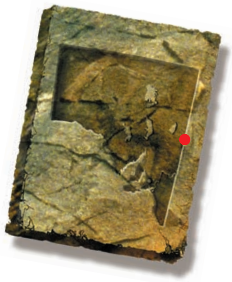

Geochemical detection of deeply buried mineralisation below the Mundi Mundi Plain, Curnamona Province

— implications for discovery success

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Introduction

One of the greatest challenges facing companies in geological exploration in Australia is how to effectively explore through significant thicknesses of overburden. The problem of discovery depletion (Harris, 1990), which arises from increasing exploration maturity, is forcing companies in Australia into regions of thicker cover. This includes the southern Curnamona Province which has been explored for over 100 years. Consequently, the application of new and more expensive techniques is necessary for discovery success in such regions.

Under the Mundi Mundi Plain in both SA and NSW (Fig. 1), BHP Minerals Discovery has previously targeted Broken Hill Type (BHT) mineralisation through transported overburden up to 150 m thick, using a number of techniques with some success. Cover consists of Tertiary and Quaternary unconsolidated sediments. Weathering can develop to a depth of 150 m and often extends well into Proterozoic basement.

Previous work by CRAE in the mid- to late 1980s highlighted the potential for BHT mineralisation at the Woolshed or Polygonum prospect. This was a catalyst for BHP to enter a joint venture in the area held by Platsearch. At Polygonum, a drill intersection (drillhole P06) within interbedded pelite and psammite averaging 0.13% Pb and 0.17% Zn over 103 m is interpreted to be within the Broken Hill Group equivalent (Fig. 1). This mineralisation occurs within a 300 m thick envelope of widely disseminated, fine-grained garnet and occurs stratigraphically above an amphibolite. Hills (1999) identified copper and Pb–Zn–Ag mineralisation of both pre- to syntectonic and post-tectonic origin. Zoning occurs from copper–magnetite±haematite in the footwall quartzo-feldspathic Wiperaminga Subgroup (for reference to stratigraphic names see Conor, 2001) and calc-silicate Ethiudna Subgroup sequence to Pb–Zn–Ag–pyrite–pyrrhotite within the 'Bimba formation' and hanging wall pelite–psammite Strathearn Group.

Disseminated aggregates of pyrite and pyrrhotite±sphalerite, galena, chalcopyrite, molybdenite and arsenopyrite are found within the 'Bimba formation' and the overlying Broken Hill Group equivalent in the Saltbush Subgroup. Disseminated to stratabound aggregates of magnetite±pyrite±pyrrhotite±chalcopyrite±molybdenite occur within the Wiperaminga Subgroup (quartzo-feldspathic suite) and Ethiudna Subgroup (calc-silicate suite). Pervasive albite alteration is associated with this mineralisation in the latter but is weak to absent in the former.

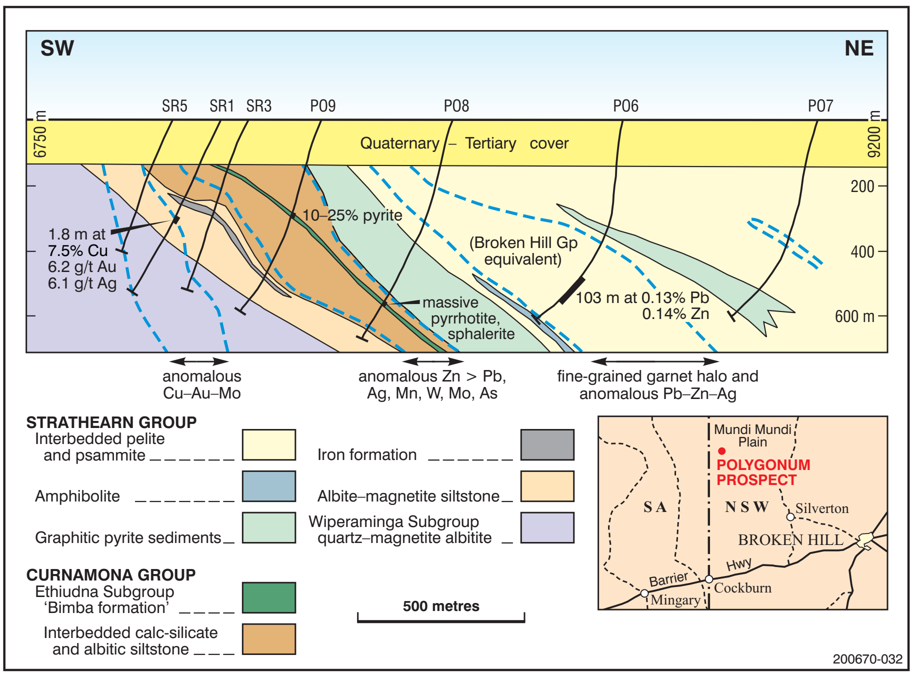

Fig. 1 Cross-section of the Polygonum prospect showing lithostratigraphy and mineralisation zoning.

Exploration techniques

A number of techniques have been used to explore for a BHT deposit. Aeromagnetic data were used as a geological mapping tool to prioritise ~20 km of the prospective pelite–psammite stratigraphy that lies immediately above the lower oxidised (i.e. magnetic) part of the Willyama Supergroup (Leyh and Conor, 2000). Detailed gravity over regional gravity features within this stratigraphy was primarily used to target drilling.

Widely spaced (~2.5 km) soil geochemistry lines, sampled at 100–250 m intervals along each line, were also placed perpendicular to stratigraphy (Fig. 2). The spacing was an optimal economic decision based on target size and depth, and the extent of prospective terrain to be tested. The environment was considered favourable for lower level metal dispersion and partial extract geochemistry, as drilling indicated that weathering extends through cover and well into basement in places. Samples were collected from the weakly calcareous zone, which marks the base of the soil evaporation zone. This sample site is analogous to the top of zone B in Rose et al. (1979). Analysis involved a partial extraction bulk cyanide leach (BCL) and four acid ICP-OES, the latter used for bulk chemistry.

Geochemical results displayed a belt of elevated BCL silver outlining the inferred trace of the prospective stratigraphy to the south of the

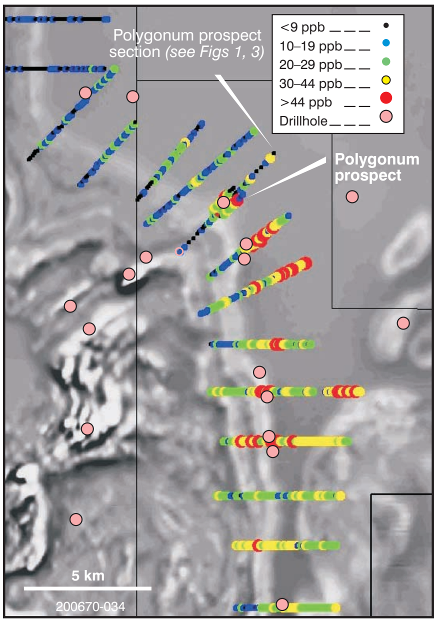

Fig. 2 Soil lines over the Polygonum trend superimposed on an aeromagnetic image; assays are for BCL silver.

Polygonum prospect (Fig. 2). A BCL silver profile over Polygonum is shown on Figure 3. This belt also contains patchy zones of anomalous BCL cadmium. Simple linear regression of BCL silver to ICP manganese and ICP calcium failed to improve this picture, although the regression to ICP manganese partially mirrors the raw data. It is suspected that a more detailed non-linear correlation, with additional variables such as pH, Eh, grain size and clay content, would prove enlightening as many correlations were noted in both the field and data. Unfortunately, the economic and time constraints placed on modern corporate exploration activities prevented this.

The silver pattern is less obvious to the north where the regolith changes from alluvium–colluvium to dominantly aeolian. The former has a more favourable argillaceous matrix and shallower sample horizon compared to the sandy matrix and therefore deeper sample horizon below the aeolian regolith. A more detailed understanding of the regolith and geochemical dispersion is warranted, as there is some debate as to the nature of anomalism given that the region lies on outwash plains adjacent to the upthrown Broken Hill basement block.

Drill testing of some gravity targets intersected a weakly mineralised package similar to that seen at Polygonum. Air core drill testing, to fresh basement, of soil anomalies failed to locate any improved grade within the package, but indicated that the surface geochemistry was seeing through 150 m of cover (Fig. 3).

Exploration through significant thicknesses of cover is expensive and confidence in the techniques applied is essential. The use of gravity as a tool to search beneath cover is by no means truly effective, with anomalies apparently caused by density contrasts in lithologies at the ‘Bimba’ contact. The ability to refine target generation using soil surface geochemistry is important, however this tool is not yet precise.

The development of reliable and robust surface geochemical techniques to ‘see through’ thick cover is a necessity for future exploration within Australia. Unfortunately the commercialisation of many deep penetrating methods has kept the techniques and their performance hidden, resulting in a ‘black box’ mentality. Most companies also lack the capital and access to appropriate test sites to adequately evaluate such techniques. This is where government bodies need to step in and assist in the development and appraisal of modern geochemical techniques. Such involvement would encourage investment in exploration and could lead to the discovery of new resources within their States.

Despite dramatically increasing exploration expenditures, there is a worldwide trend of fast-declining discovery rates (Blain, 1999). This is especially prominent in so-called mature exploration countries. If companies are to continue placing large amounts of exploration capital at risk in these mature terrains, they must have access to effective and reliable techniques. The Curnamona Province faces a significant challenge, along with the entire Australian exploration industry, to compete with other parts of the world where exploration maturity is lower and discovery depletion is low.

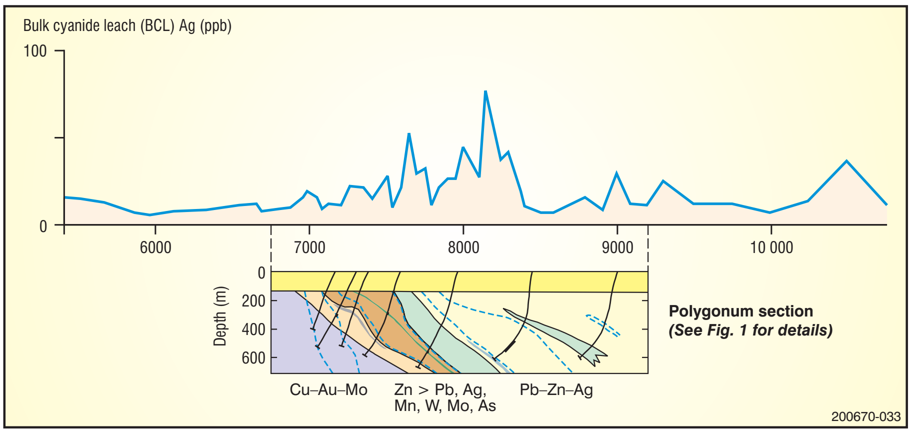

Fig. 3 BCL silver profile of the Polygonum section, with the Polygonum prospect section highlighted.

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