

SOME ASPECTS OF NAMA AND KAROO SEDIMENTATION FROM A BOREHOLE SOUTH-EAST OF GOBABIS

by

W. Hegenberger

ABSTRACT

An exploration borehole drilled in Aminuis (Hereroland East Area 2) yielded new data on the thickness of the Kalahari Group and the Karoo Sequence and on the distribution of the Nama Group below a cover of the abovementioned successions. Nama rocks in the lower portion of the borehole are considered to belong to the Kuibis Subgroup. It can be inferred that

- (i) the Nama rocks exposed south of Gobabis continue below a cover south-westwards into the Nama terrain in southern SWA/Namibia, and south-eastwards into Botswana;
- (ii) the Ghanzi ridge east of Gobabis existed in Karoo time already.

UITTREKSEL

'n Eksplorasi-boorgat wat in Aminuis (Hereroland Oos Gebied 2) geboor is het nuwe gegewens rakend die dikte van die Groep Kalahari en die Opeenvolging 15aroo asook die verspreiding van die Groep Nama onder bedekking deur bogenoemde formasies gelewer. Nama gesteentes in die onderste gedeelte van die boorgat word as tot die Subgroep Kuibis behorend beskou. Daar kan afgelei word dat

- (i) die Namagesteentes wat suid van Gobabis dagsom onder bedekking suidweswaarts na die Namaterrein in suidelike SWA/Namibië en suidooswaarts na Botswana voortsit;
- (ii) die Ghanzirug oos van Gobabis al in die Karootyd bestaan het.

1. INTRODUCTION

The Nama Group is a platform succession deposited on the craton south of the Damara Orogen. The present northern edge of its domain extends in some distance from the southern margin of the Damara succession from the Naukluft Mountains in the west to about 60 km east of Gobabis in the north-east. From there it formerly extended north-eastwards into Botswana, but the rocks have been eroded from the elevated area of the Ghanzi Ridge.

To the south of Gobabis, on the southern slope of the Ghanzi Ridge, rocks of the Kamtsas and Blaubecker Formations (Nosib Group) form a north-east striking synclinorium, in the centre of which also rocks of the Kui-

bis Subgroup (Nama Group) have been preserved from erosion in an area of about 100 x 50 km. The southern portion of this structure is overlain by the Dwyka Formation and the Prince Albert Formation (Ecca Group) of the Karoo Sequence, and all rocks mentioned so far are partly concealed by a usually thin cover of Kalahari deposits (Fig. 1).

The distribution of pre-Karoo rocks south of the synclinorium could be inferred from two structural features as shown by mapping of Hegenberger and Seeger (1980):

- (i) Taking into account that Nosib rocks at the south-western edge of the synclinorium - immediately east of the Black Nossob River - form a north-east plunging anticline, it might be assumed that Nama rocks also occur below Karoo cover on the south-eastern side of this anticline.
- (ii) Linear sedimentary features in the uppermost Kamtsas Formation, which can be recognised on LANDSAT images along the eastern closure of the synclinorium, continue southwards and are aligned approximately parallel to the base of the Nama Group as far as Schwarzwald 344 in the south-west. From there they turn southwards and continue in a roughly easterly direction (Fig. 1) suggesting that the Kamtsas Formation here too forms a flat anticline with a syncline to the south and that the Nama rocks under cover might follow these structures.

Therefore, instead of being confined to an area north of a line running straight from Court 32 to Schwarzwald 344, Nama rocks could also be expected to occur, below Karoo cover, further to the south-east in the Aranos area connecting the outcrop of Nama sediments around Gobabis with the Nama terrain in southern South West Africa/Namibia, and to extend south-eastwards into Botswana. The nearest known occurrence of the Nama Group in the area south of Aranos is that met in an exploration borehole on Vreda 281 (Mariental District); the succession was correlated with the Fish River Subgroup (Wilson 1964, 1965).

A borehole (ACP 21) drilled in the north-western portion of Aminuis (Hereroland East, Area 2), has now provided further information on the successions underlying the area; the core has kindly been made available by Anglo American Prospecting Services (Pty) for inspection by the Geological Survey, Windhoek.

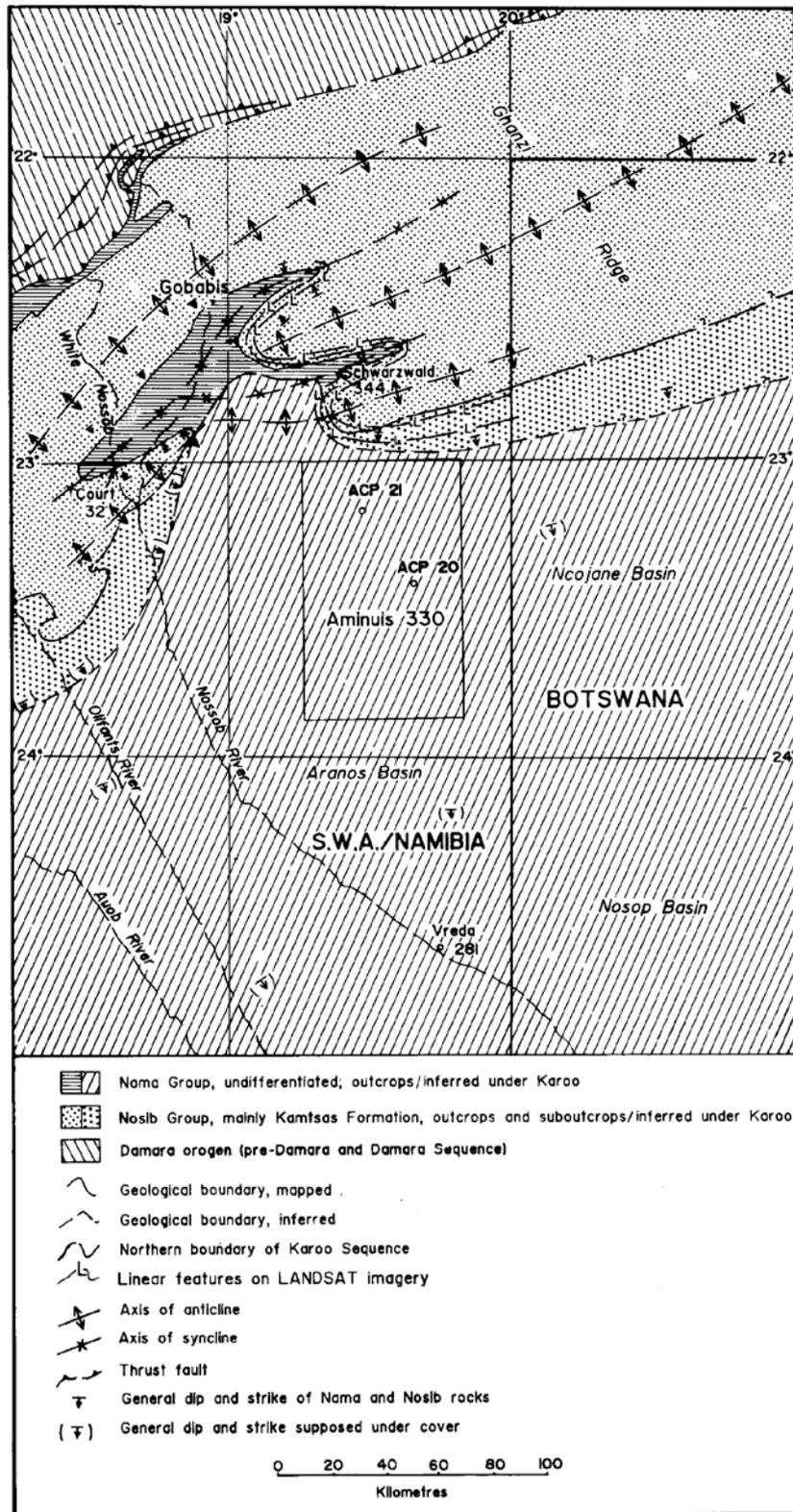


Fig. 1: Geological map of the area between Gobabis and Vreda 281, Mariental District, indicating position of boreholes in Aminuis area.

2. DESCRIPTION OF CORE FROM BOREHOLE ACP 21

Drilled for Anglo American Prospecting Services (Pty) Ltd by Rodio SA.

Date: March 1982

Site: North-western Aminuis, Area 2319 AS, 0,5 km north-west of Otjomukona.

0 - 181,38 m Rotary drill, no samples kept, logged by driller.

- 315,40 m Diamond drill, core logged by author.

Depth (m)	Thickness (m)	Rock type
KALAHARI GROUP		
0 - 33,0	33,0	Calcrete
KAROO SEQUENCE		
ECCA GROUP		
Prince Albert Formation		
<i>Auob Member</i>		
- 52,0	19,0	Sandstone, fine, soft
- 100,0	48,0	Sandstone, reddish-yellow
<i>Mukorob Member</i>		
- 139,0	39,0	Shale, grey
<i>Nossob Member</i>		
- 174,0	35,0	Shale, grey; sandstone
----Lower boundary of Price Albert Formation ----		
Dwyka Formation		
- 181,38	7,38	Shale, black
- 203,40	22,02	Mudstone to siltstone, dark grey, unbedded, slightly micaceous (white mica), some portions fine sandy; scattered pebbles of quartzite, fine-grained, medium grey, subrounded to angular, fresh, mostly 1-2 cm Ø, maximum 4 cm Ø.
- 205,50	2,10	Mudstone to siltstone, dark grey, thinly bedded, white mica on bedding planes.
- 223,40	17,90	Sandstone, fine to medium-grained, between 212,30 and 212,85 medium to coarse-grained, light grey, medium grey where slightly muddy. Slightly calcareous with whitish, lime-cemented nodules, 2-4 mm Ø, lower portion strongly calcareous.
- 215,75		poorly layered, massive with scattered carbonaceous flakes; some thin dark bedding planes from 215,0 downwards; 215,66-215,75 reworked zone. From 215,75 downwards crossbedding and slumping. Coaly patches at 215,50 and 224,70, pyrite at 215,60 and 224,55
- 223,60	0,02	Sandstone, fine, light to medium grey, calcareous; pebbles of brownish to grey quartzite, 2 cm Ø
- 234,85	11,24	Siltstone and mudstone with fine sandstone flasers, medium to dark grey, thinly bedded; intense slumping, especially in the upper half; fine sandy portions are slightly calcareous
- 239,95	5,10	Sandstone, fine-grained, light to medium grey; calcareous to strongly calcareous
- 240,70	0,75	Sandstone, fine-grained, flaser structure, medium grey
- 240,85	0,15	Mudstone to siltstone, fine sandy, dark grey, carbonaceous
- 241,15	0,30	Sandstone, fine to medium-grained, medium grey, with thin carbonaceous flasers and flakes; slightly calcareous with whitish, lime-cemented nodules, 1-2 mm Ø
- 243,00	1,85	Sandstone, fine to medium-grained, medium to light grey; few thin flasers, small flakes and patches of coaly material; slightly calcareous, with whitish, calcareous cemented nodules, 1-2 mm Ø
- 243,02	0,02	Pebbly layer; pebbles 1-2 cm Ø, subrounded, consist of fine-grained, pink to red-brown quartzite
- 243,57	0,55	Sandstone, fine-grained, light grey, unbedded; with several scattered quartzite pebbles, 1-2 cm Ø, subrounded
- 243,67	0,10	Pebbly layer; quartzite pebbles up to 3 cm Ø, subrounded, fine-grained, in fine sandy matrix
- 245,45	1,78	Sandstone, fine to medium-grained, light to medium grey, with some muddy layers and zones; scattered pebbles up to 3 cm Ø, consisting of fine-grained, brown quartzite; pebbly layer between 245,25 and 245,30
- 245,70	0,25	Gritty to pebbly sandstone; sandstone medium to fine-grained, light to medium grey; pebbles up to 2 cm Ø, of brown, fine-grained quartzite
- 246,15	0,45	0,10 m dark siltstone; 0,20 m pebbly sandstone, pebbles consisting of fine-grained, brown quartzite, up to 2 cm Ø; 0,15 m dark siltstone
- 248,15	2,00	Conglomerate; subrounded to angular quartzite pebbles and boulders mainly of fine-grained, brownish colour, subordinate pebbles with greenish grey hues, up to 5 cm Ø. Fine sandy to silty matrix, light grey to light greenish grey; upper portion weakly calcareous, lower portion calcareous to strongly calcareous.
- 248,27	0,12	Boulder of greyish red quartzite
- 248,52	0,25	Conglomerate; subrounded to angular quartzite pebbles and boulders, mainly of brownish colour, subordinate pebbles of greenish grey hues, up to 5 cm Ø. Fine sandy to silty matrix, light grey to light greenish grey; upper portion weakly calcareous, lower portion calcareous.
- 248,87	0,35	Boulder of red-brown, fine-grained quartzite
- 248,90	0,03	Siltstone and fine-grained sandstone, light grey, with some small quartzite pebble
Lower boundary of Dwyka Formation		
- 251,40	2,50	Greyish red 10 R 4/2 quartzite, fine-grained, weakly bedded by thin, dark grey heavy mineral seams and brown-red layers of more shaly material
- 251,45	0,05	Fine sandstone to mudstone, light to dark grey, thinly bedded, schlieric, wrapped around corners of small angular boulders of red-brown quartzite. Interpreted as Karoo sediment filling a fissure in Nama quartzite.
- 265,00	13,55	Quartzite, greyish red 10 R 4/2, fine-grained, uppermost portion medium-grained, weak layering indicated by dark seams of heavy

		minerals and by slight change of tint, probably due to changing proportion of shaly material; few layers of shale, 1-2 cm thick or small shaly lenses (mud pebbles?), dusky red 5 R 3/4
- 266,00	1,00	Shale, siltstone, fine-grained quartzite, greyish red 5 R 4/2 to dusky red (5 R 3/4; with zones of syn-sedimentary reworking (flat pebble layers)
- 315,40	49,40	Quartzite, fine-grained, greyish red 10 R 4/2 to 5 R 4/2, thinly, often poorly layered by thin shaly horizons (mm-thick) or dark heavy mineral seams. Crossbedding, ripples, syn-sedimentary reworking, flat pebble conglomerates, mud pebbles, slumping, small channels, angular to rounded lumps of shaly material in quartzite. Horizons of reworking are 5 to 25 cm thick and intercalated into quartzite at irregular distances. Bedding planes covered by light-coloured mica flakes. At 275,80 is a 5 cm thick and at 312,06 m a 3 cm thick vuggy weathered zone containing calcite, pieces of quartzite and shale. Both zones are horizontal fractures.

The core underneath the Karoo succession is more or less calcareous; the calcareous matter is absent in shale (which is very subordinate), scarce in silty to fine-grained portions but becomes more distinct in the coarser portions between 251,45 and about 259,2 m.

The dip of the bedding planes throughout the core is gentle, no break in the angles between the Karoo and underlying rocks could be observed; few joints in the quartzite succession below 248,9 m do not indicate major differences in the tectonic history of both units struck by the borehole.

Most of the pebbles within the Dwyka beds resemble the underlying quartzite.

Several polished slabs of the lower portion of the core were inspected microscopically and showed virtually identical composition of the quartzite. Description of a typical sample (at 311,71 m depth):

Quartzite, medium grained to silty, mainly brown grey; colour caused by matrix and by seams of mudstone, up to 0,2 mm long, irregular wavy, parallel to layering. 80 per cent quartz, 0,05-0,5 mm Ø, sub-rounded; 15-20 per cent feldspar, 0,05-0,5 mm Ø, sub-angular; 5 per cent magnetite, up to 0,1 mm Ø, sub-angular. Elongated, angular lumps of reddish mudstone, up to several centimetres long and more than 1 cm thick are embedded parallel to stratification, (flat pebble conglomerate).

3. INTERPRETATION OF ACP 21

3.1 Kalahari Group and Karoo Sequence

Due to the lack of samples, no exact description of the upper 181 m of the borehole can be given. The data were obtained from lithologic logging carried out by the driller and interpreted stratigraphically. The sup-

posed thickness of 33 m of the Kalahari Group coincides quite well with that measured in water boreholes nearby. The Prince Albert Formation of the Ecca Group which follows below the Kalahari Group in ACP 21, is subdivided (after Heath, 1972, and SACS, 1980) into the Auob Member (more than 67 m thick), the Mukorob Member (39 m), the Nossob Member (35 m) and the Rietmond Member. These thicknesses correspond with those measured in ACP 20 near Okanyama (central Aminuis), about 30 km south-east of ACP 21 (Fig. 1 and Table 1).

The boundary between the Dwyka and the Prince Albert Formations is defined by the uppermost occurrence of diamictites or boulderbeds. Although nothing of this kind has been recorded in the rotary samples, the lowermost sandstone in the rotary samples at about 174 m may be considered as the basal layer of the Nossob Member (lowermost Prince Albert Formation).

3.2 Pre-Karoo Formations

The assumption that in the Aminuis area either the Nama Group or the Kamtsas Formation underlie the Karoo Sequence is supported by the following:

- (i) the area is situated far away from the southern marginal thrust zone of the Damara Orogen, and tectonic silvers of various pre-Damara successions are not expected to occur any more.
- (ii) the Kamtsas and Nama successions forming a synclorium to the south of Gobabis have a pseudo-conformable relation and were only gently folded; thus no sudden change of the rocks forming the pre-Karoo surface is to be expected.
- (iii) faulting occurred in post-Nama and post-Karoo time but was not intense enough to bring pre-Damara rocks into juxtaposition with Kamtsas or Nama rocks below the Karoo succession;
- (iv) bedding planes in the Nama rocks underlying the Karoo rocks in ACP 21 are virtually horizontal and thus parallel to those of the Karoo beds, indicating only weak deformation of the pre-Karoo successions; therefore no pre-Kamtsas rocks are expected at the pre-Karoo surface.

Around Gobabis, the Kamtsas Formation of the Nosib Group has the widest distribution of all formations and attains a thickness of up to 6 000 m. Although fine-grained to shaly sediments occur in the uppermost as well as the lower portions of this formation, the bulk of the lithosome is medium to coarse-grained, locally even pebbly; the sorting of the fine-grained portions is less uniform than in the quartzite of the borehole. Whereas the Kamtsas rocks generally are not calcareous, the quartzite of ACP 21 is slightly calcareous throughout. The strongest argument, however, against correlation with the Kamtsas quartzite is the high feldspar content of the latter which, as the study of polished slabs has shown, may amount up to 60 per cent whereas the quartzite of ACP 21 contains only up to 20 per cent

feldspar. Thus, in all probability the quartzite in ACP 21 does belong to the Nama Group.

Red-brown quartzite exposed along the Black Nossob River between Kakus 73 and Spatzenfeld 70 (about 70 km north-west of ACP 21; see Hegenberger and Seeger, 1980), which is the stratigraphically highest unit preserved in the synclinorium and belongs to the upper Grüntal Member (Zaris Formation of the Kuibis Subgroup), closely resembles the quartzite in ACP 21 and it is therefore most likely that the two quartzites correspond. There are certain minor differences in composition: the quartzite in the Nossob valley contains a slightly higher proportion of feldspar (up to 30 per cent) but less calcareous matter. However, the strata in the borehole seem to be higher in the succession than those in the Nossob valley and some differences in the mineral content and chemical composition between core and surface samples are to be expected.

4. REGIONAL IMPLICATIONS

The Nama synclinorium on the southern slope of the Ghanzi Ridge south of Gobabis opens to the south and south-east and is connected with the main Nama terrain in the south which would mean that the whole of the Aranos Basin is underlain by Nama rocks (Fig. 1). The sediments of this group, extend into western Botswana, where they are believed to occur in portions of the Nossob and Ncojane Basins under Karoo rocks, and might be present even in the Passage Basin which is situated further north-east but still on the southern side of the Ghanzi Ridge (see Reeves 1978, p. 97, 100, 102, Figs. 6.1, 6.2; Jones 1979, Fig. 9). The eastern extension supposedly is limited by the north-trending Kalahari Line at about 22° E. This appears to be a narrow linear zone of long-lasting tectonic activity, presumably a Proterozoic suture line separating provinces of different lithologic and structural character, reflected by a structural low on its western and a high on its eastern side. Movements along the Kalahari Line still affected the Karoo succession which was uplifted in the east (Reeves 1978, p. 106, Figs. 6.1, 6.5, and aeromagnetic interpretation maps).

As the pre-Karoo beds generally dip south and south-east, away from the Ghanzi Ridge, increasingly younger Nama strata are preserved in a southward direction underneath the Karoo sediments, ranging from the basal Kuibis Subgroup in the north to the Fish River Sub-

group on Vreda 281 (2419 D).

The Nama sediments within the synclinorium south of Gobabis were partly eroded in pre-Karoo time, and the resulting topographic depression is surrounded by upper Kamtsas rocks also bounding the terrain of the Karoo succession in the north, west and north-east. The conglomerate on Leeuwpoot 598 and Oas 284 (Hegenberger and Seeger, 1980, p. 9) as well as scattered occurrences of Dwyka mixtite in the valley of the Black Nossob River south of Gobabis are erosional remnants from a time when the Karoo succession filled the depression and transgressed northwards across it.

Table 1 shows that the thickness of units of the Karoo Sequence in the area south-east of the Ghanzi Ridge decreases from south to north, indicating that a shoal within the Karoo basin was situated not far to the north of Aminuis; that suggests that the Ghanzi Ridge (Fig. 1) already existed during Karoo times. However; the former presence of Karoo rocks on the ridge is indicated by several isolated remnants of sandy to shaly sediments which are attributed to the Prince Albert Formation of the Ecca Group, occurring on the north-western slope of the Ghanzi Ridge in area 2218 AD (Hegenberger and Seeger, 1980), on Okapaue Ost 190 (Area 2218DC) and on farms 433 and 434 south of Epukiro (Area 2119DB, see Geological Map of SWA/Namibia, 1980).

The general pattern of the pre-Kalahari floor in the Aranos area may have been modified by post-Nama and post-Karoo faulting, presumably in two directions, one trending SW-NE, i.e. parallel to directions prevailing in the area north of the Ghanzi Ridge, although, in contrast to their expression in this region they are less obvious in the area south-east of the Ghanzi Ridge, and another one trending NW-SE to NNW-SSE. The latter direction incidentally also coincides with that of the principal present drainage channels, i.e. the Auob, Olifants and Nossob Rivers (Fig. 1).

5. REFERENCES

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Formation	Member	Vreda*	ACP 20	ACP 21
Prince Albert	Rietmond		>58,9 m	
	Auob	>100 m	108 m	>67 m
	Mukorob	220 m	31 m	39 m
Dwyka	Nossob	150 m	41 m	35 m
		203 m	>27 m	75 m

Table 1. Thickness of several units of the Karoo Sequence in the area south-east of the Ghanzi Ridge (*: after Wilson, 1964).

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