PRELIMINARY REPORT ON THE CAPE CROSS - UIS PEGMATITE FIELD*  

by  

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ABSTRACT  

Numerous Sn- and Nb-Ta-rich pegmatite bodies are present in a NE-trending, approximately 20 km wide zone, consisting of schistose Damara metasediments and granites, in the area between Cape Cross and Uis. Structural analysis led to the recognition of the Cape Cross - Uis pegmatite field as a graben structure. Emplacement of stanniferous pegmatite bodies was structurally controlled by graben-related, en echelon Riedel-fractures. Three major pegmatite swarms, Uis, Strathmore and Karlowa, are located in clearly defined N-S trending, fracture-bounded zones. Significant Sn, Nb and Ta mineralization occurs in replacement units showing intensive albitization and greisenization. Detailed mapping and structural analysis suggests a younger age than previously postulated for the mineralized pegmatites. A possible Jurassic - Cretaceous age of mineralization is discussed.

1. INTRODUCTION  

The “Northern Tin Belt” of SWA/Namibia, as defined by Gevers and Frommuz (1929), forms a NE-trending zone extending from Cape Cross to an area north of Uis, near the Brandberg complex (Fig. 1). This area is more accurately described as the Cape Cross - Uis pegmatite field. This report presents some preliminary observations on the field relationships and structural setting of economically interesting stanniferous pegmatites in this area.

North-east of Henties Bay, highly metamorphosed rocks of the Tsaun Formation, Nosib Group, are exposed. Metasediments of Damaran age, belonging to upper and lower Swakop Group, consist of biotite-muscovite schist, quartz-feldspar schist, knotenschiefer, quartzite, calc-silicate, marble and tourmalinite. This succession is of eugeosynclinal character (Martin, 1980; for the plate tectonic setting see Miller, 1983) and the present lithotypes originated from regional metamorphism during the Pan-African.

Three major folding phases were active (Botha et al., 1974c). The metasediments were intruded by a suite of granites, representing syn- and late- to post-tectonic phases of igneous activity. Various types of granitoid rocks occur, but most are generally muscovite poor/biotite rich. Most of these granitoids belong to the Salem granite suite of Miller (1973) and Botha et al., (1974a). Predominant rock types are foliated biotite granites, two mica granites, tourmaline-garnet granites and unfoliated leucogranites. In addition a red biotite granite of the Sorsis-Sorris type, as described by Martin (1965), is also recognized.

A wide range of syn- and post-tectonic pegmatites intruded the Damara sediments. These pegmatites have been prospected for Sn, Nb, Ta, Li, Be and REE since the early years of this country. Two tin mines are situated in the Northern Tin Belt: the Uis mine and the defunct Strathmore mine.

During late Jurassic to early Cretaceous the Damara metasediments were intruded by swarms of dolerite dykes and a dolerite cone sheet which occurs some 10 km north of Uis.

Igneous activity during the early Cretaceous is attested to by the alkaline to peralkaline granitic and gabbroic ring complexes of Brandberg, Messum and Cape Cross.

2. STRATIGRAPHY  


2.1 Nosib Group  

Rocks of the Nosib Group occur in an area some 50 km ENE of Cape Cross (Fig. 1) and consist of a quartz-feldspar gneiss sequence with subordinate amphibolite and biotite-cordierite schist, granulite and conglomerate (Botha et al., 1974b). This sequence has been named the Tsaun Formation; it is characterized by high grade regional metamorphism of cordierite-amphibolite facies (Botha et al., 1974b). It is difficult to determine the exact stratigraphic position of the Tsaun Formation and Botha et al. correlated it with the Abibas and Huab Complexes. A Nosib age of the Tsaun Formation (Botha, 1978) and correlation with the Khan and Nauwpoort Formations was suggested by Jacob and Kröner (1977). Structural investigations and detailed mapping show that the northern contact between Tsaun Formation and Khomas schist (including intrusive Damara...
granites) is of a tectonic nature. At the western contact
Khomasschist and granites are downthrown against
rocks of the Tsaun Formation by a significant N-S strik-
ing fault, along which intense brecciation occurred.
Thin, concordant marble horizons are limited to the
south-western portion of the Tsaun formation.

2.2 Swakop Group

Marbles of the Karibib Formation are usually ex-
posed in inselbergs, that occur on the southern side of
a NE-trending fault extending between Uis and the At-
lantic Ocean.

Sediments of the Khomas Subgroup are widespread in
the Cape Cross-Uis pegmatite field, and are highly de-
formed and metamorphosed (upper greenschist facies,
Botha et al., 1974c). The Kuiseb Formation consists of
a monotonous, schistose-quartzitic succession with
interbedded marbles, calc-silicates and tourmalinites.
The schistose sequence contains biotite schist, quartz-
feldspar schist, muscovite schist and knotted schist
(knotenschiefer). Botha et al. (1974c) estimated a total
thickness of about 2 000 m for the Khomas sediments
in this part of the Damara Orogen. Khomas schist oc-
curs in a zone extending from NE of Uis to the Atlantic
coast around Cape Cross (Fig. 1). Exposure is good in
the north-eastern portion of this zone, but the rocks are
increasingly covered by sand and calcrite towards the
south-west.

2.3 Karoo Sediments

A small occurrence of greyish siltstone, located some
10 km south of Uis, is a relict of formerly more exten-
sive Karoo sediments.

3. NON-PEGMATITIC INTRUSIVE ROCKS

3.1 Damaran Granites

Five major granite types, exhibiting a wide range in
composition and age, are distinguished in the study
area:

(i) greyish, coarsely-crystalline to porphyritic, foli-
ated, biotite granite - syntectonic.
(ii) greyish-white, homogeneous, fine- to medium-
grained, two mica granite - late to post-tectonic.
(iii) leucocratic, foliated and unfoliated tourmaline
granites of aplitic character (some of them garnet-
bearing) - late to post-tectonic.
(iv) greyish, homogeneous, fine- to medium-grained,
two mica granite - post-tectonic.
(v) red, medium- to coarse-grained, biotite granite
(Sorris-Sorris granite) - post-tectonic.

3.2 Post-Karoo Ring Complexes

Three post-Karoo ring complexes occur along a
north-east trending lineation parallel to the Cape Cross
-Uis pegmatite field (Fig. 1). The Cape Cross and Mes-
sum complexes are respectively gabbroic and alkaline
intrusions. The Brandberg complex consists of horn-
blende, aegirine, and arfvedsonite granites (Cloos and
Chudoba, 1931).

3.3 Karoo dolerites

Karoo to post-Karoo intrusives also include numer-
ous dykes of basaltic composition. These dolerite dykes
are regarded as fracture fillings and feeders for basalt
lava flows. The dykes have preferentially intruded N-
S and NE-SW orientated faults and fracture zones,
cross-cutting the fabric of sedimentary rocks. Olivine-,
augite- and quartz-dolerite can be distinguished pet-
rographically. A conspicuous cone-sheet, with sill-like
portions, is present north of Uis. This is interpreted as a
ring fracture (that was subsequently injected with doler-
itic magma), indicative of a deepseated igneous body.

Due to the preferred northerly orientation of dolerite
dykes a relationship between Gondwanaland breakup
and dolerite intrusion is postulated by Botha and Hodg-
son (1976).

4. STRUCTURAL GEOLOGY OF THE CAPE
CROSS-UIS PEGMATITE FIELD

From detailed field investigations and use of Land-
sat imagery and aerial photographs the Cape Cross-Uis
pegmatite field is interpreted as a graben structure, with
typical wedge-block subsidence. Shoulder uplift is dis-
distinctly recognisable along a NE-trending lineament,
representing the southern graben fault. In the central
portion of the study area the southern graben fault
cuts a reverse fault and downthrows Khomas schist
against Karibib marble. Movement on the southern
graben shoulder increases towards the SE, where Kho-
mas schist is downthrown against metasediments of
the Tsaun Formation. An isolated occurrence of Nosib
metasediments and volcanics in this part of the Damara
orogen is considered as an uplifted horst block. In the
sand covered areas near the Atlantic Ocean, shoulder
uplift of the graben is delineated by the outcrop of mar-
ble and a distinctive magnetic anomaly.

The northern graben fault is clearly recognisable only
in the area NW of Uis, where the fault is marked by a
highly weathered and kaolinized mylonite-zone in
late tectonic granite, accompanied by a NE-striking
and SE-dipping granite dyke. Recognition of the north-
erm graben fault is complicated by lack of outcrop, but
an indication of its position is given by a NE-trending
drainage system.

The fabric of faults and joints related to graben for-
mation during the Damara has been modified by later
tectonic activity. In post-Damaran times the region
was subjected to intensive block faulting, and NW-SE
striking faults have displaced the graben into many seg-
Fig. 1: Generalized geological map of the Cape Cross—Uis area.
ments. Moreover, the entire graben fault system was re-activated in Karoo and post-Karoo times. Post-tectonic Damaran granites which had intruded along zones of weakness were sheared and affected by temporary re-activation of the deep-seated faults. Open fractures and faults were filled by dolerite magmas and used as feeder dykes for lava flows.

The latest tectonic event, of Jurassic-Cretaceous age, resulted in N-S striking deep-seated tensional faults, some of which were subsequently intruded by dolerite. Faults with vertical movement are usually downthrown to the west, and may display brecciation. Strong movement took place along a prominent N-S trending fault in the Strathmore area, where Khomas schist and late-tectonic Damara granites were downthrown against the Tsaun Formation. Gossans and silicified breccias, with Al and Mn mineralization, are associated with these vertical faults. It is suggested that these faults are deep-seated and, consequently, enabled hydrothermal convection in post-Karoo times.

5. PEGMATITES

5.1 General

Numerous pegmatites, of varying composition, occur within the schistose zone (approximately 120 x 20 km) of the Cape Cross - Uis pegmatite field.

Four types of pegmatite can be distinguished mineralogically. A preliminary classification based on their index minerals/rare metal content is as follows:

(i) Cassiterite pegmatites
(ii) Niobium-tantalum-rich pegmatites (tantalite, columbite)
(iii) Lithium-rich pegmatites (amblygonite-spodumene-petalite)
(iv) Simple, quartz-feldspar-schorl pegmatites.

Types (i) and (ii) occur either as single, narrow (0.3 m - 3 m wide), dyke-like bodies with a north-easterly strike, or as swarms of large pegmatite bodies with an east-north-easterly strike. Types (i) and (ii) are unzoned. (The pegmatite mined at Uis is "typical of type (i)).

The majority of the cassiterite and niobium-tantalum-rich (Nb-Ta) pegmatites displays the effects of a characteristic phase of Li-Na-K mineralization (Von Knorring, 1985) and varying degrees of feldspar replacement by saccharoidal albite. Many albitized portions of the pegmatite bodies carry significant Sn and Nb-Ta mineralization. In pegmatite that is intensively albitized cassiterite and columbite-tantalite occur patchily as dark-brown to black grains, 0.1 - 0.5 cm in diameter.

Greisenized pegmatite occurs sporadically, forming distinct bands or schlieren of fine-grained altered rock with no preferential orientation. Within these greisens cassiterite may occur as bands up to 1 cm wide, with associated secondary, fine-grained quartz.

Type (iii): Many of the pegmatites of the Cape Cross - Uis pegmatite field contain significant amounts of lithium minerals. These may be classified as amblygonite, spodumene and petalite pegmatites in accordance with London and Burt (1982). Li-rich pegmatites, with well developed zoning and quartz cores, are exposed in the Strathmore area (e.g., Petalite Mine) and occur together with cassiterite pegmatites in a N-S trending swarm. Li-rich pegmatites, with spodumene as the dominant Li-mineral, are present in the central part of the study area (e.g., Karlowa claims).

Nb-Ta mineralization may occur in Li-rich pegmatites, concentrated in greisenized and albitized units. The Uis pegmatite swarm contains only a few distinct Li-rich pegmatites, but accessory petalite does occur in many of the cassiterite pegmatites.

Type (iv): In the Cape Cross-Uis pegmatite field small, schlieren-like, foliated, non-stanniferous pegma-

![Fig. 2: Distribution of the Strathmore pegmatite swarms.](image)
Pegmatite bodies are the most widespread. These are less fractionated than the other pegmatite types and consist of quartz, feldspar and schorl, with very small amounts of muscovite. Such pegmatites usually occur within Damaran granites and near their contacts with Khomas schist. In a few cases they are associated with secondary copper mineralization.

Another type of non-stanniferous pegmatite occurs as discordant and concordant bodies in metasediments of the Tsaun Formation. The discordant pegmatite bodies are reddish in colour, unfoliated and consist essentially of quartz and microcline with accessory albite, muscovite (in many dykes also biotite), and magnetite. Cassiterite and Nb-Ta-rich pegmatites have not been found in the Tsaun Formation.

5.2 Structural Analysis of the Cassiterite and Nb-Ta-rich Pegmatites

Detailed mapping and structural investigations indicate that the occurrence of cassiterite and Nb-Ta-rich pegmatites is limited to a schistose, NE-trending graben zone from Cape Cross to Uis. Three main pegmatite swarms, viz. Uis, Strathmore and Karlowa (Fig. 2 and 3), have intruded pre-existing zones of weakness resulting from intensive block-faulting and shearing. Structural analysis of the pegmatite swarms illustrate the tectonic structure, especially in terrains of predominantly schistose rocks to be typical en echelon Riedel fractures. These occur in N-S striking zones and apparently acted as traps for pegmatitic melts. However, a number of isolated pegmatite bodies are situated parallel to the NE-trending tectonic fabric and dip towards the graben centre. These bodies cut across both the fabric and the foliation of the metasediments. North of the Karlowa swarm some pegmatite bodies have intruded anticlinal structures.

Structural analysis demonstrates that pegmatite swarms are located in significant, N-S orientated, fracture-bounded zones, within which pegmatite emplacement has been controlled by ENE-trending Riedel fractures.

With one exception, limited movement occurred along the N-S fractures, and it is suspected that they are of tensional origin. Many N-S fractures transgress dolerite dykes, indicating a post-Karoo age.

One N-S striking fault in the Strathmore area has a major vertical displacement. Khomas schist, on the western side of this fault, has been downthrown against older sediments of the Nosib Group. This fault also displaced dolerite dykes, thus attesting to post-Karoo movement.

5.3 Age of Pegmatites and Sn-Nb-Ta Mineralization

Cassiterite and Nb-Ta-rich pegmatites in the Cape Cross-Uis pegmatite field have been related to late- and post-tectonic Damaran granites by Koornhof (1970), Gunter (1970), Van Reenen (1970), Tordiffe (1970) and others.

Many of the cassiterite, Nb-Ta-rich and Li-rich pegmatites investigated in this study, specifically those well exposed in the Strathmore swarm, display mutually cross-cutting relationships with dolerite dykes.

Where dolerite transgresses a mineralized pegmatite body, the massive dolerite is completely altered and kaolinized to a soft, brownish mass, whereas dolerite emplaced in schist or in Damaran granites is fresh and unaltered. The contact between cale-silicate horizons and pegmatites may also exhibit intense alteration. There

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Fig. 3: Distribution of the Uis pegmatite swarms (after Grobler, 1980).
are three possible interpretations for these features:

(i) Dolerite emplacement took place during consolidation of the pegmatites.

(ii) The pegmatite was emplaced after the dolerite, consequently reaction between the wallrocks and the pegmatitic liquids (melt) resulted in alteration of dolerite.

(iii) A late (hydrothermal?) phase has affected both intrusive rocks.

The first two interpretations would imply a Jurassic to Cretaceous age of the cassiterite, Nb-Ta-rich and Li-rich pegmatites, and would refute a genetic relationship with the late to post-tectonic Salem granoid suite. The third interpretation suggests that post-Karoo (hydrothermal?) fluids, controlled by the N-S trending tectonic features, were responsible for late replacement processes in pre-existing pegmatites.

In a postulated case of a Jurassic-Cretaceous age the post-Karoo alkaline granites are most suitable as a possible source for cassiterite and Nb-Ta-rich pegmatites with well developed Li-Na-K phases. These post-Karoo alkaline granites exhibit A-type affinities, and Ginsburg et al. (1979) observed that many Li and Y, Nb, Be, F-enriched pegmatites occur in areas of anorogenic alkaline fractionation. Concerning the third hypothesis, Černý (1982) pointed out that the problem of an open or closed system of pegmatite crystallization is still under discussion, with alternatives ranging from strictly closed to open for late generation of mineralizing fluids. Finally, samples of different pegmatite bodies have been collected for age determination.

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7. REFERENCES


