

KAROO SEDIMENTS OF THE ERONGO MOUNTAINS, THEIR ENVIRONMENTAL SETTING AND CORRELATION

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ABSTRACT

Coarse clastic, mainly arkosic, sediments of Karoo age are exposed around the periphery of the Erongo Mountains. These deposits can be subdivided into two, approximately coeval, formations:

- (i) Krantzberg Formation - a massive to poorly layered, terrestrial sedimentary breccia with intercalated finer material. Patchy occurrences, less than 150 m thick, fill valleys on the pre-Karoo land surface.
- (ii) Lions Head Formation - mainly sub-angular to sub-rounded, pebbly to fine-grained, alluvial fan deposits that accumulated at the base of an escarpment. This formation, which is about 700 m thick, can be subdivided into five informal units: Lower Unit, Gritstone Unit, Middle Unit, White Quartzite Unit and Upper Unit.

During deposition, these two formations were separated by an active fault that is part of the Omaruru Lineament Zone which continues farther north-eastwards as the Waterberg Thrust. Sediment for both the Krantzberg and the Lions Head Formations was derived from the Damara metasediments and associated granites. Lithology, depositional environment, source area and tectonic setting of the Lions Head Formation is strikingly similar to that of the Omingonde Formation with which it is therefore correlated. From this relationship it is inferred that the Lions Head Formation is of Triassic age.

1. INTRODUCTION

Surmounting the surrounding, dissected plains by up to 1000 m, the Erongo is a prominent mountainland situated at the edge of the Namib Desert in central-western Namibia. The massif has a roughly circular outline, measuring 40 km across, and is built mainly by volcanic and intrusive rocks of Jurassic to Cretaceous age (Cloos, 1911, 1919; Frommurze *et al.*, 1942; Blümel *et al.*, 1979). Situated in the Omaruru Lineament Zone (Corner, 1983; Miller, 1983) and within a graben

(Badenhorst, pers. comm. 1987), the origin of the massif seems to have been controlled by these tectonic structures which are located near to the southern margin of a belt of Jurassic to Cretaceous alkaline ring complexes, the latter extending from the coast for at least 350 km in a north-easterly direction (Fig. 1; Blümel *et al.*, 1979, Fig. 4; Geol. Map SWA/Namibia, 1980).

Precambrian metasediments of the Khomas Subgroup and late- to post-tectonic Damara granites (Cambrian age) underlie the surrounding country and also form the base of the Erongo Mountains, the upper portion of which consists of much younger basic and acid lava flows and ignimbrites of the Erongo Igneous Complex. Granite and granodiorite, related to the Erongo volcanic event, have intruded the rocks in the area, and today form the precipitous slopes on the southern and south-western edges. Locally, metasomatism has led to strong alteration and tourmalinization of the Damara and post-Damara rocks (Pirajno and Jacob, 1987).

This paper reports on the flat-lying, coarse clastic sedimentary succession intercalated between the Damara schist and associated granites and the extrusives of the Erongo Igneous Complex (Fig. 2). Cloos (1911, 1919) was the first to study these sediments; his detailed descriptions are still valid and were used by Frommurze *et al.* (1942), who assigned the rocks to the Karoo System (now Sequence) and completed Cloos's mapping of their occurrences. During 1987 I remapped the Karoo sediments of the Erongo. The geological maps, at a scale of 1 : 50 000, are available for inspection at the Geological Survey, Windhoek.

2. KAROO SEQUENCE

The Karoo sediments crop out as a band along the edge of the Erongo Mountains and dip between 5° and 20° toward the centre of the mountains. They are litho-

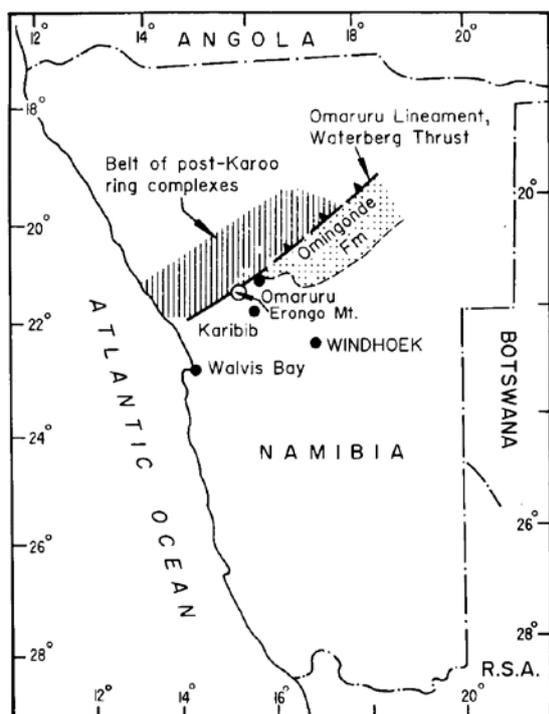


Fig. 1: Position of the Erongo Mountains and relevant stratigraphic and structural features.

logically unique in the Karoo Sequence of Namibia and were named the 'Erongo Sandstone' by Cloos (1911). These sediments can be subdivided into two formations - the Krantzberg Formation and the Lions Head Formation.

2.1 Krantzberg Formation

This rather uniform facies forms patchy to lenticular occurrences around the massif, except on the south-eastern side where the Lions Head Formation occurs (section 2.2).

Generally the formation is less than 100 m thick (Fig.

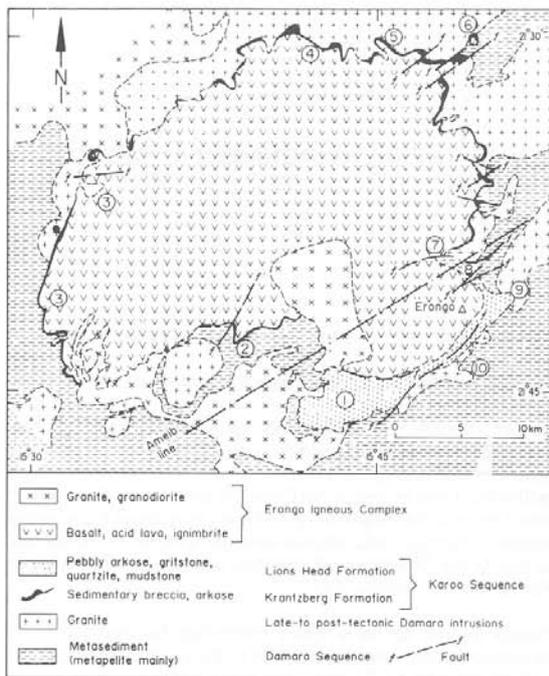


Fig. 2: Generalized geological map of the Erongo Mountains; outcrops of the Krantzberg and the Lions Head Formations. The domains of the two formations are separated by the Ameib Line. Farms and localities mentioned in the text: 1 Nieuwoudt, 2 Brabant, 3 Erongorus, 4 Omandumba Ost, 5 Pristelwitz, 6 Krantzberg, 7 Koedoeberg, 8 Hooggenoeg, 9 Erongo West, 10 Etiromund.



Fig. 3: Damara schist (S) and granite (G) form the base of the Erongo massif. The steep outcrop of the sedimentary breccia (Krantzberg Formation; KF; about 10 m thick) is overlain by basalt (B) and higher up, by acid lava and ignimbrite layers (A) of the Erongo Igneous Complex. Erongorus 166.

3). One of the few conspicuous outcrops is the cliff around the top of the Krantzberg, a north-easterly outlier of the Erongo massif (map area 2115 DB, Fig. 2). Locally the sediments have been intruded by veins and dykes of the Erongo Igneous Complex.

The Krantzberg Formation consists mainly of angular to subrounded, unsorted debris comprising Damara metasediments, granite and pegmatite. Grain size ranges from large boulders (up to 1 m³) to fine-grained 'matrix' (Fig. 4). Debris derived from Damara granite predominates in the northern and north-eastern exposures. Granular disintegration of the granite has led to a sediment which, at first glance, can only be distinguished from its parent rock by the presence of scattered pieces of vein quartz and metasediment. The colour of these Krantzberg sediments is light grey, but tourmalinization has affected the feldspar, in places leading to replacement. This has resulted in a dark grey hue (Fig. 4). In contrast, material derived from Damara metasediments (schist, phyllite, subordinate amphibole schist and vein quartz) is more abundant and, in places even dominant, on the southern, western and, locally, on the eastern margin of the Erongo, where the Krantzberg sediments



Fig. 4: Krantzberg Formation. Sedimentary breccia consisting mostly of light-coloured granite clasts ranging widely in size and subordinate darker clasts of Damara metasediments. Granite boulder fills most of the photograph. Matrix dark grey due to tourmalinization. Omandumba Ost 133. Pencil length 14 cm.

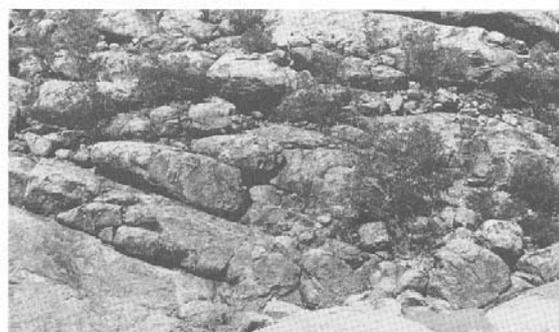


Fig. 5: Krantzberg Formation. Massive to thick-layered sedimentary breccia. Dip of 20° in lower part decreases to 8° in upper layer, due to progressive filling of a palaeovalley. Omandumba Ost 133, Otjiporo River. Exposure about 15 m high.

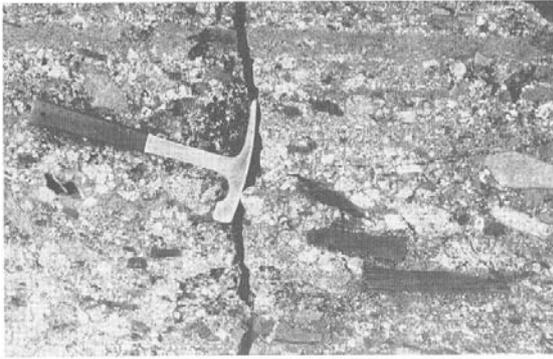


Fig. 6: Krantzberg Formation. Sedimentary breccia. Clasts of granite and pegmatite (light coloured) and of Damara metasediments (dark). The latter are of tabular shape and imbricated. In upper portion thin layers and lenses of fine-grained material. Erongorus 166, east-north-east of homestead. Pick-handle 25 cm long.

are consequently medium grey to greenish grey.

In general the sedimentary breccia forms a massive, indistinctly layered succession (Fig. 5). Bedding is, however, more accentuated where better sorted and rounded components are intercalated, forming either thin lenses or layers of conglomerate to fine-grained sandstone which can be up to several metres thick (Figs 6 and 7). The grains are cemented by silica. No pelites were observed in the Krantzberg Formation.

Platy clasts derived from metasediments are locally imbricated, e.g. on the western flank of the Erongo, north of the homestead of Erongorus 116, Fig. 6 (areas 2115 DB and DA, Fig. 2). Here the clasts are set in a matrix of medium to coarse feldspathic sand derived from granite and pegmatite.

In this area two sedimentary sequences can be distinguished: (a) the lower third of the succession is medium to thick-layered, consisting mainly of metasedimentary clasts, (b) it passes upwards into a massive layer, dominated by granitic boulders and clasts of feldspar and vein quartz (Fig. 7). Further north on Erongorus 166 (area 2115 DA) the formation is massive with granitic and sedimentary fragments in equal proportions.



Fig. 7: Krantzberg Formation. Lower portion consists mainly of clasts of Damara metasediments and is layered due to zones which are alternately rich and poor in clasts. Upper portion is apparently massive and contains mainly granite and pegmatite clasts. Erongorus 166, east-north-east of homestead. Formation 8 m thick.

As metasediments underlie the southern margin of the Erongo Mountains, granitic material is here absent from the Krantzberg Formation which is impersistent and generally less than 5m thick in this area (Fig. 2). The unconformable contact between steeply disposed Damara metasediments and the Krantzberg Formation is well exposed in many gullies.

The Krantzberg deposits fill valleys in a pre-Karoo surface, resulting in rapid change of their thickness. On Brabant 168 (2115 DA) two channels filled with Karoo sediments were recognized of which one is about 100 m wide and 20 m deep while the other is about 20 m wide and 4 m deep. Between the north-eastern boundary of Omandumba Ost 133 and the main road (2115 BC, DA; Fig. 2), the 140 m thick sedimentary breccia tapers out laterally within 500 m. This is interpreted as the result of deposition in a palaeovalley. On the same farm, about 2,5 km further south-east (2115 DA), the Krantzberg Formation is also exposed in the Otjiporo (Otjomisaona) River. In this exposure an 8 to 10m deep palaeovalley with an irregular floor of Damara granite has been filled in mainly with material of granitic origin (Fig. 5). The resultant sedimentary breccia is actually about 25 m thick and transgresses laterally beyond the channel.

The sporadic occurrence of the Krantzberg Formation is a primary feature, caused by the accumulation of detritus in depressions in a hilly country. Elevated areas of the pre-Karoo surface rise above the Karoo sediments and are directly covered by basalt of the Erongo Igneous Complex. This can be observed on Krantzberg (2115 DB), where the formation measures 75 m at the north-eastern corner, increases to nearly 150 m on the northern side and then tapers out towards the west, where a palaeohill of Damara granite is covered by the lower portion of the basalt. On the southern side, the Karoo sediments reappear, their thickness increasing along the eastern flank of Krantzberg.

Locally discordant contacts between the Karoo sediments and the overlying extrusives were observed. Basalt overlies an uneven relief of the Krantzberg Formation in a gorge immediately south of the boundary fence 1,5 km south-east of the Otjiporo (Otjomisaona) River on Omandumba Ost 133 (2115 DA). On Pristelwitz 28 (Fig. 2), about 4 m above the lower contact of the basalt, a 15 cm thick granule layer of feldspar and quartz grains, up to 5 mm in size, occurs. This layer reflects a localized sedimentary incursion during interruption of volcanism, probably a transition from sedimentary to volcanic deposits.

The Krantzberg Formation was deposited in a terrestrial environment. Debris moved downhill into the nearest valley to accumulate as a sedimentary breccia. Intercalations of better-layered, rounded and sorted material (conglomerate, coarse to fine arkose) were caused by intermittent fluvial transport over moderate distances which removed any pelitic components. Predominant mechanical weathering with granular disintegration and

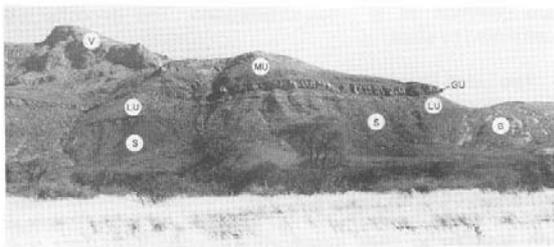


Fig. 8: Damara granite (G) and metasediments (S) form the foot of the mountain and are overlain by the Lower Unit (LU) of the Lions Head Formation. The nearly vertical cliff of the Gritstone Unit (GU) is a morphological marker overlain by the Middle Unit (MU). In the left background are volcanics (V) of the Erongo Igneous Complex which carry the trigonometrical beacon 'Erongo'. Erongo West 83.

the absence of fossil plants and animal remains indicate accumulation of the Krantzberg sediments under an arid climate.

2.2 Lions Head Formation

The Lions Head Formation is restricted to the south-eastern Erongo where the deposits form a prominent exposure extending for about 18 km around the periphery of the mountain from Erongo West 83 to Nieuwoudt 151 (Figs 2 and 8). The formation was named after the prominent Lions

Head Mountain on Nieuwoudt (2115 DC) which, despite its height of 2072 m, is not among the highest peaks of the Erongo Mountains. Granite, granodiorite



Fig. 9: Lions Head Formation, Lower Unit. Well stratified, medium-grained arkose with small pebbles, overlain with erosional contact by conglomerate to sedimentary breccia. Pencil length 14 cm.

and a few gabbroic plugs of the Erongo Igneous Complex have intruded the Lions Head Formation. The sediment consists mainly of disintegrated granite, weathered into grains ranging from silt to pebble size (Fig. 9), although angular boulders are present.

Local tourmalinization has resulted in darker colours in comparison with the otherwise light grey arenaceous rocks. Pelites are probably composed of eroded and re-deposited metapelites. Mudstone of either dark grey or reddish colour has generally been altered to hornfels due to contact metamorphism by the overlying volcanics. The deposits range from poorly- to well-sorted; pebbles occur scattered in finer-grained rocks. Scattered mudstone intra-clasts in coarse-grained sediments indicate synsedimentary erosion. Coarsening-upward and asymmetric cycles and channel-fills are common as is cross-stratification. The deposits are cemented by silica.

The Lions Head Formation thus differs from the Krantzberg Formation in the following aspects:

- (i) Clastic material was predominantly transported by flowing water over some distance and as a result became better rounded and sorted.
- (ii) Medium to thick stratification predominates; massive layers, however, form conspicuous exposures in places.
- (iii) The Lions Head Formation is much thicker (700 m) than the Krantzberg Formation (0-150 m).

No complete section could be measured either because of erosion or downthrow along faults which appear to be part of a system of ring-fractures. By combining several sections, the maximum thickness of the Lions Head Formation was estimated to be about 700 m on Nieuwoudt (2115 DC). However, on Etiromund 51 (2115 DB) and on Erongo West 83 only about 550 m is preserved due to a reduction in thickness resulting from faulting. The latter section is situated near the north-eastern end of the domain of the Lions Head Formation. From the exposure of the subunits they seem not to peter out or even decrease in thickness. Further to the north-west, at the southern tip of Hooggenoeg 170 (2115 DB), a south-west/north-east striking fault zone intersects the sediments (locality 8 on Fig. 2). This fault zone was intruded by a 20 to 50 m wide post-Karoo dyke. The strata of the Lions Head Formation are tilted in different directions on opposite sides of the fault. On the north-western side the strata disappear within 500 m, either because of non-deposition or faulting. In a northern continuation, there is a 2 km wide hiatus between the Lions Head Formation and the southwesternmost occurrence of the Krantzberg Formation on Koedoeberg 169 (locality 7 on Fig. 2).

On Nieuwoudt the Lions Head Formation is faulted against the basalt of the Erongo Igneous Complex (Fig. 2); the displacement increasing from east to west. Near

its western border the exposed lower portion is not thinner compared with that in the area where the maximum thickness for the formation has been determined. Further west the occurrence of the formation is limited by granite and granodiorite of the Erongo Igneous Complex (Fig. 2). Both in the north-east and the west, the Lions Head Formation appears to cease abruptly and no transition into the Krantzberg Formation has been observed. Although both formations are nowhere in direct contact with each other due to later faulting and intrusive activity, there can be no doubt that both lithofacies have the same stratigraphic position and can be correlated.

Differential erosion of the sediments of the Lions Head Formation has formed cuestas, facilitating subdivision into, and mapping of, five lithostratigraphic zones:

- (i) *Lower Unit*: consists of conglomerate, gritstone and arkose. Intercalated siltstone and mudstone layers are more common than in the overlying units. The well stratified sequence, which is about 150 m thick, leads morphologically from the gentle slope of the basement rocks to the steep rise of the next unit (Figs 8 and 10). Hornfels of this unit locally contains abundant nodules which are often elongated parallel to layering, up to 6cm long and 3 cm thick, and consist of one to several concentric light layers with a slightly darker, grey-brown to greenish-grey central portion in a dark grey matrix (Fig. 11). These silicified structures look like concretions and may have originated from organic remains like coprolites.
- (ii) *Gritstone Unit*: a massive sequence of conglomeratic, feldspathic quartzite and arkose forms a steep, often vertical cliff, some 23 m high on Erongo West, rising to about 40 m on Etromund and Nieuwoudt (Figs 8 and 10). The conglomeratic material is mainly made up of quartz and feldspar clasts. The quartz pebbles, which may be up to 7



Fig. 11: Lions Head Formation, Lower Unit. Silicified nodules in dark hornfels. Easy weathering of the nodules causes a pitted surface. Nodules are probably of concretionary origin. Nieuwoudt 151, south-south-east flank of Erongo. Pencil length 14 cm.

cm in diameter, are either scattered in the coarse-grained matrix or concentrated in distinct, up to 0,4 m thick, layers. Weathering of the feldspar clasts has resulted in a pitted surface to the exposures. Intercalated scattered silty to pelitic clasts which most probably represent reworked material of the Lower Unit, are locally concentrated as a mud pellet conglomerate. Cross-bedding is common and reflects current directions from the north-west.

- (iii) *Middle Unit*: consists of coarse-grained to pebbly arkose and feldspathic quartzite, subordinate intercalated finer-grained beds and sporadic sedimentary breccias of granitic detritus. The Middle Unit has a 12 to 18 m thick sandy mudstone at the bottom which erodes to form a plain on top of the underlying Gritstone Unit. The steep uppermost slopes of Witkop and Lions Head on Nieuwoudt consist of a 100 m thick, coarse to conglomeratic deposit with intercalated mudstone layers; the latter display desiccation cracks on bedding planes. The Middle Unit which exceeds 450 m on Nieuwoudt (2115 DC), forms the thickest part of the Lions Head Formation. On Erongo West and Etromund (Figs 8 and 10), where 290 and 220m respectively were measured, the unit is affected by faulting and might have been much thicker.
- (iv) *White Quartzite Unit*: This lithostratigraphic zone is a clean, well-sorted, well-bedded arenite, fine- to medium-grained. On several bedding planes coarser grains are present. Original roundness of



Fig. 10: Lions Head Formation (LU = Lower Unit, GU = Gritstone Unit, MU = Middle Unit) overlies Damara Schist (S). Their contact is exposed only in gullies. Layers are bent by a flexure. A gabbroic pipe (P) of the Erongo Igneous Complex has intruded both Damara and Karoo sediments. Nieuwoudt 151, south-south-east flank of Erongo.



Fig. 12: Lions Head Formation, White Quartzite Unit. Cross-bedded, fine, mature quartzite. Probably of aeolian origin. Erongo West 83. Pick-handle 25 cm long.

the grains is obliterated by secondary quartz overgrowth. It is the only mature sandstone in the Lions Head Formation. On Etiromund the lowermost 4 m, which are thickly bedded and contain small pebbles, are overlain by 10 to 40 cm thick, well stratified quartzite layers. The uppermost metre is feldspathic and contains scattered quartz pebbles up to 1 cm in diameter. On Erongo West, cross-bedding reveals transport from the north (Fig. 12).

The White Quartzite Unit is a 15 to 18 m thick marker which separates the Middle from the Upper Unit and forms a steep rise that is topped by a more weathered sequence. Since the beds dip toward the centre of the Erongo, but opposite to the mountain slope, the upper edge of the unit forms a ridge.

Towards the south-west, on Nieuwoudt 186, the succession becomes progressively coarser-grained, with intercalations of gritstone, and finally grades into the under- and overlying units.

- (v) *Upper Unit*: coarse clastics predominate, thus the Upper Unit resembles the Middle Unit. On Hoogenoeg and Erongo West a 13 m thick layer of sedimentary breccia forms the uppermost part of the unit, containing boulders of granite and meta-sediment up to 0,4 m across. Alternating coarser and finer beds form 5 to 70 cm thick layers. On Nieuwoudt 186, fine sandy to shaly material fills desiccation cracks in the underlying, mainly coarse-grained, arkose, while desiccation fissures in fine-grained layers are, in turn, filled by coarse material from the overlying beds.

The Upper Unit is often covered by scree and landslides from the steeply-rising volcanic rocks of the

Erongo

Igneous Complex. Moreover, the upper boundary of this unit may be affected -by ring-fractures. It is therefore doubtful whether the complete unit is represented in the profiles that were measured (20 m on Erongo West, 73 m on Etiromund, 70 m on Nieuwoudt).

Sedimentary structures and lithology of the Lions Head Formation imply fluvial transport from the north to north-west with incomplete sorting and rounding of the particles. The White Quartzite Unit (iv) is an exception with better sorting indicating prolonged reworking and probably repeated sedimentation. Sorting and cross-stratification (Fig. 12) suggest that the White Quartzite may largely be of aeolian origin with some fluvial reworking.

3. DEPOSITIONAL ENVIRONMENT AND CORRELATION

Most of the Lions Head Formation was deposited in a proximal fluvial environment. The source area was situated to the north-west and the north, i.e. in the region where the terrestrial deposits of the Krantzberg Formation were laid down. Both formations are therefore seen as having accumulated near the margin of a sedimentary basin. The Krantzberg Formation is the result of debris from highlands that formed a veneer on the palaeoland surface and filled valleys. Some of the material was carried down a scarp to be deposited as a large alluvial fan to form the Lions Head Formation.

For further considerations on sedimentary conditions and correlation with other stratigraphic units of the Karoo Sequence, the shape and size of the depositional basin must be taken into account. A palaeo height north of the Erongo Mountains separated the Goboboseb Basin in the north (area 2114) from a southern basin where the sediments dealt with in this report were deposited. The southern basin can be outlined by comparing the lithofacies and depositional environments of the Krantzberg and Lions Head Formations with two other occurrences of Karoo sediments, also believed to have been deposited in this basin. These occurrences are as follows:

- (i) Forty kilometres south-south-east of the Erongo Mountains, on Okongava East 72 (2215 BB), Karoo sediments, underlain by Damara rocks and covered by basalt, are present. These deposits consist of 4 m of coarse, fluvial arkose at the base, overlain by 26 m of shale, mudstone and fine-grained sandstone containing scattered carbonate nodules.

As indications for large-scale erosion of the Karoo sediments prior to volcanism are absent, one can assume that the thickness of 30 m is the original thickness. The lithofacies of these sediments is similar to the Lions Head Formation with which

they are correlated. The huge difference in thickness between the Erongo and Okongava areas (700 m compared with 30 m) implies that the depocentre of the basin was situated immediately south of the scarp bounding the Lions Head Formation to the north-west, and from there the sediments thin substantially southwards. This highly asymmetrical distribution of the deposits can be explained as the result of active synsedimentary faulting along the north-eastern margin of the basin. On the downthrown south-eastern side of the marginal fault or fault zone a thick sequence of fluvial sediments accumulated during increasing displacement, becoming thinner away from the area of maximum vertical movement. Toward the north-west, however, the fault sharply demarcates the region of the greatest thickness from the source area. This would explain the abrupt change from the lithofacies and thickness of the Krantzberg Formation to those of the Lions Head Formation. Deposition of the mature White Quartzite Unit of the Lions Head Formation indicates a period of tectonic inactivity along the fault.

This marginal fault runs parallel to, and is part of, the Omaruru Lineament Zone which was activated first during Damara times and again rejuvenated and extended north-eastward as the Waterberg Thrust Fault during the Mesozoic (Corner, 1983). The lineament dividing the two sedimentary facies, named Krantzberg and Lions Head Formations in this paper, was first mentioned by Cloos (1919) who also noticed its position as a parting line for different petrological units and called it the 'Ameib Line' (Fig. 2).

- (ii) The Omingonde basin, bounded on its north-western margin by the Waterberg Thrust, extends north-east of the Erongo Mountains (Fig. 1).

Some 450 m of fluvial sediments accumulated at Etjo Mountain (Lüdtke, 1970). Lithologically the sequence resembles the Lions Head Formation in that it comprises fine to coarse debris of granite, quartz and feldspar, besides clasts of Damara marble. Thick intercalations of reddish mudstone and scattered calcareous layers present in the Omingonde Formation indicate a more distal facies with a higher percentage of flood-plain sediments than the Lions Head Formation. Cross-bedding reveals provenance in the south and west, but also some transport from the north-west.

The Etjo Formation, consisting of a lower fluvial sandstone and an upper aeolianite, overlies the Omingonde Formation and is absent in the Erongo area.

Whether the Lions Head Formation could be correlated with the Omingonde Formation is a matter of conjecture; nevertheless the supporting arguments are mentioned here to stimulate further investigations:

- (a) the lithofacies of both formations are similar;
- (b) both successions accumulated in areas that were topographical highlands during early Karoo times and which apparently subsided simultaneously during late Karoo time. This suggests that both formations might be penecontemporaneous.
- (c) both depositional areas are likewise related to the Omaruru Lineament - Waterberg Thrust and may therefore have had similar configurations and epeirogenetic histories.

Correlating the Lions Head Formation with the Omingonde Formation implies that the Waterberg Thrust was already active during Omingonde times, albeit less intensive than in the Erongo area. A hypothetical equivalent of the Krantzberg Formation north-east of the Omingonde domain should have been deposited on the upthrown side of the Waterberg Thrust; if so, it has since been eroded.

Reptile fossils found at Etjo Mountain in the uppermost Omingonde Formation indicate a middle Triassic age for this formation (Keyser 1973). Should the correlation of the Krantzberg and Lions Head Formations with the Omingonde Formation be accepted, it will imply a Triassic age for these two formations.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

- Blümel, W.D., Emmermann, R. and Hüser, K. 1979. Der Erongo. Geowissenschaftliche Beschreibung und Deutung eines Südwestafrikanischen Vulkankomplexes. *Scient. Res. SWA Ser., SW. Afr. scient. Soc.*, **16**, 140 pp.
- Cloos, H. 1911. Geologische Beobachtungen in Südafrika. II. Geologie des Erongo im Hererolande. (Vorläufige Mitteilungen.) *Beitr. geol. Erforsch. dt. Schutzgeb.*, **3**, 84 pp.
- Cloos, H. 1919. Der Erongo. Ein vulkanisches Massiv im Tafelgebirge des Hererolandes und seine Bedeutung für die Raumfrage plutonischer Massen. *Beitr. geol. Erforsch. dt. Schutzgeb.*, **17**, 238 pp.
- Corner, B. 1983. An interpretation of the aeromagnetic data covering the western portion of the Damara Orogen in South West Africa/Namibia, 339-354. In: Miller, R.McG. (Ed.) *Evolution of the Damara Orogen of South West Africa/Namibia*. Geol. Soc. S. Afr. Spec. Publ., **11**, 515 pp.
- Frommurge, H.F., Gevers, T.W. and Rossouw, P.J. 1942. *The geology and mineral deposits of the Karibib area, South West Africa*. Expl. Sheet 79 (Karibib), geol. Surv. S. Afr., 172 pp.
- Geological Map, South West Africa/Namibia 1980.

- Scale 1 : 1 000 000. *Geol. Surv. S. Afr.*
- Keyser, A.W. 1973. A new Triassic vertebrate fauna from South West Africa. *Palaeont. afr.*, **16**, 1-15.
- Lüdtke, G. 1970. *The geology and structure of the area between Etjoberg and Waterberg in central South West Africa/Namibia*. Rep. geol. Surv. SWA/Namibia (unpubl.), 10 pp.
- Miller, R.McG. 1983. The Pan-African Damara Orogen of South West Africa/Namibia, 431-515. In: Miller, R.McG. (Ed.), *Evolution of the Damara Orogen of South West Africa/Namibia*. Geol. Soc. S. Afr. Spec. Publ., **11**, 515 pp.
- Pirajno, F. and Jacob, R.E. 1987. Sn-W metallogeny in the Damara orogen, South West Africa/Namibia. *S. Afr. J. Geol.*, **90**, 239-255.