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INTERDUNE DEPOSITS OF THE NAMIB SAND SEA

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ABSTRACT

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The Namib Sand Sea of southwestern Africa is dominated by large north–south trending linear dunes. Interdune areas, however, comprise about 50% of the area of the Sand Sea and may consist of exposures of the pre-dune surface or sediments deposited between the dunes. Four major types of interdune deposits are identified and described: (1) coarse poorly sorted aeolian sands; (2) localised calcareous lacustrine deposits; (3) silty deposits of ephemeral rivers that have flooded into the Sand Sea margins; and (4) sabkhas and salt marshes near the coast. The preservation potential of these sediments is poor, except where they are buried and protected by dunes or stabilised by high groundwater levels in coastal areas.

INTRODUCTION

The extent and significance of interdune deposits in modern and ancient aeolian sedimentary environments is being increasingly recognised (Ahlbrandt and Fryberger, 1981; Hunter, 1981; Fryberger et al., 1983; Hummel and Kocurek, 1984; Kocurek, 1981a, b, 1986). However, relatively little is known about the occurrence and characteristics of interdune deposits in modern sand seas. No previous account of interdune deposits in the Namib Sand Sea has been published, except for brief remarks in Besler (1980) and McKee (1982) and discussions of some of the lacustrine deposits (e.g. Seely and Sandelowsky, 1974; Selby et al., 1979; Teller and Lancaster, 1986a, b). The purpose of this paper is to document the nature and extent of interdune deposits in the Namib Sand Sea, based on field observations by Lancaster in the period 1980–1983, and by both of us in September 1983. The lacustrine deposits are the subject of continuing investigations by the authors, in conjunction with N.W. Rutter of the University of Alberta and J.D. Ward of the Geological Survey in SWA/Namibia.

REGIONAL SETTING

The Namib Sand Sea covers an area of some 34,000 km^2 along the coast of southwestern Africa between latitudes 27° and 23°S (Fig. 1). It extends inland for

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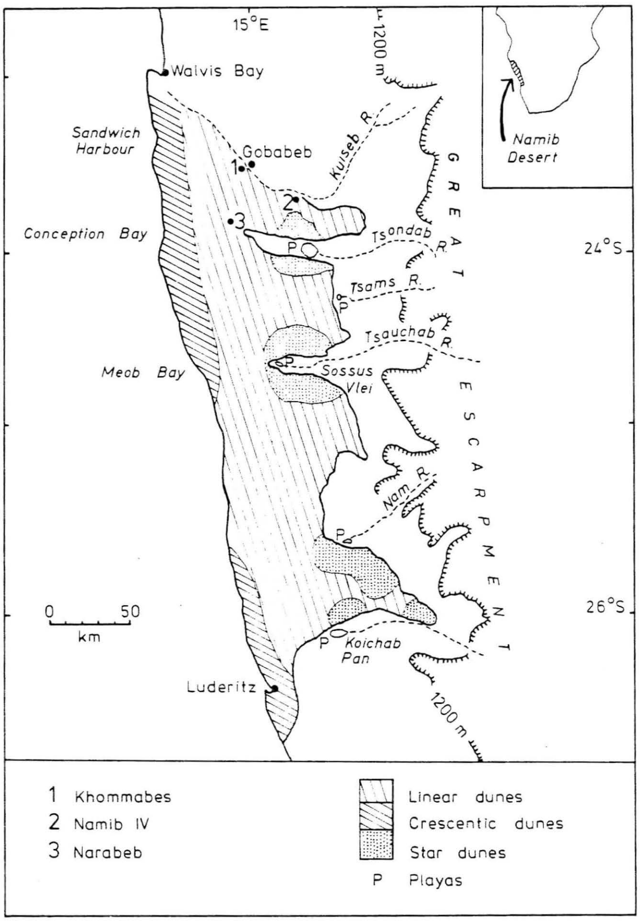

Fig. 1. The Namib Sand Sea, showing areas covered by crescentic, linear and star dunes. Also shown are ephemeral rivers that drain west from highland areas which receive higher rainfall to terminal playas along the eastern margin of the Sand Sea. The 1200 m contour lies near the base of the Great Escarpment. Trends of crescentic and linear dunes are schematic.

100–150 km to approximately the 1200 m contour near the base of the Great Escarpment. West of this escarpment the regional bedrock surface slopes at an average gradient of 1° toward the Atlantic Ocean. Rocks of Precambrian age are exposed on this pediplained surface, but are overlain in places by late Cenozoic sandstones, conglomerates and carbonates. A number of ephemeral watercourses drain toward the coast from the escarpment. One of these, the Kuiseb River, forms the northern boundary of the Sand Sea. To the south, the Tsondab and Tsauchab Rivers (Fig. 1) extend for 40–80 km into the Sand Sea in well-defined valleys, and terminate amongst the dunes in extensive playas. Relict fluvial deposits exposed in interdune areas indicate that these rivers formerly extended farther west into the

Sand Sea before their courses were blocked by the advance of dunes from the south (Lancaster, 1984). Small ephemeral streams such as the Nam and Tsams terminate against the eastern margin of the Sand Sea in small playas.

There are three main dune types in the Namib Sand Sea (Fig. 1), the distribution of which is largely controlled by regional variations in the directional variability of the wind regime (Lancaster, 1983). Along the coast is a belt up to 20 km wide of crescentic dunes, oriented perpendicular to the prevailing S–SW winds. Inland, in areas of bidirectional wind regimes, are linear dunes with N–S to NW–SE alignments, which cover some 75% of the area of the Sand Sea. In central parts of the Sand Sea, these dunes reach a height of 150 m, with a crest-to-crest spacing of 2.5 km. In eastern areas of the Sand Sea, where rainfall is higher, there are areas of low, partly vegetated linear dunes. Groups of star dunes up to 300 m high occur around Sossus Vlei and Tsondab Vlei, and along the eastern margins of the southern part of the Sand Sea, where topographically controlled funneling of winds results in a seasonally reversing wind regime.

The climate of the area is hyper-arid to arid. Mean annual rainfall increases from less than 15 mm on the coast to 80 mm on the eastern edge of the Sand Sea (Lancaster et al., 1984).

EXTENT AND CLASSIFICATION OF INTERDUNE AREAS

The extent and shape of interdune areas varies from one dune type to another. In areas of linear dunes, 38–73% (mean 60%) of the surface can be considered as lying between the dunes themselves. Interdune areas between linear dunes are strongly elongate and extend in a north–south direction for tens of kilometres. They are up to 2 km wide, with a maximum local relief of 10–15 m. In areas of star dunes, the interdune areas are more irregular and are typically less than 10 km in length and 1.5 km in width. An average of 48% of the region covered by star dunes consists of interdune areas. In areas of crescentic dunes, the slip face of one dune frequently abuts the base of the stoss slope of the next dune downwind, so that interdune areas are restricted to small sub-circular depressions in front of concave slip faces and less than 10% of the surface can be considered as belonging to the interdune area. In total, some 50% of the Namib Sand Sea consists of interdune areas.

Ahlbrandt and Fryberger (1981) recognised two basic types of interdune areas: deflationary (or non-depositional) and depositional. We have used the same basic scheme for the Namib Sand Sea:

I. Deflationary or non-depositional interdunes:
- (a) Bedrock interdunes: (i) Precambrian granites and schists
  - (ii) Tertiary Tsondab Sandstone Formation
- (b) Late Tertiary to early Pleistocene fluvial deposits of the Kuiseb, Tsondab and Tsauchab Rivers.

II. Depositional interdunes:
(a) Aeolian sands (wind ripple deposits) and lag deposits.
(b) Lacustrine carbonates, silts and sands.
(c) Fine-grained fluvial deposits of rivers that have penetrated the margins of the Sand Sea.
(d) Sands, evaporites and clays of sabkhas and salt marshes in coastal areas.

The spatial distribution of the interdune types identified above varies considerably. Most interdune areas are sand covered south of about 24°S latitude with small areas of the Tertiary-age Tsondab Sandstone Formation exposed locally. Exposures of Precambrian bedrock in interdune areas are confined to the margins of the Sand Sea. Many of the interdune lacustrine deposits occupy hollows in the irregular bedrock surface and in the relict fluvial deposits of the Kuiseb and Tsondab Rivers, notably in the northern and eastern parts of the Sand Sea.

DESCRIPTION OF INTERDUNE DEPOSITS

Deflationary or non-depositional interdunes

Exposures of Precambrian bedrock in interdune areas in marginal areas of the Sand Sea consist of irregular surfaces of salt-weathered and wind-eroded granite and schist that are partly covered by thin sand sheets on which granule ripples have developed.

Sandstone of the mid to late Tertiary Tsondab Sandstone Formation probably underlies much of the present Namib Sand Sea but is mainly exposed in interdune areas on its northern and eastern margins (Besler and Marker, 1979; Ward, 1984). This sandstone was also deposited in a dominantly aeolian environment and represents a precursor of the present Sand Sea (Ward et al., 1983).

In many places the exposed surface of the Tsondab Sandstone is extensively weathered, which releases dark reddish-brown sands to adjacent sand-covered interdune areas. Calcrete pedotubules that formed during a late Tertiary phase of pedogenesis occur in some areas (Yaalon and Ward, 1982). Similar pedotubules at Narabeb have been attributed to termite burrowing by Seely and Mitchell (1986). In places, the sandstone surface of bevelled large-scale cross-strata with dips to the north and northeast (Fig. 2). A striking feature of some interdune areas south of Gobabeb is the occurrence of large-scale polygonal cracks in the surface of the Tsondab Sandstone Formation (Ollier, 1977; Watson, 1980), termed macro-fractures by Ward (1984). In some places, these macro-fractures were the loci for the deposition of lacustrine carbonates. The size of these polygonal crack patterns is, however, much larger than those described in the Navajo and Page Sandstones by Kocurek and Hunter (1986), who attributed the formation of the cracks to thermal contraction near the water table during a hiatus in sand sea development.

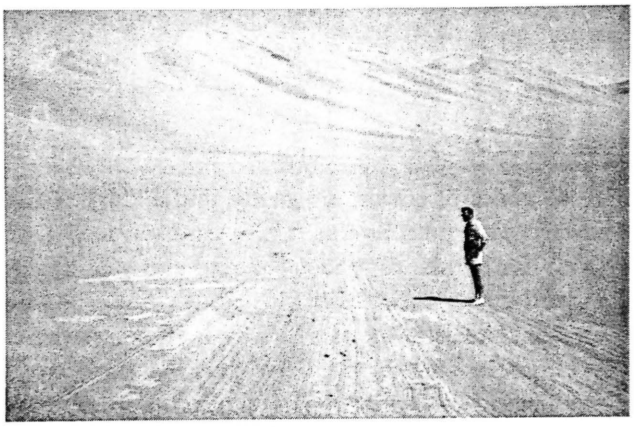

Fig. 2. Bevelled northeast-dipping beds of Tertiary-age Tsondab Sandstone exposed in interdune area in northwestern Namib Sand Sea.

Carbonate-cemented fluvial deposits of the late Tertiary to early Pleistocene Karpfenkliff Conglomerate of the Kuiseb River drainage, and their stratigraphic equivalents in the Tsondab Valley, overlie the Tsondab Sandstone Formation and are exposed in some interdune areas between these two rivers (e.g. Ward et al., 1983; Ward, 1984). The surface of the conglomerate has weathered to form an irregular deflation lag of well-rounded coarse sand, gravel or cobbles (Fig. 3). Thin sand sheets, ranging in size from tens to hundreds of square metres, have developed in undulations in this surface, forming sand drifts and shadows adjacent to erosional remnants of the conglomerate. Similar interdune deposits, consisting of deflation

Fig. 3. Pebble lag derived from late Tertiary–early Pleistocene fluvial deposits in interdune area west of Tsondab Vlei.

lags developed on fluvial deposits, have been recognised in the rock record by Steidtmann (1974) and Clemmensen and Abrahamsen (1983).

Aeolian sand

Sand-covered interdunes (Fig. 4) typically consist of gently undulating to flat wind-rippled surfaces, sparsely covered with grass clumps. These sand surfaces slope up to and merge imperceptibly with the plinths of adjacent linear and star dunes. Estimates of the thickness of the interdune sands are difficult to make, but probably range from a few centimetres in marginal areas of the sand sea to 5–10 m elsewhere. In many areas, especially in the southern part of the Sand Sea, the surfaces of sand-covered interdune areas are formed into low dunes similar to the zibars described by Holm (1960), Warren (1972), Lancaster (1982) and Nielson and Kocurek (1986). These dunes have a relief of 1–2 m, a wavelength of 200–300 m, and a crest trending perpendicular to that of the main linear dunes. These areas represent a transitional facies between interdune and dune deposits. In the north-western part of the Sand Sea, small linear and transverse dunes, on a trend oblique to that of the main linear dunes, extend partly or completely across interdune areas.

The sands of interdune areas are typically moderately to poorly sorted, medium to coarse sand. They are invariably coarser and less well sorted than those of the immediately adjacent dunes. Many zibar and interdune sands are slightly bimodal, with a coarse mode centering on 1.5–2.0 ϕ (0.25–0.35 mm) and a fine mode at 3.0–3.5 ϕ (0.09–0.125 mm) (Fig. 5). Their mean grain size ranges from 2.2 to 1.8 ϕ (0.21–0.28 mm), with an average value of 2.05 ϕ (0.24 mm). Where zibars occur,

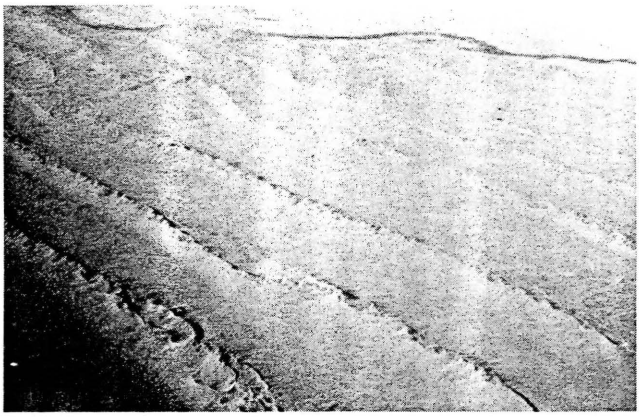

Fig. 4. Oblique aerial photograph of large complex linear dunes and broad interdune areas in the Namib Sand Sea. Interdune areas are about 1.5 km wide in this area and mainly sand covered. Kuiseb River can be seen near top (northeast) of photograph.

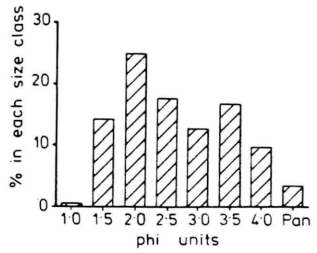

Fig. 5. Grain-size distribution of representative sand from interdune area between linear dunes in the central part of the Namib Sand Sea.

there is some variability in grain size and sorting from troughs to crests. On zibars in the southern part of the Sand Sea, the mean grain size changes from 1.8 ϕ (0.28 mm) in the troughs to 2.0 ϕ (0.25 mm) on the crests of the undulations. Most zibar and interdune sands are moderately or poorly sorted. Phi standard deviations range from 0.70 to 1.10, with a mean value of 0.87. They are also distinctly fine skewed, with a mean phi skewness of + 0.26. On bivariate plots of grain size and sorting parameters, interdune sands are always coarser, less well sorted, and more positively skewed than adjacent linear and star dunes. There is a well-marked gradient of decreasing mean grain size and improved sorting from interdune areas to dune plinths, crests and slip faces in all areas of linear and star dunes (Lancaster, 1981).

In areas adjacent to sources of coarse sand, such as the relict fluvial deposits of the Kuiseb and Tsondab Rivers or outcrops of granitic rocks, interdune sands have

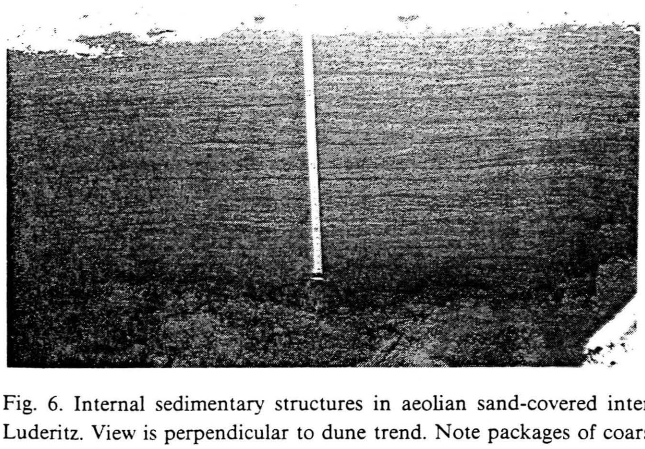

Fig. 6. Internal sedimentary structures in aeolian sand-covered interdunes between linear dunes near Luderitz. View is perpendicular to dune trend. Note packages of coarse sand laminae (? granule ripples) separated by thin packages of finer sand. At 15 cm depth, gently dipping laminae of medium sand may have been deposited by the migration of a zibar across the interdune area. Sand in this interdune area is much coarser than elsewhere in the Sand Sea, because it lies near the upwind end of the Sand Sea.

developed a lag of coarse sand. Similar lags have been noted from the Lyons Sandstone (Permian) by Walker and Harms (1972) and Permian red-beds in Arran, Scotland by Clemmensen and Abrahamsen (1983).

Sedimentary structures of sands in interdune areas between linear dunes in the Namib Sand Sea show that the deposits are composed of flat lying to very gently dipping (2–4°) wind ripple laminations (Fig. 6) (McKee, 1982; Lancaster, in press). In this respect they differ considerably from interdune deposits in some areas of crescentic dunes, which appear to consist of the bevelled cross-strata of previous generations of such dunes (McKee and Moiola, 1975). In the rock record, it would probably be difficult to distinguish sandy interdune deposits from those of dune plinths as they appear to possess similar sedimentary structures and grain size characteristics. Horizontally laminated wind ripple deposits have been interpreted as interdune deposits by Kocurek (1981b) in the Jurassic Entrada Sandstone of Utah, and by Clemmensen and Abrahamsen (1983) in Permian red-beds in Arran, Scotland. There is little evidence of bioturbation in interdune sands, except for the occasional presence of calcified "pedotubules" and abandoned termite burrows.

Lacustrine carbonates

Outcrops of calcareous mudstones and sandstones and of sandy limestones are present in a number of interdune areas in the northern part of the Namib Sand Sea (Fig. 7). These sediments commonly occur in shallow depressions developed in Precambrian bedrock, the Tertiary Tsondab Sandstone Formation, or in the overlying late Tertiary–early Pleistocene Karpfenkliff Conglomerate. In some areas they underlie or grade into the margins of linear and star dunes. Such deposits were termed the Khommabes Carbonate Member of the Sossus Sand Formation (the

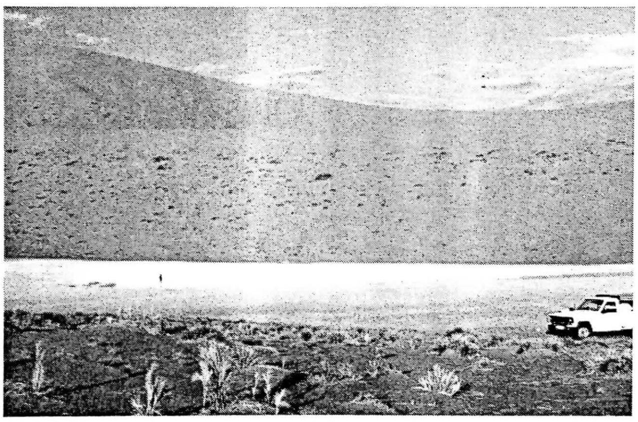

Fig. 7. Small carbonate pan at edge of star dunes in northeastern part of the Sand Sea. Note man for scale at edge of pan.

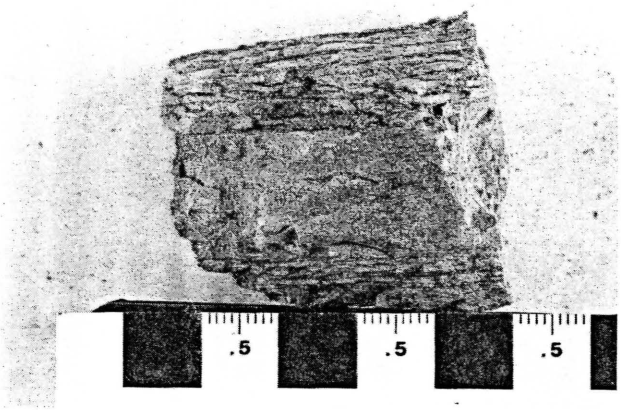

Fig. 8. Laminated and massive calcareous mudstones from Narabeb. Scale in centimetres

dune sands of the Sand Sea) by Ward (1984). They appear to have been laid down in shallow ephemeral or seasonal water bodies.

These deposits are rarely more than a metre thick and a few thousand square metres in areal extent (Fig. 7). Some beds are dominantly carbonate and contain only a small percentage of clastic material. Others are comprised mainly of detrital quartz and clay, e.g. the calcareous mudstones at Narabeb (Fig. 1) that contain 20–46% calcite (Teller and Lancaster, 1986b). Calcareous sandstones, including many with greater than 20% carbonate content, are also common in these interdune lacustrine sequences, such as at Khommabes and Namib IV (Fig. 1). Calcite is the dominant mineral of the carbonates, although dolomite, aragonite and magnesian calcite are present in some beds. At Narabeb and Khommabes, where the sedimentary sequence has been studied in detail, the sand-sized fraction in the carbonates is dominated by rounded to subrounded quartz, that is stained an amber to red colour. These grains are very similar in appearance to those of the adjacent dunes (Teller and Lancaster, 1986a, b).

Individual carbonate-rich units are occasionally laminated (Fig. 8), as are interbedded and underlying weakly cemented sandstones. Although beds of evaporites have not been found, halite occasionally occurs in fractures and desiccation cracks, as well as discontinuously along bedding planes, especially where the rocks contain clay. Some desiccation cracks are filled by sand. Calcified reed casts (Fig. 9), carbonate-cemented root and termite burrows, and fresh to brackish water gastropods and diatoms have been identified from some of the calcareous lacustrine beds (e.g., Vogel and Visser, 1981; Ward et al., 1983; Ward, 1984; Teller and Lancaster, 1986a, b; Teller et al., in press).

At some localities, the playa deposits display a characteristic association of facies, with limestones in the center of the basin and carbonate-cemented sands and

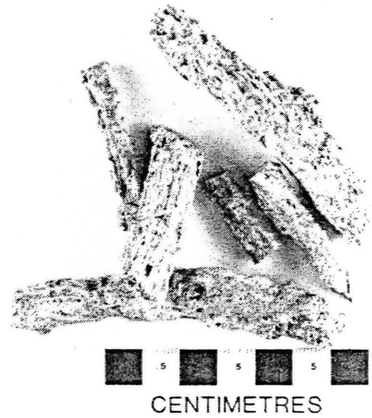

Fig. 9. Calcified stems of *Phragmites* reeds from Khommabes.

calcified reeds overlying bleached and mottled aeolian dune and interdune sands on the basin margins. Detailed studies at Khommabes and Narabeb (Fig. 1) (Teller and Lancaster, 1986a, b) suggest that lacustrine and aeolian environments have alternated during the accumulation of the playa deposits. In both examples, the uppermost sediments are dune sands similar to those of the modern dunes, which have transgressed over the margins of the basins.

Similar thin (0.3–1.0 m) flat-lying beds of siltstone and claystone and thin lenses of limestone have been described in the Navajo Sandstone (Jurassic) in Utah and Arizona and the De Chelly Sandstone (Permian) in Arizona (Kiersch, 1950; Harshbarger et al., 1957). These beds were interpreted as interdune deposits by McKee (1979). Fryberger (1979) has suggested that thin carbonate horizons and lenticular beds of dolomitic mudstone, which grade downwards into dolomitic and calcareous sandstones represent the deposits of interdune ponds in the Weber Sandstone (Pennsylvanian–Permian) in Colorado.

The interdune lacustrine deposits have been laid down periodically during the accumulation of the Namib Sand Sea. The earliest known period of interdune lacustrine carbonate formation crops out at Namib IV, in the northeastern part of the Sand Sea (Fig. 1). These deposits contain fossils of *Elephas recki* and associated Acheulian stone artefacts, suggesting a Middle Pleistocene age of 400,000–700,000 B.P. for the deposits (Shackley, 1980). Selby et al. (1979) published $^{234}U/^{230}Th$ dates of 210,000–260,000 B.P. for the deposits at Narabeb (Fig. 1), but these are at variance with the radiocarbon dates of between 20,000 and 26,000 B.P. reported in Teller and Lancaster (1986b). Radiocarbon dates on most of the interdune lacustrine carbonates and molluscs cluster between 20,000 and 32,000 B.P. (Vogel and Visser, 1981).

The potential for preserving interdune lacustrine deposits in areas of linear and star dunes may be limited. The linear dunes extend downwind parallel to each other and migrate laterally at a slow rate. Interdune areas remain open and exposed to wind erosion for tens of thousands of years. Deflation of interdune lacustrine sediments is rapid, and residual deposits remain for long periods only where they have been protected by carbonate cement or case-hardening. West of Sossus Vlei, J.C. Vogel (pers. commun., 1986) reports that trees which died 300–400 years ago are now standing on 2–3 m high pedestals of fluvial silts. Even hard calcareous mudstones are severely wind eroded in most places. This process may be aided by salt efflorescences and clay-mineral expansion and contraction. Preservation of both calcareous beds and uncemented sands is most likely to occur only when they are buried by adjacent dunes soon after deposition. In areas of linear dunes, such as the Namib Sand Sea, deposits next to dune plinths will provide the maximum potential for burial and preservation.

Distal fluvial deposits

The ephemeral Tsondab and Tsauchab Rivers terminate in playas which lie as much as 40–80 km into the dunes of the Sand Sea (Fig. 1). As proposed by Seely and Sandelowsky (1974), Lancaster (1984), and Teller and Lancaster (1986b), the Tsondab River formerly flowed at least 60 km west of its present end-point and deposited silts, sands and gravels within an area that is now topographically isolated by the dunes of the Sand Sea. Other rivers to the south, such as the Tsauchab, probably also extended farther west at earlier periods, but no fluvial record has yet

Fig. 10. Horizontally laminated fluvial silts in interdune between star dunes 1 km west of Tsondab Vlei.

Fig. 11. Transverse dune encroaching on mudcracked interdune flood silts of the Kuiseb River 50 km downstream of Gobabeb.

been discovered in the largely sand-covered interdune areas of this part of the Sand Sea.

At Tsondab and Sossus Vleis (Fig. 1) there are extensive areas of horizontally laminated silts and silty sands up to 3 m thick (Fig. 10) that extend into interdune areas between large star dunes. In places silt has draped onto the basal portions of the dunes. Carbonate from these deposits at Tsondab Vlei is dated to the period from 8640 to 14,000 B.P. (Vogel and Visser, 1981).

Along the northwestern margin of the Sand Sea, floodwaters of the modern Kuiseb River have occasionally invaded interdune corridors, where they have deposited micaceous silts (Ward, 1984). In the lower Kuiseb Valley near Rooibank, these silts form mudcracked drapes around low transverse and shrub coppice dunes (Fig. 11) and between 50–80 m-high linear dunes. Silt thicknesses of up to 2 m have been observed. Teller and Lancaster (1986a) also proposed that some of the interdune sediment at Khommabes, dated at > 32,000 B.P., may have been deposited by flooding of an interdune corridor prior to that depression being isolated from the Kuiseb River by a transverse dune. Even the calcareous mudstones at Narabeb may owe their origin partly to an influx of river sediment.

Sabkha and salt marsh deposits

Sabkhas and salt marshes occur at a number of localities along the coastal margin of the Namib Sand Sea, but were not investigated in detail by the authors. At Meob Bay, and south of Conception Bay, Sandwich Harbour and Walvis Bay (Fig. 1), barchans and transverse dunes cross extensive sabkhas which are flooded at high spring tides and remain damp for much of the year in this cool foggy area. Adhesion ripples and the truncated cross strata of small barchans are common in

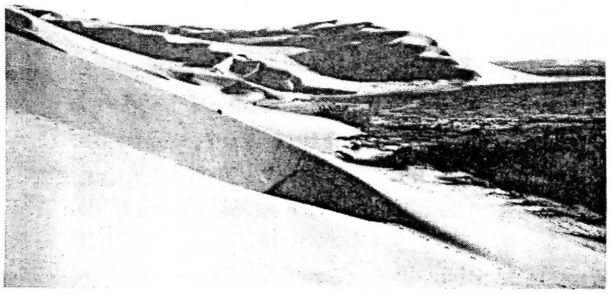

Fig. 12. Coastal salt marsh deposits adjacent to large compound crescentic dunes at Sandwich Harbour.

these interdune areas (Nagtegaal, 1973). Also present are thin (1–5 cm) halite beds and a variety of features such as contorted and wavy bedding resulting from deformation of soft sediments. At Sandwich Harbour, extensive salt marshes occur adjacent to and between the arms of large compound crescentic dunes (Fig. 12). Organic-rich sands and organic muds are being buried by the advance of these dunes.

DISCUSSION

Formation of the interdune deposits

The internal sedimentary structures of the interdune sand sheets investigated indicate that they have deposited by the migration of wind ripples. Locally, deposition by the migration of zibars and small transverse dunes may have occurred. Sedimentation has not been significantly influenced by vegetation in this hyper-arid area. Relatively coarse sands in interdune areas may be the result of the reworking of pre-existing sandy aeolian or fluvial sediments by the wind. Such a model was favoured by early workers in the Sahara (Capot Rey, 1970) and by Folk (1971) for the Simpson Desert and implies that the interdune areas are the source for the dunes. In the Namib Sand Sea, however, as in many other areas of linear dunes, the interdune areas are demonstrably not the source for the dune sands. Sand transport paths are oblique to the dune trends, and sand moves from dune to dune across interdune areas.

Rubin and Hunter (1985) have presented evidence which suggests that linear dunes migrate laterally, albeit at a very slow rate. If lateral migration of Namib linear dunes does take place, which seems probable in view of the high percentage of winds that are oblique to the dune trend, then interdune sands between linear dunes may represent a "trailing margin" of coarse sand deposited by the lateral migration of the dunes.

Aeolian sands in the interdune areas consist of a mixture of two grain-size populations: a dominant coarse fraction with a modal size of 1.0–2.0 ϕ, which represents grains moved primarily by surface creep; and a fine fraction with a modal grain size between 2.5 and 3.0 ϕ, which represents the saltation load. Differential rates of transport of the two sub-populations result in the slow-moving creep population being trapped in interdune and dune plinth areas, whilst the dunes are largely composed of the faster moving saltation population (Lancaster, 1981). This results in a lateral increase in sorting and a decrease in mean grain size from interdune to dune areas.

The carbonate-rich deposits are indicative of increased moisture availability in this normally hyper-arid to arid region. Diatom and molluscan faunas indicate that the water bodies were fresh to brackish in composition. Modern analogues suggest several possible depositional environments. Shallow seasonal or ephemeral lakes may have formed in interdune areas as a result of increased regional or local precipitation, which may have given rise to ponding of water in pre-existing depressions in interdune areas. Long-continued periods of increased rainfall may have raised local groundwater levels such that seepage from shallow aquifers occurred. In some areas, such as at Khommabes on the northern margin of the Sand Sea adjacent to the Kuiseb River, lakes may have formed adjacent to ephemeral water courses in response to high groundwater levels in those river valleys (Teller and Lancaster, 1986a). At other localities, for example at Narabeb, lakes formed at the former end points of ephemeral rivers, which at one time were able to penetrate much farther west into the Sand Sea than they do now (Seely and Sandelowsky, 1974; Teller and Lancaster, 1986b). This implies that rainfall and runoff in the headwaters of the rivers in the highlands east of the Sand Sea were at times greater and/or that linear dune patterns were sufficiently open to permit water to flow as much as 40 km west of the present terminal playas of these rivers. Evidence from elsewhere in the arid zone of southern Africa (Deacon et al., 1984) indicates that rainfall in this climatic zone was probably significantly higher during the period when these lacustrine beds were deposited. This may have resulted in partial or complete stabilization of the dunes of the Sand Sea and possibly the development of soils on the dune sands, giving rise to the formation of a climatically controlled regional bounding surface (Talbot, 1985) or "super surface" (Kocurek, 1985).

SUMMARY

The Namib Sand Sea is dominated by large, widely spaced north–south trending linear dunes, with small areas of star and crescentic dunes. Although bedrock is exposed in depressions between some dunes in marginal areas of the Sand Sea, aeolian sand covers most interdune areas. In places, zibars, transverse dunes and

even small linear dunes that trend obliquely to the main linear dunes have developed in the interdune corridors. In a few areas, fluvial silts have been deposited in interdune depressions by ephemeral rivers. Scattered across the northern part of the Sand Sea are a number of thin lacustrine carbonate beds, which although areally insignificant, are very important in elucidating the late Quaternary climatic history of the region. The preservation potential for most interdune deposits in areas of linear and star dunes is limited.

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