

Note: The potential for stratabound copper(-silver-platinum) mineralisation in the Rehoboth-Dordabis-Witvlei area, central Namibia: a new approach

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Potential exists for the further discovery of sediment-hosted copper and perhaps Olympic Dam-type breccia-hosted mineralisation on the margins of the inland branch of the Damara Orogen and in the underlying mid-Proterozoic basement. Previous investigations have focussed on or around known exposures of copper mineralisation, many of which were discovered in the last century. A new regional approach integrating the latest geological maps, the geochemical data base compiled by mining companies in the 1970s and the regional geophysical data compiled by the Geological Survey would almost certainly be more rewarding. Preliminary results indicate that the platinum group element (PGE) potential of the Southern Margin Zone of the Damara Orogen has not been fully assessed.

Introduction

Copper is one of the metals on which a technological society is based and its behaviour as an electrical and thermal conductor appears to ensure a long-term future for the metal in spite of threats of substitution by fibre optics and ceramic superconductors. Moreover, because of the large number of producers in the world, the metal is not as susceptible as other commodities to large price swings as a result of speculation or cartel sales. Furthermore, because of its inherent geochemical properties, copper is invariably associated with gold, silver and the platinum group elements (PGE) regardless of geological setting (Goldschmidt, 1958; Skinner, 1981). These metals commonly add considerable value to copper deposits. This note examines the potential for the discovery of copper mineralisation suitable for exploitation by opencast mining in central Namibia.

Mining and exploration history of the Rehoboth-Dordabis-Witvlei area

There are a large number of late-Proterozoic sediment-hosted copper(-silver) showings in the Rehoboth-Dordabis-Witvlei area (Fig. 1; Killick, 1986; Ruxton and Clemmey, 1986) and both the Oamites (Lee and Glenister, 1976) and Klein Aub mines (Ruxton, 1986) supported substantial underground mining operations for several years (Oamites: 6.1 million tons at 1.33% Cu, 12 g/t Ag; Klein Aub: 6 million tons at 1-2% Cu, 50-100 g/t Ag). The copper sulphide mineralisation is hosted by both argillaceous and arenaceous lithologies and is the strike extension of the Zambian Copperbelt (Toens, 1975). Potential exists in the same area for the further discovery of sediment-hosted stratabound copper deposits and possibly Olympic Dam-type (Roberts and Hudson, 1983; Selby, 1991) breccia-hosted copper mineralisation that would be suitable for open-cast mining. Although exploration was conducted for stratabound copper deposits in central Namibia during the 1970s (particularly by Anglovaal and General

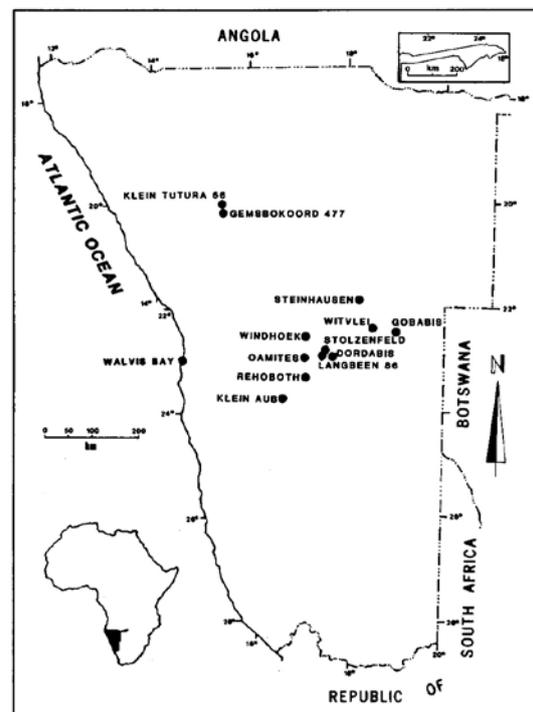


Figure 1: Location of the sediment- and breccia-hosted copper mineralisation of Namibia

Mining), several factors indicate that a new, regional approach would be more rewarding. Firstly, regional geological mapping conducted by the Geological Surveys of Namibia and Botswana during the 1980s has improved geological understanding of the area (Hoffman, 1983, 1987, 1989; Hoffman and Schalk, 1987; Aldiss and Carney, 1992). Secondly, investigations into the geology and geochemical nature of the central Namibian copper deposits (Borg, 1988a, 1988b; Borg and Maiden, 1986; Borg *et al.*, 1988) have brought to light several ideas and concepts worth testing. Thirdly, there is a large amount of geochemical data on copper contents in soils that was obtained during regional soil sampling programmes conducted by mining companies in the 1970s. This data has not been analysed by computer on a regional basis nor integrated with the new

geological maps. Fourthly, the regional geophysical data, especially the aeromagnetics, available could be reprocessed and refined by high-resolution techniques. Thus detailed geophysical maps for the area could be produced quickly and at relatively low cost. Finally, the area of central Namibia targeted for copper exploration lies within 200 km of Windhoek and has good infrastructure (notably roads and electricity and, to a lesser extent, water). Infrastructural development in the area will increase with the completion of the Trans-Kalahari Highway.

The regional geology: similarities with South Australia

Late-Proterozoic sediment-hosted copper deposits are common throughout the world (Windley, 1977; Boyle *et al.*, 1989). The main advantage to explorationists of stratiform/stratabound copper deposits compared to porphyry copper systems and cupriferous massive sulphide ore bodies is that the former tend to have both a high-grade and high-tonnage potential (Gustafson and Williams, 1981). Attention is drawn to the similarity of the styles and variety of sediment-hosted copper mineralisation found in the Southern Margin Zone (SMZ) of the late-Proterozoic/early Paleozoic Damara Orogen in central Namibia and the well-documented Stuart Shelf - Adelaidean Geosyncline of South Australia. A good review of the regional controls on the location of late-Proterozoic stratabound copper deposits in southern Africa and South Australia has been given by Maiden *et al.* (1984). In all cases the tectonic setting is intracratonic or epicratonic and the sequences are dominated by medium- to coarse-grained, red-coloured clastic sediments. There is, however, no consistency in lithology or depositional environment of the host rock. Particular emphasis was placed by Maiden *et al.* (1984) on the sedimentary onlap of copper-bearing sequences onto a basement high, a common occurrence in the SMZ. Hoffman and Schalk (1987) have shown the importance of thrusting in the SMZ and the duplication of sequences. This is relevant because in several areas the Damaran sediments are almost flat-lying and, where cupriferous, would be amenable to opencast mining.

It is instructive to look at the history of the Western Mining Corporation exploration programme for copper in southern Australia during the period 1957-1975 which culminated in the discovery of the massive copper-uranium-gold ore body (2000 million tons at 1.6% Cu, 0.6 g/t Au) at Olympic Dam (Roberts and Hudson, 1983). Long-term planning was essential for this find. The area was selected for copper exploration because of the large number of copper showings in essentially unmetamorphosed sediments. The initial idea tested was that copper had been derived from extensive leaching of underlying altered basalts in the basement. Although the presently accepted genetic model for the Olympic Dam deposit (see Youles, 1984; Mortimer *et al.*, 1988;

Oreskes and Einaudi, 1990) is far removed from the initial model in terms of genesis and metal associations, the aim of the exploration programme in 1957 was to locate a stratiform copper ore body and in 1975, after several interruptions in the exploration programme, a sedimentary breccia-hosted (principally) copper deposit was discovered. The SMZ of central Namibia which has a plethora of copper showings, both in late Proterozoic sediments and the underlying basaltic rocks (Dordabis Formation; Williams-Jones, 1984; Williams-Jones and Marsh, 1985), these lithologies themselves underlain by rifted granitic crust (which itself contains numerous copper, gold and uranium showings) and with a history of medium-scale copper mining, is at the same stage of development as South Australia was in 1957. Moreover, the SMZ, much of which is covered by windblown sand, is prospective for hidden Klein Aub/Oamites-type copper mineralisation which may only be lying at a depth of several metres below surface.

Mineralogy of the copper ores of the SMZ and their platinum potential

The cupriferous ores of the SMZ are characterised by a relatively simple sulphide mineralogy and are commonly suitable for liberation by flotation. The ores at Oamites (chalcopyrite, bornite, pyrite and chalcocite; Lee and Glenister, 1976) and Klein Aub (chalcocite; Klein Aub Koper Maatskappy Beperk Field Guide prepared for Chamber of Mines visit in 1981) contain significant silver concentrations (6 g/t Ag and -80 g/t respectively). A comprehensive petrographic description of the Witvlei copper ores, and thus the type of ore that can be expected in the SMZ, was given by Anhaeusser and Button (1973). Borg *et al.* (1988) have conducted preliminary research on the platinum (up to 0.12 g/t) and gold (up to 0.066 g/t) potential of the Cu-Ag ores of the SMZ.

Aims of exploration

Three primary and overlapping aims of an exploration programme for stratabound copper have been identified. The first of these is to locate sediment-hosted copper mineralisation of Klein Aub or Oamites type suitable for exploitation by opencast methods. The general model which will help define exploration targets at this stage is that copper was leached from basalts in the basement and was reprecipitated in the overlying Damaran sediments (the original Olympic Dam model). The second aim of an exploration programme would be to look for Olympic Dam-style mineralisation, i.e. breccia-hosted copper mineralisation, in the pre-Damara basement. A third aim would be to investigate the potential for low-grade (0.4-1.0% Cu), but high-tonnage (20 million tons) stratabound copper mineralisation near thrust faults that is flat-lying (possibly duplicated by thrusting) and is amenable to opencast mining.

Methods to be employed

A possible methodology would be as follows:

- obtain all the soil sampling data (specifically copper) compiled by mining companies over the last twenty years from the Geological Survey of Namibia and then plot the data (or composite data) with a digitiser on maps at a scale of (say) 1: 10 000 for the SMZ and Southern Zone (SZ), i.e. the area Windhoek-Steinhausen-Gobabis-Rehoboth-Klein Aub, taking the Kalahari sand cover north of Gobabis as the northeastern limit;
- compile a composite stratigraphic, lithological-geochemical map(s) of the SMZ/SZ to identify prospective lithostratigraphic packages;
- use the regional geophysical information (primarily the aeromagnetics, but also the gravity) held by the Geological Survey of Namibia to locate basement inliers (those that are hidden by Kalahari sand);
- look for a correlation between elevated portions of basement (palaeo-highs?) and copper mineralisation;
- look for block-faulted basement to identify major fluid pathways (these faults may be marked by volcanic rocks and magnetics may be used to distinguish Damaran from basement volcanic rocks);
- possibly conduct stratigraphic drilling in selected areas;
- conduct (possibly blind) percussion and diamond drilling on favourable horizons at 1-2 km intervals.

Two possible starting points

Southern Margin Zone (SMZ): Langbeen-Stolzenfeld area, Windhoek District

An area of sediment-hosted copper mineralisation that warrants further work is located between the farms Langbeen and Stolzenfeld, 50 km southeast of Windhoek (Fig. 1). On the farm Stolzenfeld 89, 1.5 million metric tons of copper ore has been proved to a depth of ~100 metres below surface by percussion drilling, but the overall grade of the mineralisation (~0.6% Cu) is too low to support underground mining. The host rock, a pebbly quartz-biotite schist, which may be the equivalent of the Chuos Formation, dips at 55°N and is probably the stratigraphic equivalent of the Oamites Mine Suite. Similar low-tenor chalcopyrite mineralisation developed over a strike length of several kilometres was investigated by Nu Exploration on the farm Langbeen 86 approximately halfway between the Oamites Mine and the Stolzenfeld prospects. Should any of these cupriferous rocks, which also contain 5-12 g/t Ag, dip at a relatively shallow angle (<20°), a modest opencast operation could be envisaged.

Northern zone (NZ): Gemsbokoord 477 and Klein Tutura 56, Outjo District

Located 80 km due west of Outjo on the southern side of the Kamanjab Inlier (the northern side of the Damara

Orogen; Fig. 1), a cupriferous breccia pipe several hundred metres in diameter hosted by Damaran sedimentary rocks on the farm Gemsbokoord and nearby uranium mineralisation in underlying mid-Proterozoic granitic basement rocks on the farm Klein Tutura is worthy of further work. The superficial similarities between this area and the lithologies and envisaged processes at Olympic Dam, South Australia, are striking.

Platinum potential in central Namibia: a concurrent assessment

Two PGE models thought to be worthy of testing are: (i) the PGE potential of the siltstones and mudstones of the Klein Aub Formation (formerly pre-Damaran, now part of the Damaran Tsumis Group; Hoffman, 1989) and (ii) the PGE potential of the Damaran serpentinite bodies of central Namibia. Gold and PGE are concentrated in cupriferous black shales in Poland (Kucha, 1982) and in the Zambian Copperbelt (Unrug, 1984; Unrug, pers. comm., 1992). The preliminary work conducted by Borg *et al.* (1988) shows that noble elements are enriched in the Klein Aub ore: their work is certainly worthy of follow-up both on a larger scale and to include those shales which are not cupriferous (see Kucha, 1982, on the locally antipathetic relationship between copper and PGE in the Polish deposits). The important role played by bitumens in the generation of base and precious metal deposits is now widely accepted (Parnell *et al.*, 1993). The well-documented serpentinite bodies in the Windhoek district (Barnes, 1982) are chemically classified as Alpine type (Miller, 1983). Whether they represent "the dismembered ultramafic portions of an ophiolitic sequence" (Barnes, 1982) or not, their PGE potential is worth investigating (Morrissey, 1988).

Conclusion

A pilot study of three- to four-months duration is envisaged as being the best way of initiating the project and assessing the chances of long-term success. This would involve a literature study (specifically to assess sampling methods and analytical techniques), compilation of the existing soil sampling copper data on a map and image processing system and geological reconnaissance in the Rehoboth-Dordabis-Witvlei area. The main aim of the pilot study would be to identify geographical areas, lithostratigraphic entities and geological features for more detailed investigation. For example large areas of the SMZ are underlain by Nosib Group clastic (fluvial) sediments which are almost certainly not prospective for copper.

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