMI Ag and Pb in soils extended slightly further than detectable anomalies in the total analyses (Perry, 1998). Weakly anomalous total Zn and CHX Zn occurred in soils on ridges of sandstone up to 20 m thick that overlie mineralization but only within 100 m of the contact with outcropping volcanics (line B–B': Figure 3). It is still unclear if the selective extraction patterns are due to lateral or vertical hydromorphic dispersion from mineralization or the incorporation of mineralized volcanic material in the overlying sandstone.

REFERENCES

Colquhoun, G.P., Meakin, N.S., Krynen, J.P., Watkins, J.J., Yoo, E.K., Henderson, G.T.M. and Jagodzinski, E.A., 1997. Stratigraphy, Structure and Mineralisation of the Mudgee 1:100 000 Geological Map Sheet. Quarterly Notes 102. Geological Survey of New South Wales, 38 pp.

Corbett, G.J., 1998. Comments on the geology of the Bowdens Ag-Pb-Zn project, New South Wales. Report to Silver Standard Australia Pty. Ltd., (unpublished).

McConachy, T.F., Doe, A.R.D., Terrill, J.E. and Kouni, J., 1992. Annual report for EL3252 (Bara), EL3311 (Rylstone 1) and EL3671 (Rylstone 2) for period ending 12 January 1992. CRA Report 17837 (unpublished).

Perry, B., 1998. The Geological Setting of the Bowdens Ag-Pb-Zn Deposit, Lue. BSc (Hons) Thesis, University of New South Wales (unpublished).

Pringle, I.J. and Elliot, J., 1998. Bowdens silver - lead – zinc deposit, Mudgee. In: D.A. Berkman and D.H. Mackenzie (Editors), Geology of Australian and Papua New Guinean Mineral Deposits. The Australasian Institute of Mining and Metallurgy, Melbourne, Australia. pp 627–634.

Purvis, A.C., 1994. Mineralogical Report No. 6738. Pontifex & Associates Pty. Ltd. Report to Silver Standard Australia Pty Ltd. (unpublished)

Ramsden, A.R. and Williams, P.A., 1998. New data on the ore mineralogy of the Bowdens Gift Silver Prospect, Mudgee, New South Wales. Report to Silver Standard Australia Pty. Ltd., (unpublished).

Shaw, S.F., Flood, R.H. and Langworthy, P.J., 1989. Age and association of the Rylstone Volcanics: New isotopic evidence. Advances in the Study of the Sydney Basin, 23rd Symposium. Department of Geology, University of Newcastle, 45-51.

SAMPLE MEDIA - SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection limits (ppm)	Threshold (ppm)	Maximum anomaly (ppm)	Dispersion distance (m)
Primary mineralization	Ag	AR-AAS/ICP	0.1	0.3	5,000	minimal
	Pb	AR-AAS/ICP	5	10	70,000	minimal
	Zn	AR-AAS/ICP	5	30	80,000	minimal
Saprolite/saprock	Ag	AR-ICP	0.1	0.3	100	<20
	Pb	AR-ICP	0.5	2	120	<20
	Zn	AR-ICP	0.3	1	10	<20
Gossans/ironstone	Ag	AR-AAS/ICP	0.1	0.3	0.5	<20
	Pb	AR-AAS/ICP	0.5	5	15	<20
	Zn	AR-AAS/ICP	0.3	8	10	<20
	As	AR-AAS/ICP	0.2	20	65	<20
Soil / colluvium (<180µm)	Ag	AR-AAS	1	4	150	500
	As	Hyd-AAS	5	30	1800	350
	Pb	AR-AAS	20	35	2500	500
	Zn	AR-AAS	5	40	2000	800
	Ag	MMI	-	5*	115*	~20 (vertic.)
	Pb	MMI	-	5*	16*	~20 (vertic.)
	Zn	MMI	-	3*	13*	~20 (vertic.)
	Ag	CHX-AAS	0.1	3*	10*	<5 (vertic.)
	Pb	CHX-AAS	5	5*	-	<5 (vertic.)
	Zn	CHX-AAS	5	2*	10*	<5 (vertic.)
	Ag	CHX	0.1	0.3	100	<5 (vertic.)
	Pb	CHX	0.5	1.8	100	<5 (vertic.)
	Zn	CHX	0.3	0.8	70	<5 (vertic.)
Stream sediments (<5mm)	Ag	BCL	0.001	0.010	0.450	1500
	Au	BCL	0.0005	0.004		-
(<180µm)	Ag	AR-AAS	0.1	0.2	4	1500
	Pb	AR-AAS	5	30	650	1500
	Zn	AR-AAS	5	60	800	<500
	As	Hyd-AAS	5	25	190	1500
Vegetation (leaves)	Zn	ICP-MS	0.1	0.4	5.2	

Key: AR–aqua-regia; BCL–bulk cyanide leach extractable; Hyd–mixed acid digest with hydride extraction.

*Ratio to 25th percentile