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REPORT ON RECONNAISSANCE GEOLOGICAL MAPPING OF A PORTION OF THE DAMARA OROGEN (AREA 2015D)

by

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ABSTRACT

Area 2015D is underlain largely by rocks of Damaran age, most of which are covered by unconsolidated sands. Igneous rocks of Karoo and post-Karoo age intrude the Damaran rocks. The outcrop area of Damaran rocks can be divided into a southern and a northern domain. The southern one consists of high-grade schists and marbles of the Swakop Group intruded by four major types of Damaran granites. The northern domain is separated from the southern one by a major thrust fault, and the rock types found in this domain are low-grade schists, mixtites and marbles. Both domains were intruded by Karoo and post-Karoo granites, quartz-feldspar porphyries and dolerites. Only one phase of deformation, which gave rise to NNE-trending fold axes, has been recognised.

1. INTRODUCTION

No previous geological mapping of the area has been done, but Guj (1974), Miller (1973, 1980), Klein and Badenhorst (1984, pers. comm.) have mapped the area to the north, west, south-west and south, respectively. Vervoerd (1967, p. 228) has briefly described the Osongombo carbonatite which lies just to the east of the study area. Porada and Wittig (1983) have studied the turbidites in the Okonguarri basin.

A northern and a southern lithologic domain have been recognised in the area which differ strongly in metamorphic grade and structural style. They are separated by a thrust fault along which rocks of the southern domain rest upon those of the northern one (see Fig. 1). In the northern domain weakly metamorphosed sedimentary rocks prevail, whereas in the southern one their stratigraphic equivalents display a medium to high metamorphic grade and were profusely intruded by granitic rocks. Both domains have been intruded by Karoo and post-Karoo granites, dole rites and quartz-feldspar porphyry dykes. A very immature sequence of Tertiary (?) fanglomerates is found adjacent to highland areas, while a veneer of recent, uncemented, largely alluvial sediments covers much of the study area. The lithostratigraphy of the area is summarised in Fig. 1. The location of farms and rivers mentioned in the text is shown in Fig. 2.

2. LITHOLOGICAL DESCRIPTIONS

2.1 Damara Sequence

2.1.1 Northern Domain

Ugab Subgroup

The Ugab Subgroup, which is represented in the northern domain by the Okonguarri Formation, underlies the north-eastern portion of the area (see Fig. 1), but exposures are poor. It is a heterogeneous sequence of metasediments with low-grade biotite schists being the dominant rock type, with subordinate quartz arenites, calcarenites, dolomites, carbonaceous schists and brown marbles. Sedimentary structures are easily recognised as the grade of metamorphism is low. Structures commonly recorded are graded bedding and ripple cross-stratification. Fluid escape structures are also found.

Porada and Wittig (1983) have identified partial Bouma sequences in both the siliceous and calcareous deposits. The sedimentary structures are diagnostic of turbidites and palaeocurrents measured by these authors suggest that the siliceous sediments were derived from the east, while the calcareous sediments came from the north. However, quartzites and calcareous sediments which are both proximal have been found immediately adjacent to each other which suggests that they had similar source areas.

Chuos Formation

Interbedded with the Okonguarri Formation, several metres below the base of the Karibib Formation, is the Chuos Formation (see Fig. 1). This formation consists of a matrix supported mixtite (see Fig. 3) with clasts up to 80 cm in size, and with a wide range of pebble types, with quartzite, marble, granite/gneiss and chert pebbles being present. The best exposures of the mixtite are found in the Ozongombo River on Venus 60, where it has a minimum thickness of 40 m. Two separate mixtite units are found on Onze Rust 61. They are separated by 10-15 m of graded schist. A light brown marble, 1-2 m thick, is found in close association with the mixtite in the north-western exposures of this unit. It overlies the Chuos, but is separated from it by a few metres of

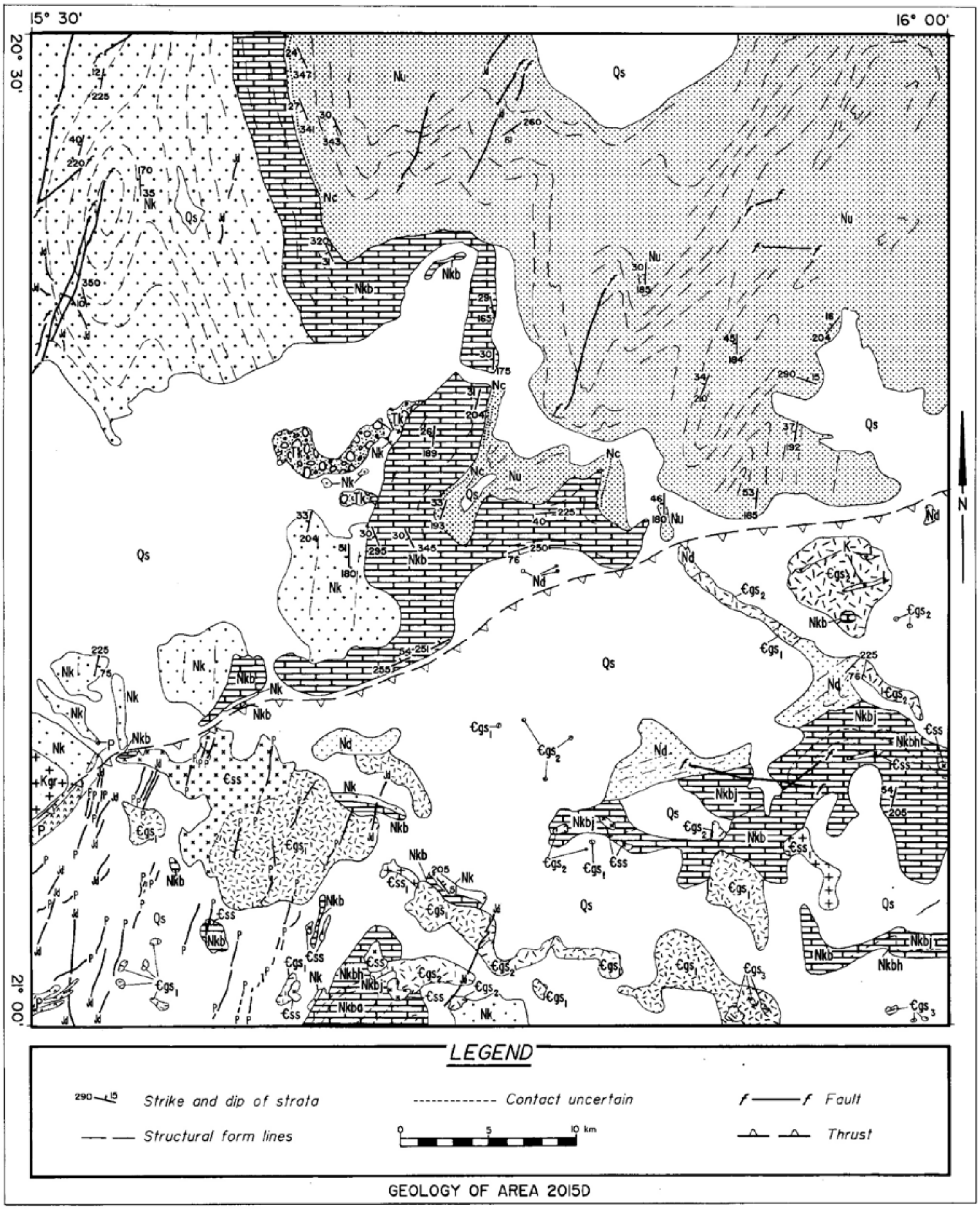


Fig. 1: Geological map of Area 2015D.

graded schist. Altogether the Chuos Formation is not continuous along strike, apparently being absent from some areas.

Karibib Formation

Forming a prominent range of hills, this unit is best exposed in river valleys on Klein Omahoro 8. It is generally dark blue, fine- to medium-grained marble, with subordinate white marble, pelites and dolomites. The blue marble characteristically weathers with a "rillenkarren" pattern. Calcite and dolomite are the most common minerals found, but accessory scapolite, tremolite and pyrite have been observed. On Nuremberg 88, to the north of the area, orthoclase crystals have been observed within the marble, and these are possibly pseudomorphous after gypsum.

The tectonic deformation which these rocks have undergone has destroyed many of the sedimentary structures, but graded bedding, ripples and cross-stratification could still be observed. Large channel features, with sharp bases, up to 1,5 m thick and several tens of metres wide are also present.

Kuiseb Formation

The Kuiseb Formation schists outcrop in the north-western portion of the area, but in general exposure is poor. The formation consists mainly of low-grade biotite schists (see Fig. 4), with sandstone beds. The full sequence is not exposed but Miller (1980) measured a maximum determinable thickness of 9 800 m between Ondundotjiuapa and Okenyenya villages, 11 km from the western boundary of the area.

The most common sedimentary structure observed was graded bedding, the best exposures being found in the river bed near the farmhouse on Gross Omahoro 9 (see Fig. 5). Associated with the graded bedding are well developed flame structures and ripples.

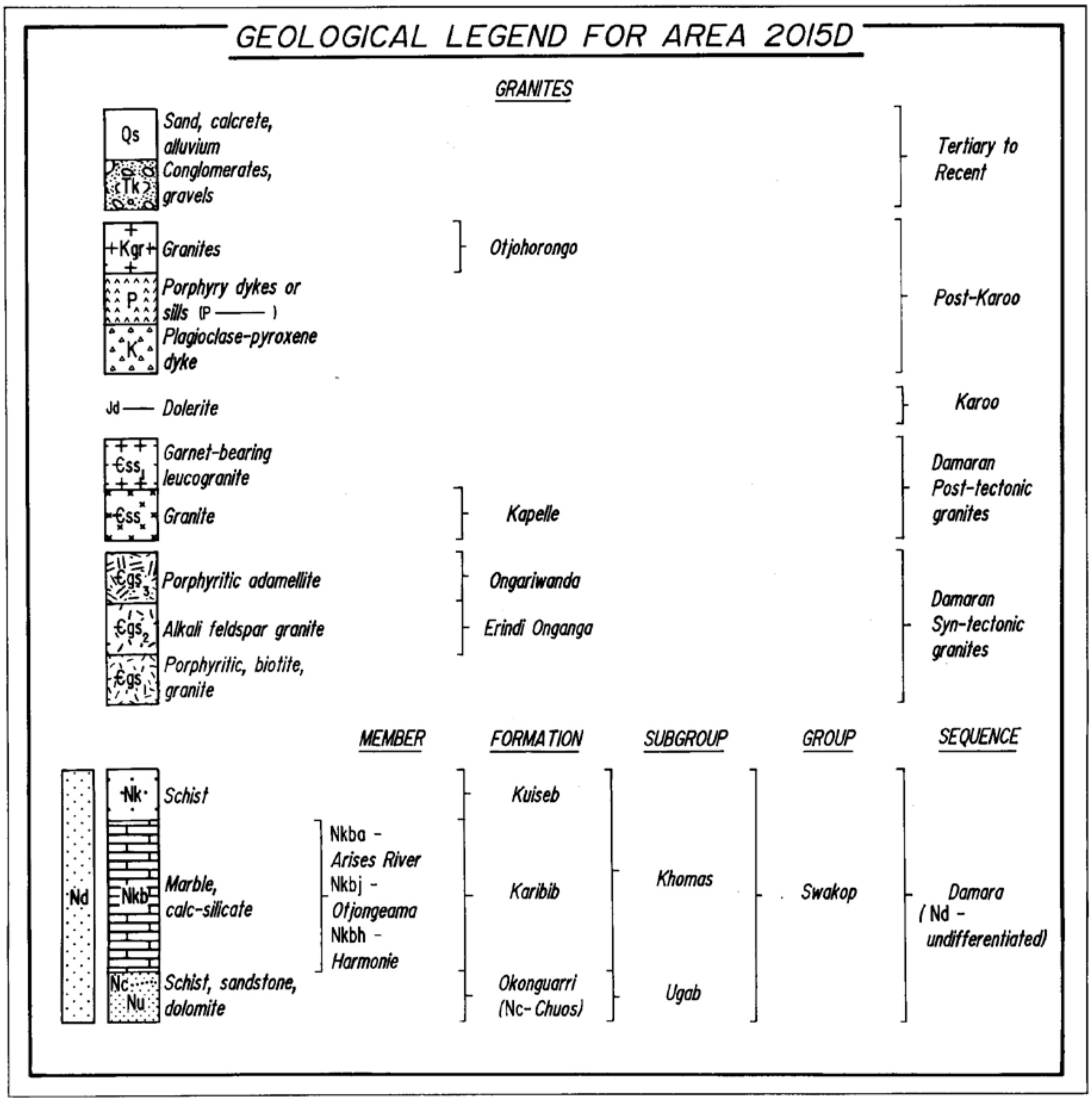
2.1.2 Southern Domain

Ugab Subgroup

A succession of poorly exposed biotite schists, white marbles and calc-silicates probably belongs to this unit. The only exposures are on the farms Klein Okarumue Nord 72 and Klein Okarumue Sud 71. This unit was intruded by dykes of pegmatitic, garnet-bearing leucogranite.

Karibib Formation

The Karibib Formation consists of white marbles and calc-silicates. These have been subdivided into three members by Klein (see Table 1). These members can be identified in the southern domain, although the basal, Harmonie Member does not appear to be well developed.



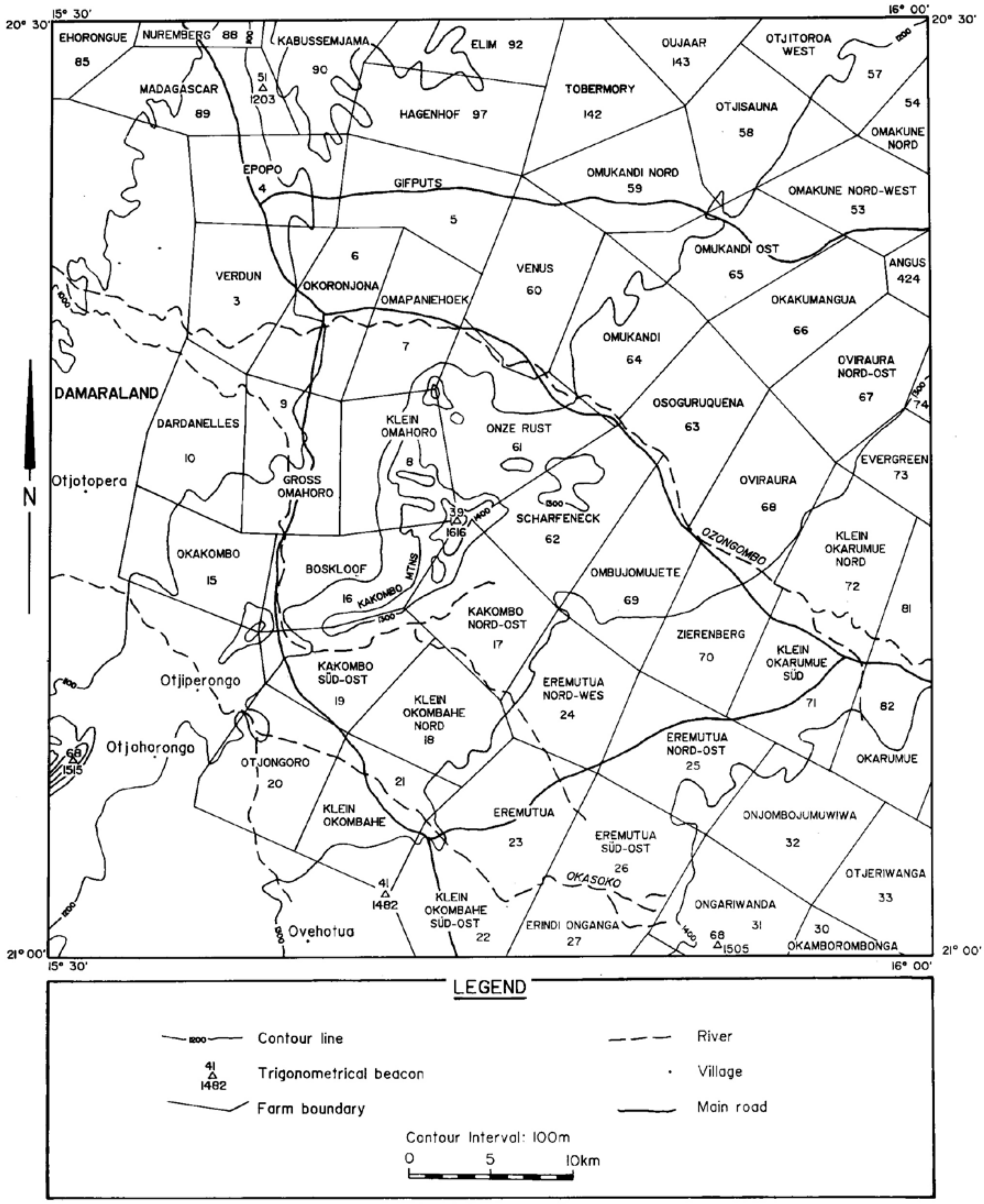


Fig. 2: Map showing the major topographical features of Area 2015D.

TABLE 1: Subdivisions of the Karibib Formation in the southern domain (after Klein, 1980, 1980a)

N_{kba}	'A' member	Arises River Member
N_{kbj}	'B' member	Otjongeama Member
N_{kbh}	'C' member	Harmonie Member

Harmonie Member - This is only developed in the dome structure in the south-western portion of the area. The calc-silicate layers are dominant over the marble bands, generally being 1-2 m thick. The full thickness of this unit is not exposed, but has a minimum thickness of 20 m. The poor exposure prohibits further description of this unit.

Otjongeama Member - Again calc-silicate layers form a major part of the sequence but are only a few centimetres thick. The best exposure of this unit is found in the

Fig. 3: Matrix-supported Chuos Formation mixtite showing the poor sorting of the dominantly marble clasts (locality: Venus 60, Ozongombo River).

Fig. 4: Graded beds in the Kuiseb Formation with stratigraphic top to the right. Note the load structures in the middle right of the photograph (locality: West of farmhouse on Gross Omahora 9).

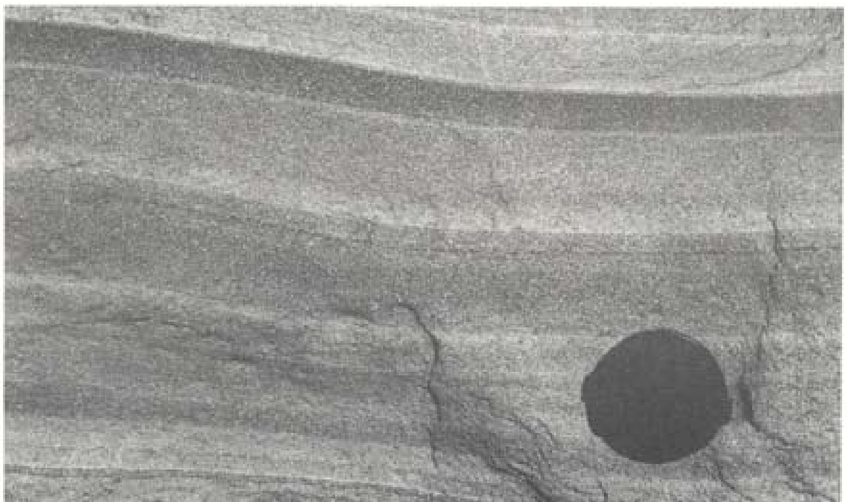


Fig. 5: Detail of pelitic beds in the Kuiseb Formation. Beds young upwards (locality: West of farmhouse on Gross Omahora 9).

river bed south of the farmhouse on the Farm Otjeriwanga 33. The marble bands consist mainly of calcite with accessory diopside and tremolite. Original sedimentary banding in the calc-silicate layers has been retained on a microscopic scale despite the metamorphism. This can be seen in thin section where different bands can be distinguished on the basis of pyroxene colour in plane polarised light. This phenomenon demonstrates (a) the isochemical nature of the metamorphism, and (b) the fact that original composition, and not metamorphic grade, is the primary determinant of mineral colour. Maximum thickness of this unit is 50 m.

Arises River Member - This marble unit consists of clear white calcite and is generally coarse- to very coarse-grained with crystals up to 16 cm in size. Accessory minerals are scapolite, graphite, phlogopite, diopside/hedenbergite, chondrodite, tremolite and pyrite. The graphite-tremolite-phlogopite-pyrite marble on Klein Okarumue Sud 71 is fetid. Calc-silicate bands, generally less than 1 cm thick, are uncommon.

Kuiseb Formation

Only small outcrops of the Kuiseb Formation schists are found in the southern domain. Exposures are poor, and the best samples were obtained from old well sites. The schist consists of quartz, biotite and plagioclase together with some garnet and non-poikiloblastic cordierite. Near contacts with the Salem granite, a certain degree of partial melting appears to have taken place (e.g. under the power line on Klein Okombahe 21 and on Ongariwanda 31).

2.2 Damaran Granites

2.2.1 Porphyritic Biotite Granite

This granite, the oldest in the area, outcrops throughout the southern domain, but, as it weathers easily, individual plutons cannot be recognised. The best exposures are found on Eremutua Nord Ost 25 and along the length of the Okasako River. The contact relation with the Kuiseb schists, which it mainly intrudes, are obscure, but where it has been observed a high grade of contact metamorphism is found. This is marked by an increase in grain size of the schist towards the granite, the presence of cordierite and K-feldspar and the lack of primary muscovite. Garnet is also present. Partial melting has occurred in places manifested by myrmeketic intergrowths in the schist. Schist xenoliths are common throughout the area.

This granite is a coarse-grained (0,5 cm) porphyritic rock with a greyish colour. Large subhedral to euhedral phenocrysts of microcline, up to 6 cm across, but commonly 2-3 cm, dominate the field appearance of this granite. The phenocrysts are set in a coarse ground mass of quartz, anhedral plagioclase, microcline and biotite. Books of biotite may be up to 1 cm long and 0,5 cm thick.

2.2.2 Erindi Onganga Granite

This granite occurs largely as dykes throughout the southern domain. It mainly intrudes the porphyritic biotite granite, and only in the eastern part of the area did it intrude the metasediments. It intruded mainly along orthogonal joints in the porphyritic biotite granite (Fig. 6). At many places it has not been eroded as deeply as the biotite granite and as a result the dykes form low ridges which stand above the surrounding granite. The depressions which result may fill up with water in the rainy season forming pools which are utilised by the game in the area. This is particularly well displayed in the Okasako River near the Klein Okombahe Sudost 22 farmhouse and on Erindi Onganga 27. “Erindi Onganga” in fact means “guinea fowl pools” and as this is such a characteristic expression of the granite it was chosen as the name for this granite.

The contact between the two granites is sharp, showing no sign of contact metamorphism, and only occasional development of a chill zone (Fig. 7). A well developed banding (Fig. 8) is present which appears to have resulted from magma-flow as it parallels the contacts. Many schist xenoliths are orientated parallel to this banding (Fig. 9).

In hand specimen the granite is light grey with an even distribution of the biotite grains. It is fine- to medium-grained (0,2 - 0,4 cm) with occasional phenocrysts of microcline. It is characterised by scattered phenocrysts of magnetite and garnet (up to 0,6 cm in size). The magnetite grains may be surrounded by an up to 0,4 cm wide, mica-free zone (Fig. 10). It is uncertain if this texture is of igneous or metamorphic origin. Some magnetite grains are euhedral with crystal faces which reflect alternating development of octahedron and rhombic dodecahedron faces (Phillips, 1971, p. 175).

In thin section the granite is seen to be allotrio-morphic granular. Myrmeketic intergrowths are found and pleochroic haloes are developed around zircon and allanite grains enclosed by biotite crystals. In some samples K-feldspar grains poikolitically enclose quartz grains. The modal composition of the granite is oligoclase 15 per cent, quartz 40 per cent, K-feldspar 35 per cent and biotite 15 per cent. Accessory minerals are allanite, zircon, apatite, magnetite and garnet. Primary muscovite is a rare accessory mineral.

2.2.3 Ongariwanda Granite

The Ongariwanda Granite crops out as small circular bodies, the largest of which is 1 km in diameter. They are confined to the south-eastern portion of the area, the best exposures being found on Ongariwanda 31 where the granite forms a number of whaleback hills.

Hand specimens of this granite are indistinguishable

Fig. 6: Dykes of the Erindi Onganga Granite intruded along orthogonal joints in the biotite granite (locality: Klein Okombahe Sud Ost 22; 100 m north of where road crosses river).

Fig. 7: Sharp contact between the biotite granite and the Erindi Onganga Granite (locality: Klein Okombahe Sud Ost 22).

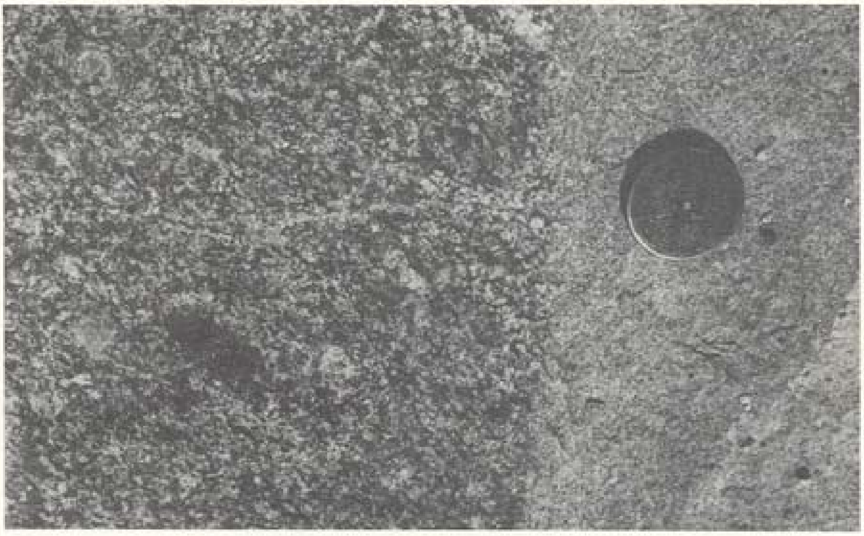


Fig. 8: Flow banding in the Erindi Onganga Granite (locality: Eremutua Nordwest 24).

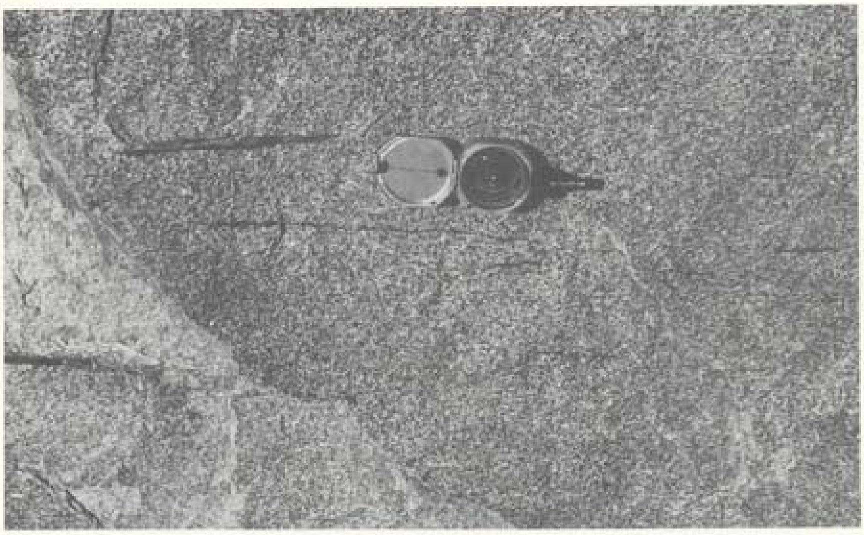


Fig. 9: Schist xenoliths oriented parallel to the flow banding in the Erindi Onganga Granite (locality: Eremutua 23).

Fig. 10: Magnetite phenocrysts surrounded by biotite-deficient haloes (locality: Okawarongo village, eastern Damaraland).

from those of the porphyritic biotite granite. Both have a light grey colour and a coarse groundmass of plagioclase, quartz, biotite and K-feldspar, with microcline phenocrysts. It differs however from that granite in its field relations. These differences are:
1) Topographic expression: this granite forms prominent, rounded hills on which little or no vegetation exists, whereas the biotite granite underlies flat country;
2) Relationship to Erindi Onganga Granite: contrary to the biotite granite it does not appear to have been intruded by the Erindi On ganga Granite;
3) Marginal banding: a marginal banding defined by the parallel orientation of K-feldspar crystals is present in the Ongariwanda Granite (see Fig. 11) but not in the biotite granite;
4) Xenoliths: it has much fewer schist xenoliths than the biotite granite.

2.2.4 Kapelle Granite

The post-tectonic Kapelle Granite is found largely in the south-western portion of the area, but a few dykes of a similar granite occur also in the south-east. It is recognised in the field by the bouldery hills that it typically forms, and a well developed horizontal jointing (see Fig. 12). There is possibly a relationship between this and the Erindi Onganga Granite as in the field they are often found in close association as at Ovehotua. The contact between the two granite types is obscure and the exact nature of the relationship between the two is still uncertain. At contacts with the Karibib Formation, skarns have developed containing variable amounts of garnet (some euhedral crystals are up to 5 cm long), scapolite, epidote and diopside. Large rafts of the marble are occasionally found in the granite and where these have weathered away caves and overhangs were formed, many of which are the sites of rock paintings. The best exposures of this granite are found at Ovehotua in Damaraland and Kapelle koppie which is situated at the boundary between Klein Okombahe 21, Klein Okambahe Sud Ost 22 and Damaraland.

The Kapelle Granite is a vuggy, coarse-grained leu-

Fig. 11: K-feldspar phenocrysts in the Ongariwanda Granite showing a preferred orientation (locality: Ongariwanda koppie).

Fig. 12: Typical boulder strewn hills formed by the Kapelle Granite (locality: Ovehotua, eastern Damaraland).

cocratic rock which is deficient in mica. Consisting of quartz, zoned subhedral plagioclase (bytownite), K-feldspar and accessory magnetite, tourmaline, sphene, altered pyroxene and amphibole (ferro-hastingsite), its composition varies from granitic to granodioritic. Antiperthitic textures also occur.

2.2.5 Leucogranite

This granite occurs mainly as pegmatitic dykes and sills in the southern domain. It is a very coarse-grained pegmatitic rock which contains little or no biotite. The coarse-grained nature of the rock makes modal analysis difficult; it consists of quartz, muscovite, microcline and plagioclase and also includes large anhedral phenocrysts of garnet. The plagioclase may be light green. Muscovite is present as a trace constituent.

2.3 Karoo Intrusions

2.3.1 Dolerite Dykes

These occur throughout the area, but are most common in the south-western portion. They vary in thickness varies from a few centimetres to 5 m. The dolerite is fine- to medium-grained with subophitic and intergranular textures. Phenocrysts of plagioclase and olivine are found. Zoning of the plagioclase is common.

2.4 Post-Karoo Intrusions

2.4.1 Otjohorongo Granite and associated Quartz-feldspar Porphyries

Miller (1980) has described this granite and its associated dykes. It is located in the south-western portion of the area. The NNE trend of the linear dykes described by Miller (1980) is also developed to the east of the area mapped by him. This is parallel to the structural grain of the Damara for this area. These dykes are between a few centimetres to 10 cm wide.

2.4.2 Alkaline Dykes

These dykes are found in the eastern portion of the area. The rocks are dark green and may show a trachytoid texture. A chilled zone can be observed at the contact with the surrounding granites. The age of the dykes is still uncertain, but is possibly post-Karoo. The dykes are composed of plagioclase and pyroxene (aegirine-augite), with plagioclase phenocrysts being common. The fine-grained nature (<0,1 cm) makes estimation of the modal composition difficult. Glass is also possibly present.

2.5 Recent Sediments

Most of the area is overlain by a veneer of unconsolidated sediments, the composition of which usually resembles that of the underlying bed rock, where this can be observed.

A group of up to 10 m thick, calcite-cemented, conglomeratic sediments derived largely from the Okakomba Berge in the central portion of the area is found on Klein Omahora 8, Gross Omahora 9 and Omapaniehoek 7. These deposits have been deeply dissected and largely eroded, and only small remnants remain of what was possibly a more extensive sheet.

3. STRUCTURE

Little work was done on the structural aspects of the area. The major thrust fault which separates the northern and southern domains is of Damaran age, with post-Karoo movement (Miller, 1980). The fault is exposed nowhere in the study area but has been identified on aeromagnetic evidence and on the presence of breccias on Scharfeneck 62 and in the Ozongomba River. The fault can, however, be observed to the west of the area where high-grade schists are thrust over low-grade metasediments. Evidence for post-Karoo movement is the fact that the ring dyke of the Otjohorongo Granite has been affected by the fault (Miller, 1980).

Only one tectonic foliation was observed in the northern domain, and this is axial planar to the NNE-trending fold axes. It is significant that not only the dykes of Karoo and post-Karoo age parallel this trend but also a dyke of the Kapelle Granite on Klein Okombahe 21.

Recumbent isoclinal folds, overturned to the east, are found within the marbles of the northern domain, especially on Klein Omahora 8 (Fig. 13). A crenulation cleavage is developed in the pelitic layers interbedded with the marbles. The significance of this cleavage is uncertain.

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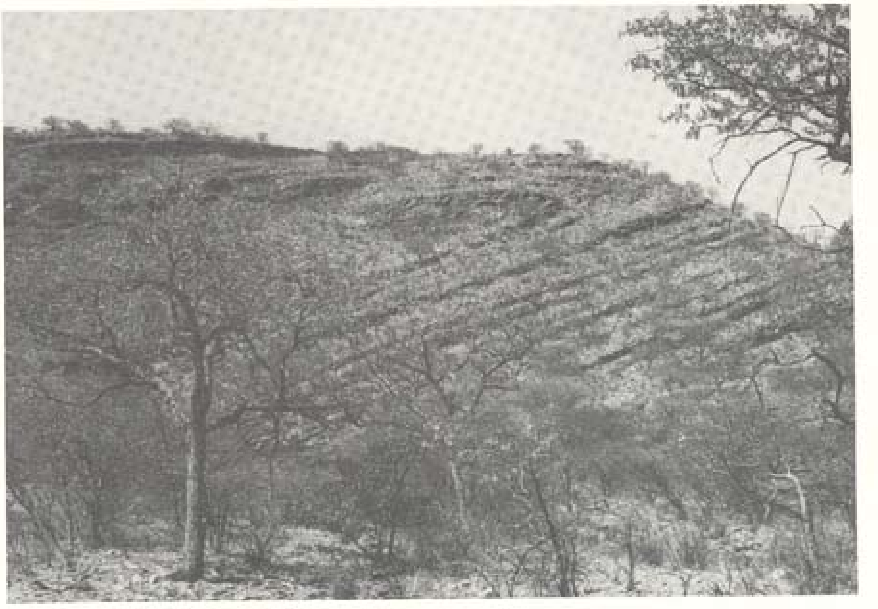

Fig. 13: Recumbent, isoclinal folds in the Karibib Formation in the northern domain (locality: Okakomba Berge, Klein Omahora 8).