ECONOMIC GEOLOGY RESEARCH UNIT

University of the Witwatersrand
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EVALUATION OF THE SANDAMAP NOORD TURBIDITE-HOSTED GOLD PROSPECT, CENTRAL NAMIBIA, FOR A HEAP-LEACH GOLD OPERATION : IMPLICATIONS FOR REGIONAL GOLD EXPLORATION IN THE NAVACHAB DISTRICT

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INFORMATION CIRCULAR No. 337

UNIVERSITY OF THE WITWATERSRAND

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by

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October, 1999

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ABSTRACT

A 3 400m-long zone of auriferous alteration and quartz veining within a high-strain zone in Pan-African-age (~750Ma) Kuiseb Formation schists has been identified, sampled, geologically mapped and diamond drilled on the farm Sandamap Noord, central Namibia. Potentially economic, on- or near-surface gold grades (2-3 g/t Au) over minable widths of up to 7m have been discovered on several drill-sections, though no minable ore has yet been delineated. Metallurgical studies, conducted in Australia, reveal that gold in oxidised and semi-oxidised rock is amenable to cyanide leaching. Recoveries range from 52 – 61% for column leach and 84% for bottle-roll experiments. In addition, considerable soil geochemistry, rock sampling data and orientation bulk leach extractable gold (BLEG) data for drainage sediments have been obtained. Sandamap is a type of late Proterozoic turbidite-hosted gold zone that shows certain similarities with Archaean mesothermal gold deposits. The mineralising event occurred during the intrusion of a late-tectonic, leucogranite-cored, diapiric dome. Auriferous fluids were channeled into structures that lie parallel to a major, regional magnetic lineament. It is speculated that the ultimate source of the gold was the Kuiseb Formation metasediments. It is considered that the Karibib-Usakos area remains highly prospective for metasediment-hosted (calc-silicate, marble and schist) gold mineralisation of magmato-hydrothermal origin. A regional geological and geochemical study of the area around Navachab - Sandamap using GIS methodology, similar to that presently being used in the Carlin Trend, Nevada, is recommended.

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Published by the Economic Geology Research Unit
Department of Geology
University of the Witwatersrand
1 Jan Smuts Avenue
Johannesburg 2001
South Africa

ISBN 1-86838-263-X

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INTRODUCTION

A 2 500m-long auriferous zone was discovered on the farm Sandamap Noord near Usakos, central Namibia in 1988 (Fig. 1; Steven, 1992; Steven et al., 1993). This paper documents the subsequent exploration and evaluation work conducted at this prospect. The Sandamap prospect is favourably located 30 km from Usakos in central Namibia, a country with a good technical and administrative infrastructure as well as an attractive mining, legislative and fiscal climate.

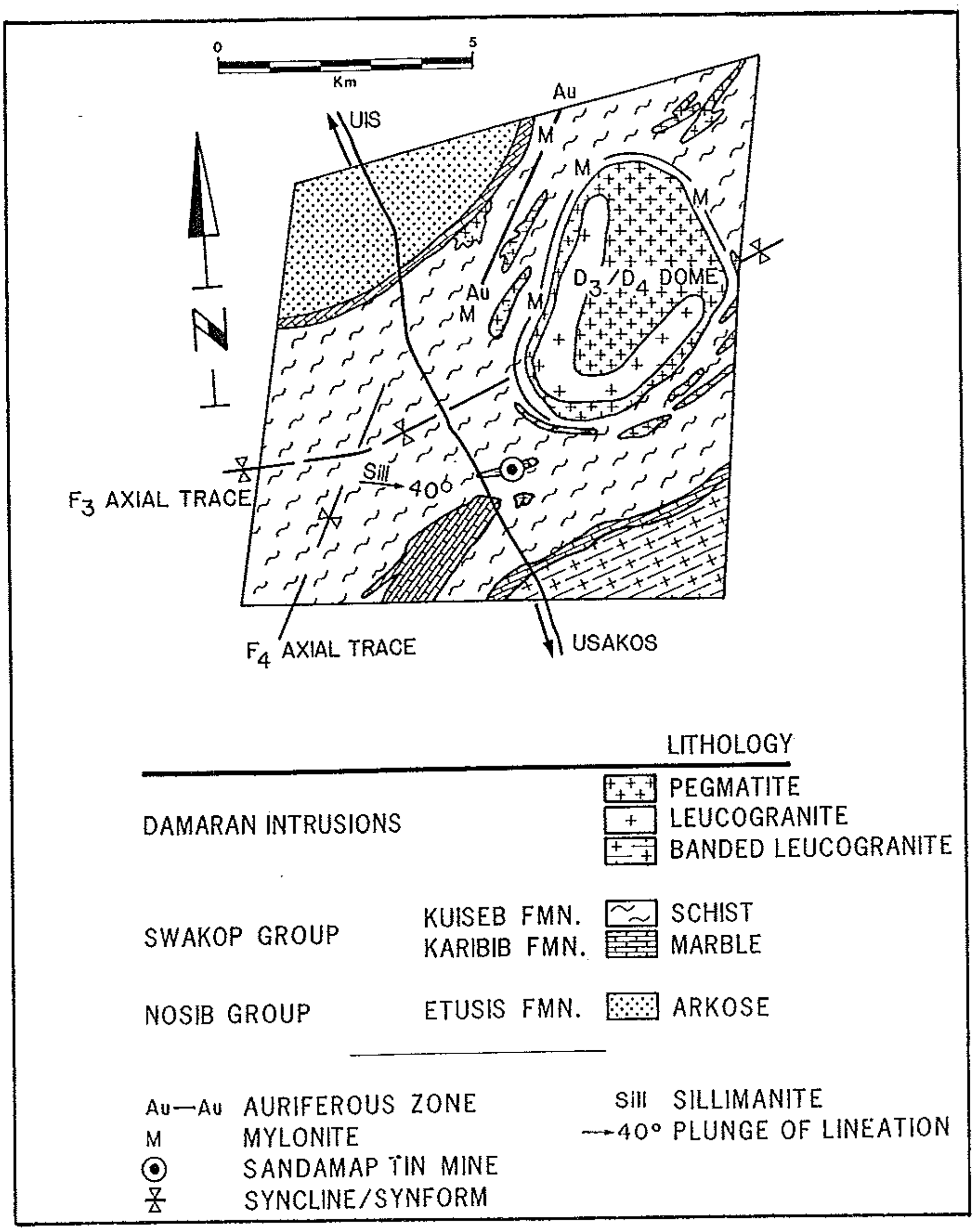

Figure 1: Simplified geological map of the Sandamap Noord gold prospect.

PROSPECT LOCATION, DISCOVERY, DESCRIPTION AND EXPLORATION HISTORY`

In early 1988, a sample of limonite-impregnated ferruginous schist from the farm Sandamap Noord, located 30km WNW of the town of Usakos, central Namibia, was determined to contain 18.6g/t Au (Steven et al., 1993). Further rock-chip sampling revealed the presence of a 2 500m-long zone of steeply dipping auriferous, ferruginous and jarositic schist, ferruginous quartz veins, gossan stringers and zones of alteration within Damaran (~750Ma) Kuiseb Formation schists. The presence of sheared lithologies, especially unusual quartz + fibrolite mylonite rocks (Vernon, 1987), indicates that the gold-mineralised zone occurs within a high-strain zone that is parallel to a prominent regional structure, the NNE-trending Welwitschia Lineament. Several gold grains, up to 0.1mm across, were identified optically in polished ore sections and then recovered from jarositic schist by panning in the Department of Geological Sciences at the University of Cape Town (UCT; Steven, 1992, 1993). Silicate, sulphide, oxide and sulphate minerals were identified optically or by X-ray diffraction and analysed using a Cameca electron microprobe.

The prospect was cursorily examined by Gold Fields Namibia and Genmin before being 'pegged' (i.e. covered by four claims; Fig. 2) by Namibia Mineral Development Company (NMDC) in 1992. Detailed geological mapping of the best-mineralised claims was then conducted to assess the areal extent of the mineralised zone and to determine the viability of a shallow, opencast, heap-leach operation. In 1993, NMDC entered into a Joint Venture agreement with the Australian-financed Namaust Exploration (Pty.) Ltd. to conduct a drilling and metallurgical assessment for oxidised, thus easily leachable, ore. Additional finance was raised through 'private placements' in Australia. Although respectable gold recoveries were obtained in the metallurgical tests conducted on drillcore, the ore resources delineated to date are too small to warrant gold exploitation. However, the zone, now known to be >3.4 km long, remains 'open' along strike and untested at depth for unaltered sulphide ore. The exploration conducted in the period 1993 - 1995 (namely the geological, geochemical, drilling and metallurgical work) is discussed in this report, but details of the regional and local geology are not repeated.

GEOLOGICAL AND GEOCHEMICAL DATA

Surface geological mapping

Geological mapping at a scale of 1:1 000 was conducted on the three claims covering the best-exposed mineralised rocks. The mineralised zone occurs in two NNE-striking, linear drainages (Fig. 2) that mark a subtle topographic depression one kilometre southeast of the Sandamapberg trigonometric survey beacon. The expression of the zone on the standard 1:50 000 aerial photographs and higher resolution 1:10 000 photography conducted by the Joint Venture is not prominent. The shear zone broadly strikes 030° (Fig. 1), but all planar structures (the major schistosity of the schist, the fibrolite-filled stringers in the pegmatite and the quartz + fibrolite rocks) dip steeply (60-85°) to the ESE

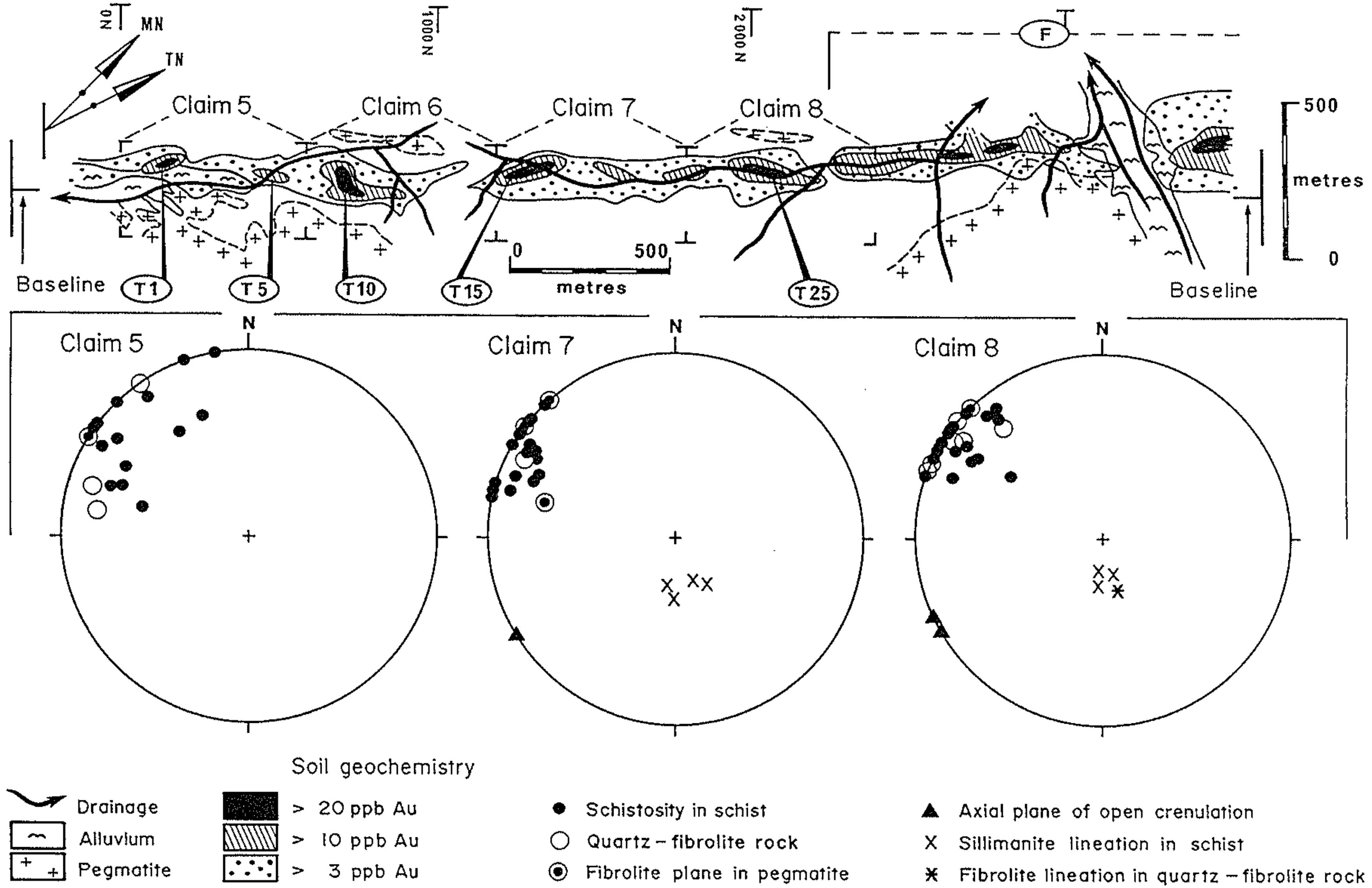

Figure 2: Simplified map showing key features of the soil geochemistry of the auriferous zone and stereograms showing the key structural elements of claims 5, 7 and 8.

or SE (Fig. 2). A steeply southward-plunging (60-80°) mineral lineation is evident in the schist and, to a lesser extent, in the quartz + fibrolite rocks (Fig. 2).

Rock and soil geochemistry

Rock-chip and channel sampling, conducted in three separate surveys by the author (1988-1989; Steven et al., 1993), Gold Fields Namibia (Petzel, 1990) and the NMDC-Namaust Joint Venture (Namaust, 1993, 1994), confirmed the presence of fine-grained gold in the range 0.2 – 4 g/t Au in the altered and ferruginous schist and quartz veins. Gold concentrations in rocks were determined by a combination of atomic absorption spectroscopy and fire assay at laboratories in Windhoek, Cape Town and Johannesburg. A statistical study of sixty surface rock samples collected by the author and analysed for gold by fire assay and arsenic by X-ray fluorescence spectrometry (XRF) gave an Au-As correlation coefficient of + 0.82 (average Au content = 1.25 g/t, standard deviation = 2.13 g/t ; average As content = 3 207 ppm, standard deviation = 5 570 ppm). The equation for the corresponding power curve is:

$$\text{Arsenic concentration in ppm} = 1\,987\,([\text{Gold concentration in g/t}]^{0.9})$$

The above results, plus the strong correlation between Au and As contents (+ 0.64) in an additional 32 rock samples of gossanous and altered schist, and the presence of loellingite (Steven, 1993) indicated a clear genetic association between these two elements. Consequently, 609 samples of the – 1mm fraction of the 'soil' (or, more correctly, degraded bedrock), at a depth of 15cm below surface were taken on a 3.4 km x 400 m grid every 25m at a line spacing of 80m. Samples were analysed for Au and As by Genalysis Laboratory Services (Pty.) Ltd. in Perth, Australia. The analytical technique employed was leaching and partial extraction of the gold followed by atomic absorption analysis.

A low order, 50 to 250m-wide, soil-gold anomaly (> 3 ppb Au) is present over almost the entire 3 400m of strike examined and extends to the northern Sandamap Noord fence boundary (Figs. 1 and 2). This anomaly remains 'open' at both ends. The soil is essentially 'in situ' residual rock and the anomaly reflects primary gold dispersion around the shear zone. Thus the entire shear zone (Figs. 1 and 2) is weakly anomalous in gold. Where mineralised schist is covered by the thin (< 1m-thick) Quaternary calcrete, rock rubble and creek alluvium, gold concentrations are attenuated in the cover sediments relative to the residual bedrock (Fig. 2). Using the 10 ppb Au and 50 ppm As values as thresholds, seven elongate gold anomalies (some with coincident arsenic) ranging from 100 to 700m in length were identified (six are shown in Fig. 2). The gold anomalies were defined by values in the 20-45 ppb Au range. Interestingly, the soil sampling supports an important surface mapping observation, namely that the best-mineralised portions of the shear zone are *en echelon* and are lying at 10-15° to the main structure (i.e. they are oriented at 015°- 020°). All the soil anomalies are located immediately above mineralised bedrock. Secondary dispersion of arsenic appears to be restricted to the physically dispersed mineralised detritus in the alluvial sediments of the creeks. No secondary gold or arsenic anomalies are present.

Geological data from diamond drilling

Eight short diamond drill holes (NQ diameter; total metrage of 356.90m) were drilled by RUC Namibia (Pty.) Ltd. to test three anomalies at vertical depths of 10-15m and 25-30m below surface. The drilling programme was designed to identify oxidised and semi-oxidised ore suitable for extraction by opencast mining methods and heap leaching. It was considered that mining costs for opencast mining to shallow depths would be relatively low and that narrow oxidised zones defined over extensive strike distances could yield a substantial tonnage of ore. The T15 anomaly was investigated in detail (six holes; SND1-6), while the T5 and T25 anomalies were tested by one scout hole each (SND7-8). No significant drilling problems were encountered. Core recovery and water return were good and, importantly from an extraction perspective, little pegmatite was encountered; this lithology comprises less than 3% of the drilled core.

The unmineralised metaturbidites of the upper Kuiseb Formation are quartz+biotite+cordierite±sillimanite schists. A gneissic (almost augen gneissic) texture is locally developed. Where the schist is lenticular and has been sheared and subjected to extreme flattening, cordierite is absent and the schist contains white streaks of fibrolite/sillimanite up to several centimetres long. Biotite is concentrated in folia and may be accompanied by small (<2mm diameter) pink garnets. Elsewhere in the high temperature-low pressure Central Zone of the Damaran Orogen, garnet is extremely rare (Steven, 1993). In the auriferous zone, a porphyroclastic texture is locally developed. Streaky rocks with a more planar texture are interpreted to be portions of a high-strain zone that is the host to auriferous/ferruginous alteration (Fig. 3). Steeply pitching (60-90°) biotite and sillimanite lineations within the plane of schistosity appear to be extension lineations, implying that the major (or most recent?) movement on the shear zone has been almost parallel to the dip of the zone. In contrast, the unsheared schist, in which cordierite porphyroblasts can be readily identified, only contains obvious signs of alteration and ferruginisation in the immediate hanging and footwall of the target zone (Fig. 3). Several boreholes intersected thin (<0.5m), fine-grained, magnetic mafic dykes whose contacts are parallel to the schistosity in the enclosing schist (Fig. 3).

The nature and intensity of the alteration (which has presumably been modified by weathering in an arid climate) varies considerably, but can generally be described as a cream yellow or buff kaolinite-alunite-jarosite-garnet rock with ferruginous alteration and quartz veins. The alteration/weathering at depth is the same as that on surface. Much of the jarosite is a weathering product. Carbonate alteration is very minor except in an unusual calcite+graphite+tourmaline rock. The enclosing schist contains zones of foliation-parallel ferruginisation and, locally, cross-cutting veins of iron oxides. Thus there is an alteration envelope (up to 13m thick) on either side of the most obviously mineralised rock; the latter has a true thickness of 1-7m (Fig. 3). Several subsidiary zones of ferruginisation that are weakly mineralised with gold were identified in all boreholes.

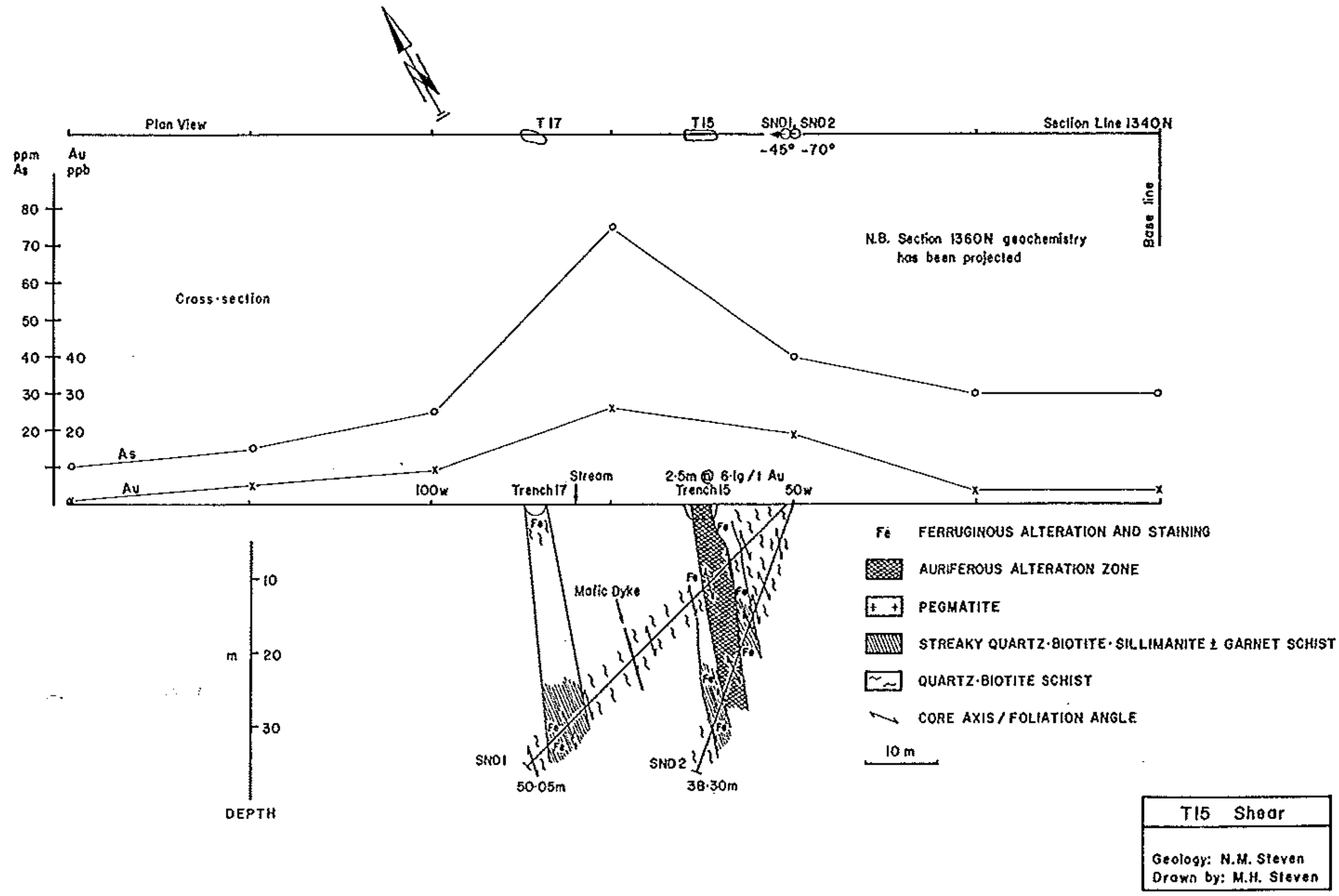

Figure 3: Cross-section of the 1340N gridline showing the soil geochemistry and drillholes SND1 and SND2.

Gold assay results and gold distribution

The highest gold grades occur on surface in altered rocks at the T15 target, which was tested with six holes over a strike length of 160m (Fig. 2). Greyish quartz veins are associated with lower-grade contents (<1g/t Au). Ninety-eight samples of mineralised core were analysed for their gold contents by Genalysis (Pty.) Ltd. in Australia. The drilling intersections exceeding a provisional 0.4 g/t Au cut-off (Table 1) were calculated following the methods of Wellmer (1986) and Stone and Dunn (1996). In most intersections, there is internal dilution (material assaying below the cut-off), but this waste is mineralised in the 0.1-0.4 g/t Au range. It is unlikely that this waste could be easily identified during a mining operation and it is considered that it would be treated as ore. The gold contents of drillhole intersections (Table 1) are similar to those recorded in surface chip and channel samples. Thus, there is no evidence of gold enrichment or depletion at the present-day surface or in drillcore.

A high correlation (+ 0.99) between the initial and repeat assays of 40 of the 98 drillcore samples that were analysed in duplicate, supports all previous observations and data that

Table 1: Sandamap diamond drilling results using a 0.4 g/t Au cut-off

Hole No.	From (m)	To (m)	Int. Width (m)	True width (m)	Au (g/t)
SND1	9.00	16.50	7.50	5.99	3.32
SND2	16.70	26.80	10.10	7.02	2.07
	20.80	26.80	6.00	4.17	3.01
SND3	19.00	21.00	2.00	1.53	1.69
SND4	24.44	27.30	2.86	1.60	1.51
SND6	17.05	18.00	0.95	0.73	0.56
SND8	12.70	14.65	1.95	1.75	1.03

the majority of the gold at Sandamap is fine-grained (<100μm). Summary statistics are presented for the 98 samples of split core sent for assay (Table 2) and the frequency distribution using a 0.25 g/t Au assay class interval is shown in Figure 4.

Table 2: Summary statistics for 98 samples of drillcore

	Au (g/t)
Mean	0.77
Median	0.08
Mode	0.04
Standard Deviation	1.69
Sample Variance	2.85
Kurtosis	16.72
Skewness	3.70
Range	11.19
Minimum	0.01
Maximum	11.20
Sum	75.05
Confidence Level (95.0%)	0.34

An additional 103 samples of drillcore (taken on a one-metre sampling width) were analysed by the Navachab Gold Mine (NGM) laboratory to determine whether low-grade gold concentrations are present in the Kuiseb Formation schist that is not visibly altered. The lower limit of detection for this analytical work was 0.1 ppm Au (Badenhorst, 1994, pers. comm.). No gold contents of economic interest were recorded by NGM.

Metallurgical work

One quarter of the assayed core was tested for amenability to cyanide leaching by J.C.N. Mining Services in Kalgoorlie, Western Australia. A relatively small composite sample (17.6kg) of the six best intersections (Table 1) was made. This represented 24.29m of core with a weighted average grade of 2.18 g/t Au. Several samples with gold grades in the 0.2 – 0.4 g/t Au range were included to increase the composite sample size. This

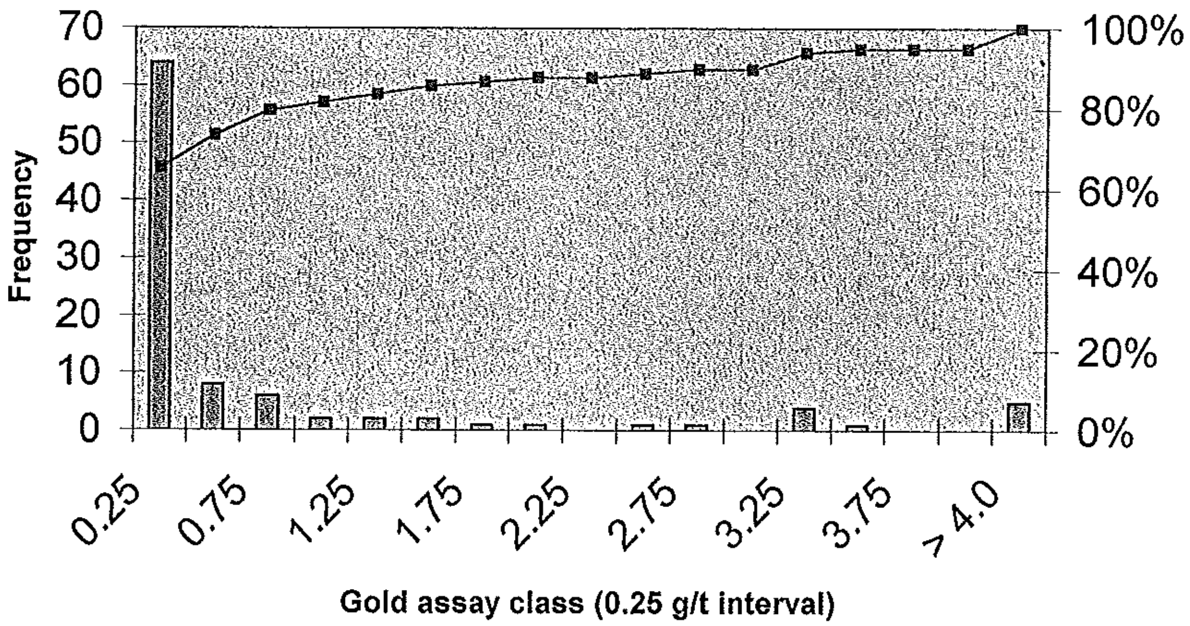

Figure 4: Gold grade distribution in 98 samples of drillcore.

accounts for the fact that grade of the composite sample (2.18 g/t Au) is lower than the indicated resource grade of 3.6 g/t Au for the T15 target.

Crushing

All drillcore was crushed with the jaw crusher set at 25mm and all material subsequently passed the – 22mm square mesh. One quarter of this product was then crushed at 9 - 10 mm and used for the finer leach size.

Bottle roll test

Approximately 84% of gold was recovered by leaching of 2.08kg of fine-ground (70% -75 micron) sample in a 24-hour period. No additional work was done to determine whether gold recovery could be improved with a finer grind or whether the ore was refractory.

Column leach

For the column leaching tests, 6.32kg of coarse product (-22mm) was leached in a 140 mm column and 2.2kg of fine material (-10mm) was leached in a 75mm column. The ore was immersed in cyanide at all times during the 42-day period. Coarse recovery was 51.8%, fine 61.4%. It was concluded that a better recovery (perhaps 66%) could be obtained if the ore is crushed to a size of between 4 -11mm.

Summary

The majority of the gold is readily extractable by simple cyanide leaching. With finer crushing, it appears that gold recoveries would be in the range 55-65%. Most of the gold is 'free' and lock-up of gold within sulphides, at least within the oxidised material, appears to be minimal. The small size of the composite sample notwithstanding, these results are encouraging.

Gold grain morphology and chemistry

The ferruginous schist sample containing 45.8 g/t Au (the highest assay recorded) was dissolved in hydrofluoric acid and the largest gold grains from the residue were examined optically. The dimensions of the seven largest grains are given in Table 3. The average geometric mean grain size of the seven largest particles is 105µm. A representative chemical analysis of a gold grain, determined by electron microprobe, is as follows: 98.04 wt% Au, 1.63 wt% Ag and 0.14 wt% Hg (Total = 99.8 wt%).

Table 3: Dimensions of the seven largest gold grains at the Sandamap Noord gold prospect

Sample No.	Length (µm)	Width (µm)	Geometric mean* (µm)
NSP8-1	113	83	97
NSP8-2	15	15	15
NMSL733-1	285	148	205
NMSL733-2	148	126	137
NMSL733-3	100	50	71
NMSL888-1	200	126	159
NMSL888-2	52	44	48
Mean (n=7)	130	85	105

Geometric mean = µ (Length in microns x Width in microns)

Indicated gold resources at the T15 target

The best results were obtained in boreholes SND1-4 at the T15 target, which remains open to the north and at depth. A resource calculation using a relative density of 2.4 g/cm^3 indicates a resource of 45 000t at a grade of 3.6 g/t Au to a depth of 40m below surface (Namaust, 1994).

Bulk cyanide leach orientation survey on Quaternary drainage sediments

Five creek or drainage sample sites were selected for a bulk cyanide leach (BLEG) orientation survey. At each site, two 5 kg sieved samples (–1mm/+425µm fraction and –1mm fraction) of creek sediment were collected. No particular sample site selection strategy was pursued, other than avoiding very coarse material, because the drainages are partly derived from sheetwash. Samples were analysed by Exploration Services (Pty.) Ltd. in Windhoek for their gold contents using a cyanide leach (see Table 4). Samples taken at the northern end of the gold zone are clearly anomalous whereas those at the southern end have slightly elevated contents. The data set is too small to draw any major conclusions, but BLEG sampling would be of assistance in locating a gold zone of the Sandamap type.

Table 4: Gold contents in ppb for ten 5 kg bulk cyanide leach (BLEG) orientation samples in two sample fractions

Sample Nos.	-1 mm +425µm	-1 mm	Site Description
BL01, BL02	6.3	2.4	NNE end of Au zone
BL03, BL04	0.6	0.6	1 km downstream from BL01 and 02
BL05, BL06	0.4	0.8	Granite terrain: supposed background
BL07, BL08	0.9	0.9	SSW end of Au zone (trench #1)
BL09, BL10	0.2	0.3	1 km downstream from BL07, 08

STABLE ISOTOPE INVESTIGATION OF CALCITE+GRAPHITE+TOURMALINE ALTERATION

A single sample (NS303) of the unusual calcite+graphite+tourmaline rock (Steven et al., 1993, fig. 8) was petrographically and isotopically investigated in the Department of Geological Sciences, University of Cape Town (analytical methods are documented in Steven and Moore, 1994). This fine-grained, massive, black rock contains calcite (40-50%), graphite (~30%), tourmaline (~10%), quartz (~10%), muscovite (~5%), scapolite (2-3%), brown mica (possibly biotite, ~1%) and gossan after sulphide (~1%). The graphite is very ragged, occurring as clots. Tourmaline occurs as stubby prisms (0.2 - 0.5 mm) with numerous inclusions of graphite. Quartz is extremely angular and has a 'hydraulically fractured' appearance. Calcite is anhedral and is interstitial to all other minerals; thus it is probably late-stage. This rock, unknown elsewhere in the central Damara, is interpreted to be a type of cataclasite/alteration associated with the shear zone. Disseminated graphite is a fairly common accessory mineral (up to 2 volume %) in the Kuiseb Formation schists (Steven, 1993). Concentrations of graphite may have arisen from mylonitisation of schist. Similarly, the calcite may be derived from fragments of the southeastward-dipping Karibib Formation marble (see dome to northwest of auriferous zone; Fig. 1) that were caught up in the NNE-trending shearing event.

Electron microprobe and whole-rock geochemical analysis (see Steven et al., 1993, p.847), confirmed that the carbonate is an almost pure calcite. The carbonate has a $\delta^{13}C_{PDB}$ value of –5.4 ‰ and a $\delta^{18}O_{SMOW}$ value of +24.4‰, whereas the organic fraction, essentially graphite, has a $\delta^{13}C_{PDB}$ value of –10.0‰. It appears as if the graphite and the calcite were not in isotopic equilibrium. The field relationships between the calcite+graphite+tourmaline rock and the shear zone are obscured by scree; thus not many conclusions can be drawn from one sample. However, the carbonate $\delta^{13}C_{PDB}$ value of –5.4‰ is almost in the middle of the range of $\delta^{13}C_{PDB}$ values (-2 to - 8.5‰) reported for hydrothermal carbonate from the Yilgarn Block and Abitibi Belt gold deposits (Colvine et al., 1988). The simplest interpretation is that the carbon in the carbonate was derived from a magmatic reservoir and could be 'a testament to the common source and processes' (Colvine et al., 1988) involved in the Canadian and Australian Archaean gold systems and Sandamap. The $\delta^{18}O_{SMOW}$ value of +24.4‰ for the carbonate is too high for a magmatic origin, but within the range (21 – 28‰) for marine carbonates that have been regionally metamorphosed (Frimmel, 1999, pers comm.). Thus the favoured interpretation of the oxygen isotopic data of the carbonate is that the oxygen was derived from fragments of Karibib Formation marble.

GEOLOGICAL RECONNAISSANCE WORK IN THE REMAINDER OF THE SANDAMAP - DAVIB OST TIN BELT

Many of the geological and geochemical features of the Sandamap zone are particularly unusual within the Central Zone of the Damara Orogen (Miller, 1983; Steven, 1993). The combination of high strain zone rocks, quartz+mylonite rock, grunerite assemblage, calcite+graphite+tourmalinite rock, garnetiferous schist, kaolinite+alunite+jarosite rocks, associated galena-bearing quartz veins, and a prominent arsenic anomaly at one locality, Sandamap Noord, is especially notable. Surprisingly, the expression of the Sandamap gold zone on aerial photographs is restricted to two linear drainages oriented 029-030°, but there are no features of special note. A preliminary assessment of the Sandamap – Davib Ost tin belt for additional gold zones is reported below.

Attention was focussed on the northeastern section of the Sandamap – Davib Ost tin belt where the metamorphic grade is lower than at Sandamap, specifically the farms Brabant, Davib Ost, Elsenhof, Cameron and Goabeb. All available geochemical data collected by exploration companies for the relevant farms were obtained from the Geological Survey of Namibia in Windhoek.

On Brabant, the BLEG Au anomalies are on the periphery of the Brabant leucogranite where the Kuiseb Formation cordierite schist or hornfels has been tourmalinised. There is a suggestion on Brabant that a magmatic-hydrothermal continuum (leucogranite dome - stanniferous pegmatite - tourmalinite - weak hydrothermal Au+As mineralised zones in the country rock) is present, as suggested by Steven (1993) elsewhere in central Namibia. Auriferous tourmalinites have been documented at Ohere in the Damaran Orogen by the author and a replacement origin for the central Namibian tourmalinites has been proposed by Steven and Moore (1995). These granite-cored domes are surrounded by Buchan-type metamorphic assemblages (cordierite, andalusite, sillimanite). On Brabant, the peak metamorphic grade was greenschist facies or lower amphibolite facies and there is a lower degree of deformation than at Sandamap.

On Davib Ost, several prominent drainage sediment gold and arsenic anomalies were followed up. The most notable feature is that weak BLEG anomalies occur in streams underlain by Kuiseb Formation schists. Indeed, the entire schist belt is geochemically defined. Areas underlain by granite are usually not anomalous in any of the base metals or gold. It is evident that there are at least three explanations for elevated arsenic concentrations in the stream sediments other than auriferous high-strain zones of Sandamap type:

1. there is disseminated pyrite and arsenopyrite of syndiagenetic or synsedimentary origin within Kuiseb Formation metaturbidites and schists (see Steven, 1993, p. 151 for a discussion);
2. scorodite after loellingite is common in pegmatites (e.g. Sandamap tin mine) ; and
3. there are arsenic anomalies on the margin of (and probably related to the intrusion of) the early Cretaceous (140 – 130 Ma) Erongo Complex (Pirajno, 1990).

Similarly, on Elsenhof, Cameron and Goabeb, greenish alteration in pegmatites is reminiscent of scorodite at Sandamap. The arsenic anomaly on the western side of Cameron is the strike extension of a particularly prominent arseniferous zone on Sandamap detected by Anglo American as long ago as 1980 (Keenan, 1983). Other arsenic and low-order gold anomalies are probably related to elevated concentrations of these metals in disseminated, synsedimentary/diagenetic sulphides within the tin belt sediments.

In summary, no additional gold or high strain zones were discovered using basic prospecting methods and geological knowledge. Further visual inspection of the tin belt will achieve little, but a thorough geochemical or scientific survey integrating the geology and the geochemical data already collected has yet to be conducted.

SUMMARY AND IMPLICATIONS FOR FURTHER EXPLORATION

Sandwiched between two late-tectonic domal structures (Fig. 1) and lying parallel to the Welwitschia Lineament Zone, the genesis of the Sandamap Noord turbidite-hosted Au-As zone is debatable. Nevertheless, if a 3.4km-long auriferous zone, with visible gold (and contents of up to 48.6 g/t Au) can still be found on surface in an area of Namibia with a prospecting, exploration and mining history exceeding 135 years, then a re-evaluation of the Karibib-Usakos area for auriferous magmato-hydrothermal deposits using a geographical information system (GIS) could be rewarding. A very large amount of geochemical data (from rock samples, drainage and soil sampling and BLEG) was generated during the 'Navachab gold rush' of the late 1980s using the best analytical techniques available at the time. All these data are now stored at the Geological Survey of Namibia and are worthy of geochemical terrain and favourability analysis (Harris et al., 1993). Any regional linear arsenic, bismuth or tellurium anomaly (Steven et al., 1994) is considered worthy of investigation for possible vapour-rich portions of a magmatic system, as it is in Nevada (Kotlyar et al., 1998). The Canadian company Echo Bay Mines Ltd. conducted such a study recently in Nevada with exceptionally interesting results (Dean Turner, 1999, pers. comm.). The latest research on gold enrichments in the vapour phase of porphyry and magmatic systems (Kesler, 1999) indicates that a knowledge of "potentially large radii, commonly 5 km or more" (Sillitoe and Bonham, 1990) around such systems (such as Navachab) will be essential for future successful gold exploration.

ACKNOWLEDGEMENTS

Le Roux van Schalkwyk (NMDC) is thanked for general assistance, many stimulating discussions over the years and retaining an open mind. Frikkie Badenhorst of the Navachab Gold Mine is thanked for considerable logistical assistance and advice during the drilling operations. The late Dick Rickard is thanked for his help in determining mineral compositions with the electron microprobe at the University of Cape Town (UCT). Kevin Faure (formerly of UCT, now with the Institute for Geological and Nuclear Science, New Zealand) is particularly thanked for conducting the stable isotope analysis. Hartwig Frimmel (UCT) commented on the isotopic data. Moeve Steven is especially thanked for her work and loyalty in the field, core-yard, laboratory, drafting room, office, on the telephone and at the end of a fax (sometimes on another continent) over the years.

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