# Description of Late Cenozoic Sediments at Narabeb, Central Namib Desert.



by

James T. Teller,
Department of Geological Sciences,
University of Manitoba,
Winnipeg, Manitoba,
Canada, R3T 2N2.

and

N. Lancaster,
Department of Environmental and Geographical Science,
University of Cape Town,
Rondebosch 7700*

*Present address:
Department of Geology,
Arizona State University,
Tempe, AZ 85287,
USA.

ABSTRACT

A sequence of calcareous mudstones and sands is exposed in an interdune corridor of the Namib Sand Sea at Narabeb, 30 km south of Gobabeb. This 36 m section is unique in the region and is described in detail. There are 6 radiocarbon dates and two $^{234}U/^{230}Th$ dates from the calcareous mudstones of this section. The sediments were deposited at the fluctuating end point of the Tsondab River prior to 20,000 years B.P. They represent the alternation of a series of wet and dry periods in this now hyperarid region.

CONTENTS



## 1 INTRODUCTION

A 36 m section of lacustrine mudstones and interbedded sands is exposed for 1 km along the eastern side of the interdune corridor at Narabeb (23 49' S, 14 57' E). The deposits lie at an elevation of 407 m between 90 to 100 m high linear dunes in the northern part of the Namib Sand Sea (Fig. 1).

The existence of these sediments was first recorded by Seely and Sandelowsky (1974), who noted the abundance of Early Stone Age artefacts in the area. They suggested that the deposits had been laid down at a former end point of the Tsondab River, which presently terminates at Tsondab Vlei, some 40 km to the east. Selby, Hendy and Seely (1979) published $^{234}U/^{230}Th$ dates of 210-260,000 years B.P. from a lower member of the deposits, which they regarded as having been laid down in a shallow interdune pond. Lancaster (1984) briefly outlined the stratigraphy of the deposits and suggested that they had been formed in a fluctuating lacustrine environment at a former end point of the Tsondab River.

No sequence of Late Cenozoic sediments of comparable thickness is known from the central Namib. Most interdune pan and carbonate deposits included in the Khommabes Carbonate Member of the Sossus Sand Formation by Ward (1984) are thin and restricted in their areal extent. The existence of a thick sequence of sediments deep within the sand sea is clearly of considerable importance to the palaeoenvironmental and archaeological record of the region. We feel that a detailed description of its stratigraphy and composition is therefore necessary. The sedimentology and palaeoclimatic implications of these sediments are fully discussed elsewhere (Teller and Lancaster 1986).

## 2 DESCRIPTION OF SEDIMENTS AT NARABEB

The 36 m sequence of alternating calcareous mudstones and sands is exposed on a gentle slope on the eastern side of the interdune corridor at Narabeb, with the more resistant mudstones forming small cliffs or steps (Fig. 2). The sediments and their stratigraphy are

described in detail in Table 1 and their composition is summarised in Table 2.

The sands in this sequence are slightly calcareous. They are composed mainly of rounded to sub-rounded quartz, which is lightly stained by iron oxides. The sands are similar to those of the Tsondab Sandstone Formation which underlies the deposits, as well as to those of the surrounding dunes of the Namib Sand Sea.

TABLE 1: Description of sediments at Narabeb

| Unit | Thickness in m | Description* |
|---|---|---|
| XI | 11.0 | Sand, fine to medium grained, mod. well sorted, >90% quartz, distinct horizontal laminae especially near base, non-calcareous except for weak cementing along some laminae in basal metre, nearly all grains frosted, rounded to well rounded, and uniformly stained "amber" (7.5 YR 7/6, reddish yellow), overall reddish yellow (7.5 YR 6/6), upper surface is a flat "bench" adjacent to flank of longitudinal dune, lower contact distinct. |
| X | 1.1 | Calcareous mudstone, not visibly laminated, cementing variable, halite-filled fractures common, silt and sand is stained amber to red, overall white (10 YR 8/2), lower contact distinct. |
| IX | 3.6 | Sand, fine grained, mod. well sorted, silty in middle part of unit, >90% quartz, well laminated, some laminae in lower half contain calcareous clay chips, grains subangular to rounded (mainly subrounded) with larger ones frosted, pale to dark amber stained grains dominant but some with a "blotchy" red colour (2.5 YR 4/8), overall reddish yellow (5 YR 6/6) to pinkish grey (7.5 YR 7/5) in silty part, lower contact gradational. |
| VIII | 2.8 | Calcareous mudstone, more silty and well laminated in lower part with sand in basal 80 cm, silt and sand is stained amber to red, overall pinkish grey (7.5 YR 7/3), lower contact completely gradational. |
| VII | 1.4 | Sand, fine grained, mod. well sorted, increasingly silty toward top, >90% quartz, poorly laminated, grains dominantly subrounded to rounded and pale to dark amber stained, some (mainly very fine) grains are stained a "blotchy" red, larger grains frosted, lower contact distinct. |
| VI | 1.0 | Calcareous mudstone, sandy, laminated with thin halite film and iron staining (dark brown, 7.5 YR 4/6) along laminae, occasional vertical fracture filled by halite, silt and sand is stained amber to red, overall very pale brown (10 YR 8/3), lower contact distinct. |
| V | 3.0 | Calcareous mudstone, upper part very sandy with distinct pink laminae, poorly laminated elsewhere, silt and sand is stained mainly amber with some red grains, overall pink (7.5 YR 8/3), lower contact gradational over 5 cm. |
| IV | 0.5 | Sand, fine to very fine grained, mod. well sorted. >90% quartz, calcareous silty clay laminae that may be windblown chips, dominantly pale to dark amber staining with red "blotchy" staining more common in finer fraction, mainly subrounded to rounded grains with larger ones better rounded and frosted, strong brown (7.5 YR 5/6) with pink (7.5 YR 7/4) calcareous laminae, lower contact distinct. |
| III | 3.7 | Calcareous mudstone, basal 10 cm very sandy and well laminated, poorly laminated to massive in most of unit but distinct silty laminae scattered throughout, polygonal pattern of fractures containing a halite-cemented infilling of fine quartz sand (strong brown, 7.5 YR 5/6), halite film on fine pattern of fractures and laminae planes, silt and sand is stained pale amber to red and is subangular to rounded, overall colour pinkish white (7.5 YR 8/2), lower contact distinct. |
| II | 7.6 | Sand, mainly fine to very fine grained but scattered much coarser grains and some laminae comprised of coarse sand to granule sizes, moderately sorted, a few laminae contain chips of calcareous silty clay, only upper part of this unit is well exposed, >90% quartz, weakly cemented in upper 15 cm, subangular to well rounded with coarsest grains best rounded and frosted, very coarse sand comprised mainly of well rounded dark quartzites and some quartz plus subangular rock fragments of quartz and mafic minerals with a few subrounded white limestone fragments, finer fraction comprised of pale amber to red-stained quartz with an increase in red staining, quartzite grains and black minerals in the very fine sand fraction, overall reddish yellow (7.5 YR 6/6), lower contact distinct. |
| I | 0.4 | Calcareous mudstone, not visibly laminated, weakly bedded near base, scattered vertical fractures (mudcracks?) infilled by light grey (2.5 Y 7/2) mudstone, overall colour very pale brown (10 YR 7/3), unit fractured into very large angular blocky fragments with surfaces stained dark brown (7.5 YR 2/2) and encrusted with halite crystals (more toward top of unit), many silt grains stained red, lower contact distinct. |
| — | 5 mm | Calcium carbonate, with very coarse sand and granules (up to 5 mm in diameter) in a finer sand matrix partially cemented by silica) belonging to underlying Tsondab Sandstone cemented by calcite into the base of this unit, overall 72% calcite, coarse grains mainly rounded dark quartzites and quartz, finer sand mainly subrounded red-stained and amber quartz like in underlying unit, lower contact distinct. |
| — | 0.8+ | Sandstone (Tsondab Fm), fine to very fine grained, very well sorted, >90% quartz, weakly cemented by silica, distinct parallel laminae with many stained red (2.5 YR 4/8) and light reddish brown (5 YR 6/4) overall colour yellowish red (5 YR 5/8), "pedotubules" of carbonate-cemented sand extend downward from top of unit, grains subangular to well rounded but mainly subrounded, all quartz grains stained either a uniform deep reddish amber (5 YR 7/8, reddish yellow) or uniform to "blotchy" red colour (2.5 YR 4/8, red), all have a vitreous patina. |

* "Amber" quartz is the result of a transparent stain that is about 7.5 YR 7/6 (reddish yellow). "Red" staining may be as dark as 2.5 YR 4/8 and 10 R 4/8 (red) and is variable in Munsell "value"; it is commonly irregularly distributed ("blotchy"), being concentrated in pits and embayments of the grain.

Six calcareous mudstone units have been identified. They are variably laminated and sandy and contain halite-filled fractures and desiccation cracks. Unit IV contains planktonic diatoms, mainly *Tabellaria fenestrata,* which are characteristic of eutrophic freshwater lakes (Goldsborough, pers. comm).

There are several radiocarbon dates from the calcareous mudstones, as follows: Unit I, 22,500 ± 340 B.P. (Pta-3704); Unit V, 20,320 ± 300 B.P. (Beta-9115); Unit X, 26,400 ± 340 B.P. (Pta-3759) and 22,330 ± 600 B.P. (Beta-9116). Calcareous pedotubules in the underlying Tsondab Sandstone were dated at 28,500 ± 500 B.P. (Pta-1197). A date from the base of Unit I, 39,800 ± 1170 B.P. (Pta-3770) may have been contaminated by older carbon.

## 3 CONCLUSIONS

The sediments described above represent an alternation of wet and dry periods in this now hyperarid region. The mudstones appear to have been deposited in a shallow lake, a former end pont of the Tsondab River. The lake probably resulted from the damming of the course of the Tsondab by dunes. Flow in the Tsondab River as far west as Narabeb indicates increased rainfall and runoff in its highland catchment area (Lancaster, 1984; Teller and Lancaster, 1986).

The six mudstone units represent at least six periods of ponding of the Tsondab River. The sands which lie between each mudstone unit probably represent aeolian deposition in dry phases. Desiccation is evidenced by mud cracks and halite in the upper parts of the mudstone units. The presence of calcareous mud chips in some of the sand units indicates deflation of a nearby lake bed.

The age of the Narabeb deposits remains uncertain. Radiocarbon dates on the mudstones, as well as on carbonates elsewhere in the Namib (Vogel and Visser, 1981), indicate that the period 20-35,000 years B.P. was wetter than the present. However the $^{234}U/^{230}Th$ date from the basal mudstone obtained by Selby *et al* (1979) suggests an age of more than 200,000 years for the whole sequence. Archaeological materials of both Early and Middle Stone Age affinities are associated with deposits at Narabeb (Shackley, 1985), indicating that the deposits are more than 25,000 years old.

## 4 ACKNOWLEDGEMENTS

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TABLE 2: Summary of characteristics of each unit at Narabeb.

| | | Lithology: U = upper L = Lower | | Insoluble residue[1] | | | HCl sol. | Sand stats[2] | | Clay mineralogy[3] | | | | Bulk-mineral X-ray and microscopic analyses[4] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sand | Silt | Clay | | Mean size | Std. dev. | I | Ex | K | C | Qtz | Alb | Dar | Mic | Cal | Hal |
| XI | 11.0 | Sand | L | 100 | 0 | 0 | 0 | 1.7 | 0.51 | | | | | + | – | – | | – | |
| X | 1.1 | Mudstone | | 5 | 36 | 59 | 41 | | | 45 | 33 | 13 | 9 | + | – | – | | + | – |
| IX | 3.6 | Sand | | 98 | 2 | 0 | 7 | 2.6 | 0.53 | | | | | + | – | – | | – | |
| VIII | 2.8 | Mudstone | U | 2 | 28 | 70 | 40 | | | 38 | 41 | 12 | 9 | + | – | – | – | + | – |
| | | | L | 17 | 57 | 26 | 20 | | | 58 | 9 | 23 | 10 | + | – | – | – | + | |
| VII | 1.4 | Sand | | 92 | 5 | 2 | 5 | 2.6 | 0.56 | | | | | + | – | – | | – | |
| VI | 1.0 | Mudstone | | 16 | 42 | 42 | 46 | | | 63 | 11 | 19 | 8 | + | | – | – | + | – |
| V | 3.0 | Mudstone | U | 32 | 34 | 34 | 19 | | | 55 | 13 | 20 | 12 | + | – | | – | + | – |
| | | | L | 1 | 41 | 58 | 31 | | | 51 | 23 | 18 | 7 | + | – | | | + | |
| IV | 0.5 | Sand | | 100 | 0 | 0 | 0 | 2.5 | 0.73 | | | | | + | – | – | | – | |
| | | Silty chips | | 0 | 62 | 38 | 3 | | | 68 | 0 | 22 | 10 | + | | | – | + | |
| III | 3.7 | Mudstone | U | 2 | 34 | 64 | 35 | | | 50 | 21 | 24 | 5 | + | – | – | – | + | – |
| | | | L | 24 | 34 | 42 | 23 | | | 68 | 0 | 28 | 4 | + | – | – | – | + | |
| II | 7.6 | Sand | U | 97 | 3 | 0 | 3 | 3.2 | 0.82 | | | | | + | – | – | | – | |
| I | 0.4 | Mudstone | | 1 | 33 | 66 | 36 | | | 44 | 33 | 10 | 13 | + | – | – | – | + | – |
| – | 0.8+ | Tsondab Ss | | 97 | 2 | 1 | 4 | 2.5 | 0.30 | | | | | + | – | – | | – | |
| Linear dunes of region | | | | 100 | 0 | 0 | – | 1.8-2.75 | 0.20-0.90 | | | | | + | + | – | | | |

[1]Determined by first removing carbonates in HCl, then removal of sand by wet sieving, followed by hydrometer analysis for silt and clay.
[2]In phi, using Folk and Ward (1957) graphic calculations.
[3]I = illite, Ex = expandables K = kaolinite, C = chlorite.
Determined by measurement of peak heights of X-ray diffractograms; clay slides glycolated and heated to 340°C and 500°C (I = 10°A peak glycolated; Ex = 10°A peak heated to 340° – 10°A peak glycolated; K+C = 7°A peak; C = 7°A peak heated to 500°).
[4]Qtz = quartz, Alb = albite, Dar = dark and opaque grains, Mic = mica, Cal = calcite, Hal = halite; + = major component, – = minor component (<10%)

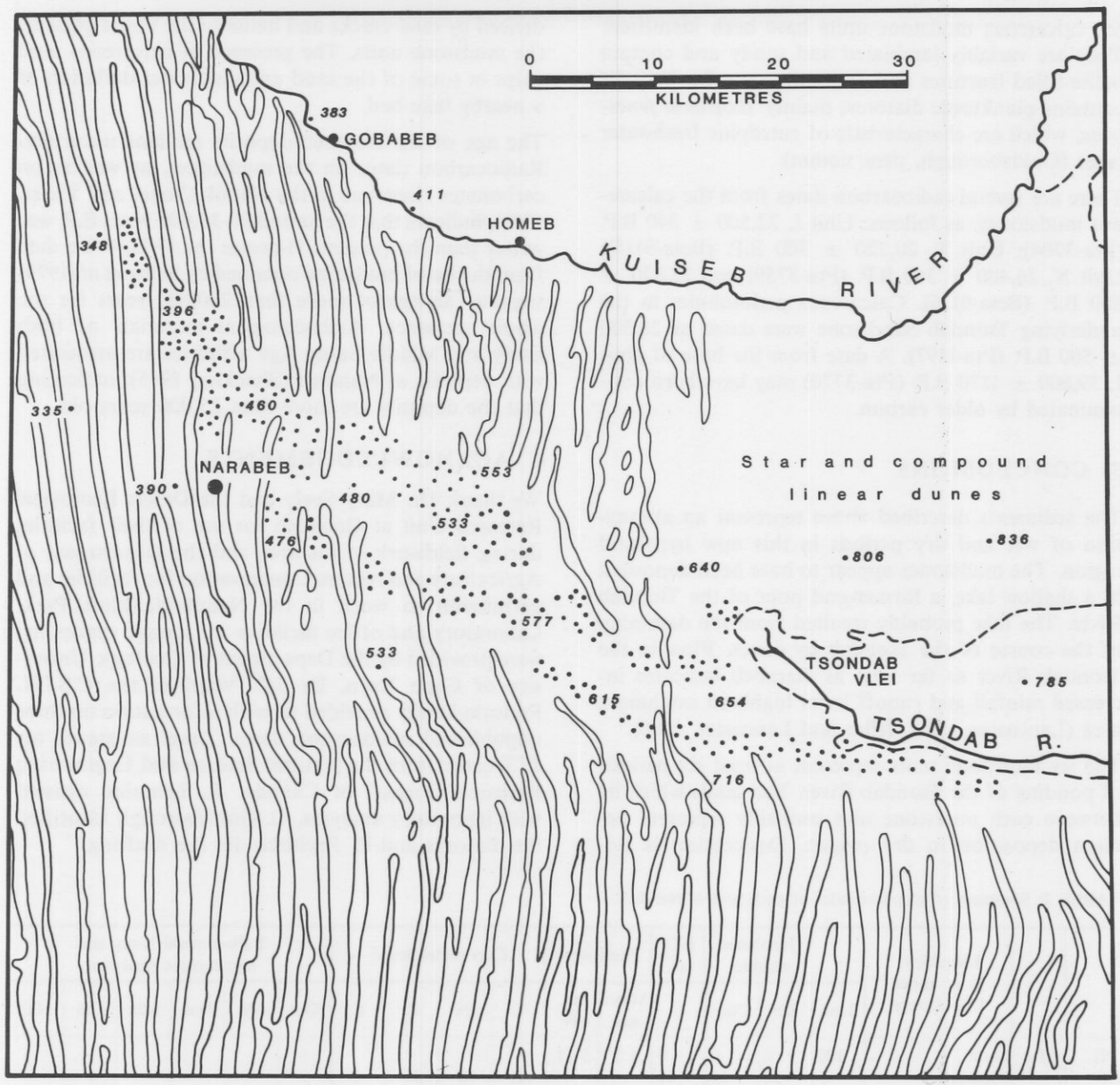


FIGURE 1: Location map to show position of Narabeb within the northern part of the Namib Sand Sea. Spot elevations in metres. Stippled areas indicate extent of exposures of fluvial deposits associated with former courses of the Tsondab River. Position of dunes indicated by form lines.

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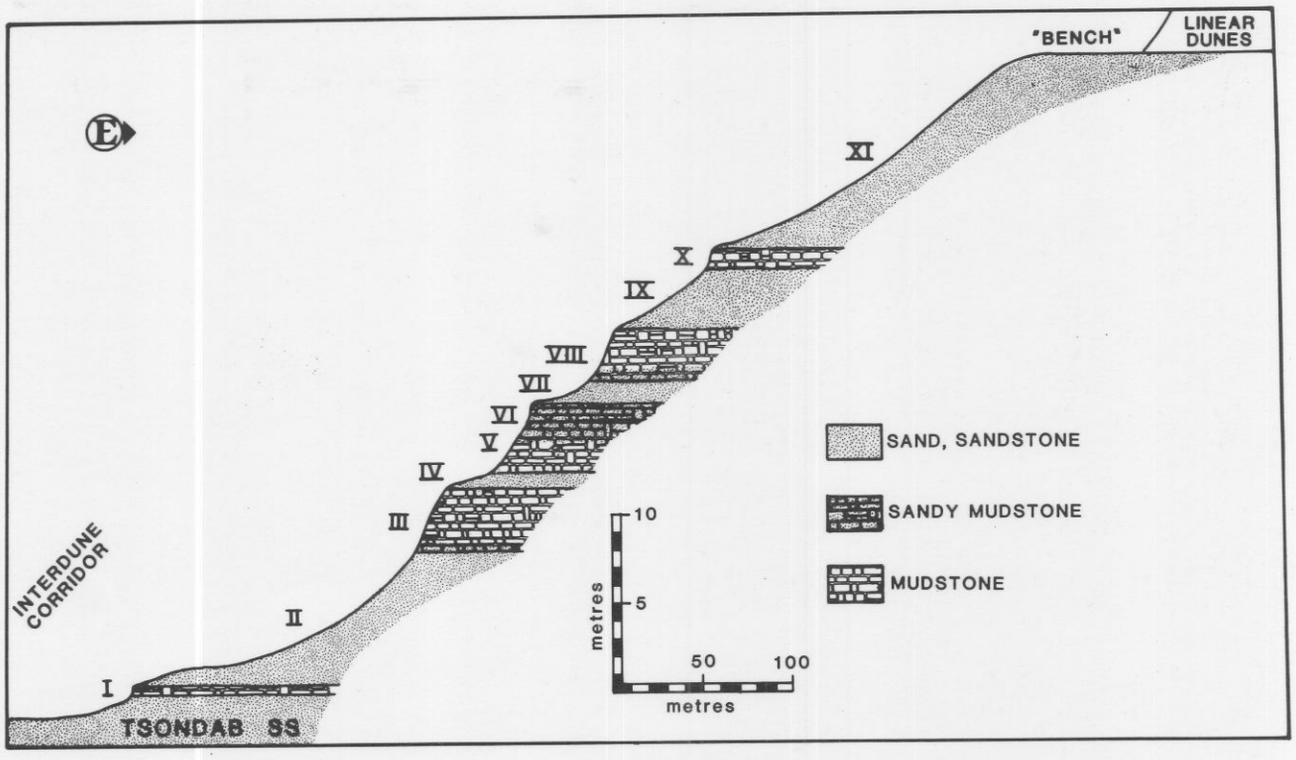


FIGURE 2: Generalised cross section of the deposits at Narabeb to show position of Units identified and described in Table 1. Derived from field survey and measured sections by JTT and NL in September 1983.