RED SANDS OF THE NULLABOR

A Preliminary Note

by

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A predominantly rounded, red aeolian quartz sand has been found in two caves and one doline on the Nullarbor. No acceptable source for the sand can be inferred from present knowledge.

INTRODUCTION

In the course of the 1982 Davey expedition to the Nullarbor, red, apparently aeolian sands were noted in several caves in the Diprose area. A small sample of the sands were obtained from N99 where two piles of sand occurred below "blowhole" type entrances (a "Thylacine" type cave, Lowry, 1970). Similarly deposited sand was observed in Diprose Number 3 Cave (N98); in both caves the gravity piles have been dissected by fluvial action. In Diprose Number 1 Cave (N97) the sands appear to be trapped in the shallow collapse doline a few metres below the surface of the Plain.

ANALYSIS

A limited particle size analysis was carried out on the small sample; the sand is well sorted with a strong mode in the fine sand range, there is some coarse skewness (Figure 1).

Optical microscope examination showed that the sediment is dominantly made up of subrounded to rounded quartz grains, with a high sphericity and frosting of the grain surfaces. The reddish colour of the deposit derives from iron oxide coating of the grains. There is a small component of heavy minerals, many of which are also well rounded. A calcareous component of secondary importance decreases from the very coarse sand class to the fine sand class. At the coarse end these calcareous grains are angular to subangular clasts but at the fine end of their range they are more rounded and spheroidal. There are some biogenic fragments - molluscan shell and chitin- - which are probably derived from cave biota. From this examination it was concluded that the deposit consists of aeolian sand but there is probably a clastic fraction from weathering of the local rock, possibly from the cave roof.

An aeolian origin for the coarse sand is supported by scanning electron microscope examination of the acid insoluble fraction of the medium and fine sand classes. The very low surface relief ($<3\mu$) of the grains is attributable to prolonged abrasion during aeolian transport and is much less than that observed on continental dune sands from the Simpson Desert (Plate 1). Low parallel ridges, especially prevalent on grain edges, are interpreted as remnants of upturned silica plates. Such upturned plates are the result of collisions between saltating quartz grains during wind transport; a plate density - wind velocity relationship has been determined (Krinsley & Wellendorf, 1980).

In addition the Scanning Electron Microscope study revealed secondary accretion of silica over the quartz grain surfaces as silica pellicles and globules. Similar silica plastering is known from old dune sands elsewhere, including the Simpson Desert, and is considered to be due to pedogenic (in situ) processes in the cave (Plate 2).

The conclusion from this evidence is that it is essentially an aeolian sand, dominantly of quartz but with a calcareous component and that the sand has a complex origin with two major sub-populations as follows:

1. Well rubefied, rounded aeolian quartz grains from a dune source, with evidence of several cycles of pedogenic alteration and reworking.
2. Angular to subangular calcareous grains derived from local rock, possibly as roof fall.

DISCUSSION

Aeolian sand accumulation is absent from most of the Nullarbor Plain including the neighbourhood of these cases. It appears that these caves (and maybe others) have trapped sand saltating across the Plain. Two questions immediately suggest themselves : firstly what is the source and secondly, when did this movement occur and/or is transport occurring today? Turning first to modern wind movement, records are available for a number of sites across the Nullarbor but only Forrest has instrumented windrun; the remainder have 0900 and 1500 observations of direction and strength. The Diprose Caves lie within a triangle whose apices are the three stations of Eucla, Cook and Ceduna. The particle size analysis, although in whole phi classes (Figurel), suggests that the graphic mean of 2.13 phi (225 microns) is probably representative further suggesting an impact threshold velocity of 4 m s^{-1} at 1 cm height equilavent to 16 km hr^{-1} at 1 metre height (Mabbutt, 1977 : 219). The Bureau of Meteorology wind records are in classes of 10 km hr^{-1} so percent occurrences of direction for winds above 11 km hr^{-1} will be considered.

At Cook, the data for 1500 hours are most relevant as the effects of surface moisture will be minimal (Table 1).

TABLE 1. COOK. Percentage wind occurrence above 11 km hr^{-1} at 1500 hours.

	E	SE	S	SW	W	NW	N	NE
January		23	17					
April		9	9					
July					20	14	12	
October		9	12	9		8		

There is a strong south-south easterly component in January which accounts for 40% of occurrences. This component declines to 18% in April, and a shift to a west-north west component occurs by July. This component accounts for 34% of occurrences above 11 km hr^{-1}. In October there is less dominance of a single direction, but a southerly component accounts for 30% of occurrences. The resultant wind at Cook is therefore likely to be from the south, with an easterly component.

Ceduna shows a clear dominance of southerly and southwesterly winds in January, April and October, (Table 2).

TABLE 2. CEDUNA. Percentage wind occurrences above 11 km hr^{-1} at 1500 hours.

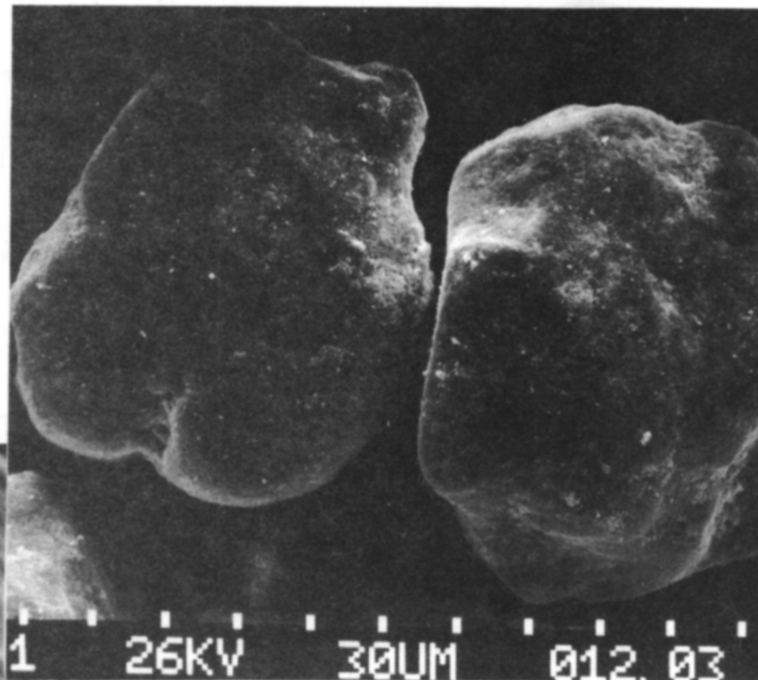
	E	SE	S	SW	W	NW	N	NE
January			60	20				
April			35	25				
July				18	17	11		
October			37	29				

These directions make up 80, 60 and 66 percent of occurrences in these months. In July winds from the west and southwest dominate with 17 and 18 percent of occurrences. The resultant wind at Ceduna is likely to be from the southwest.

The 1500 hours data for Eucla indicates dominance of southeasterly winds in January, April and October. Westerly winds appear more frequent in July. Although all these data are limited, the inferred resultant sand-moving wind in the Diprose area would likely be southerly with an easterly component. However there are southwesterly, westerly and northwesterly winds of sufficient strength to move grains of the size in question. Bowler (1975) has argued that in the Late Pleistocene there was a more northerly component to the wind regime thus allowing transport from more western and northern directions.

Turning to the question of source, dunes are to be found in all directions and distance from the Diprose Caves area but chiefly to the north (Queen Victoria Desert), east (Ooldea to Lake Ifould), southeast (Head of the Bight) and westerly (Roe Plains - Hampton Range areas). Only the dunes to the north and northeast are predominantly quartz; those to the north are conspicuously reddened whilst the eastern dunes are less so. However the trends of the dune systems suggest resultant winds in different directions from those required to bring sand to the caves. They also lack the calcareous sand component necessary to match the cave sand.

Coastal dunes from the Head of the Bight (20 km, SW) and the Roe Plains - Hampton Range area (250 km, W) are predominantly calcareous with a relatively small quartz component. Because of the lower specific gravity calcareous sand will travel at least as far as quartz in given wind conditions. On the other hand, the softer calcite sand will suffer more from attrition than quartz. However, it seems unlikely that during travel over 20 km differential attrition will reverse so dramatically the proportions of calcareous to quartz sand. One would also expect the calcareous component in the cave sand to show even more pronounced rounding and sphericity than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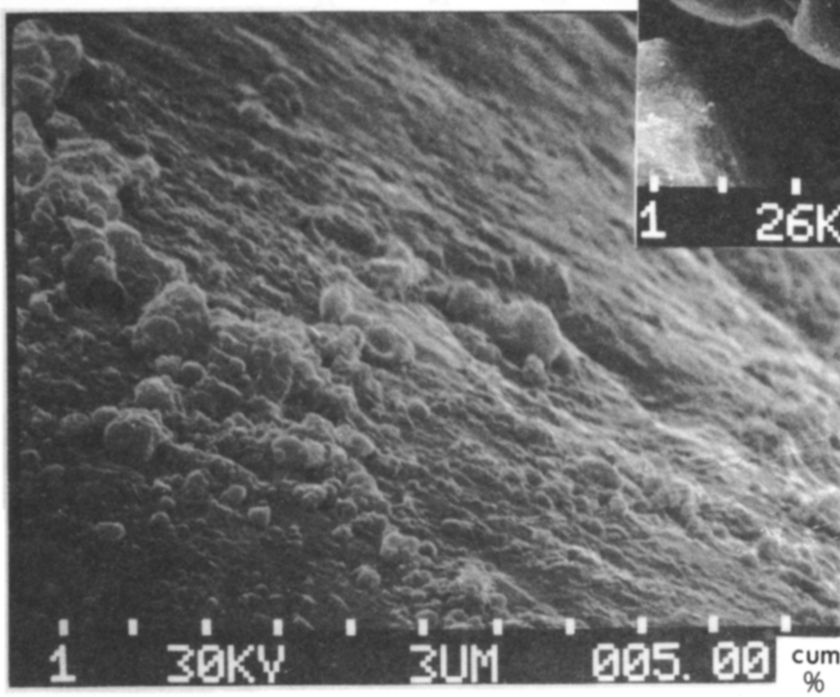
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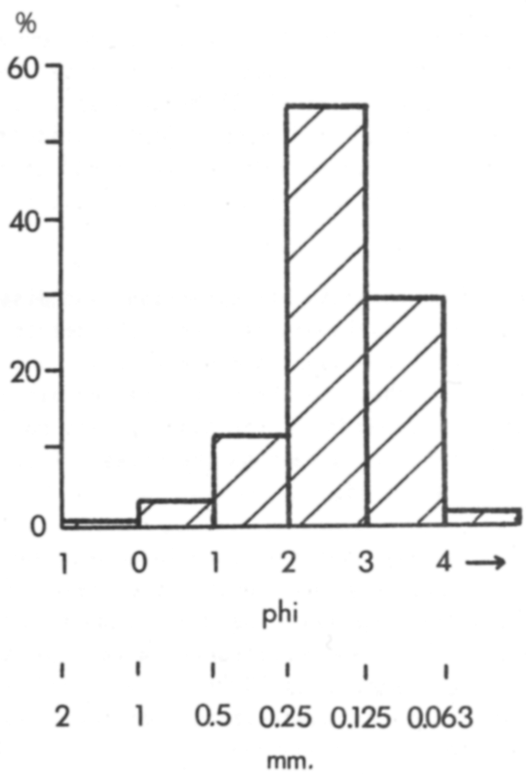
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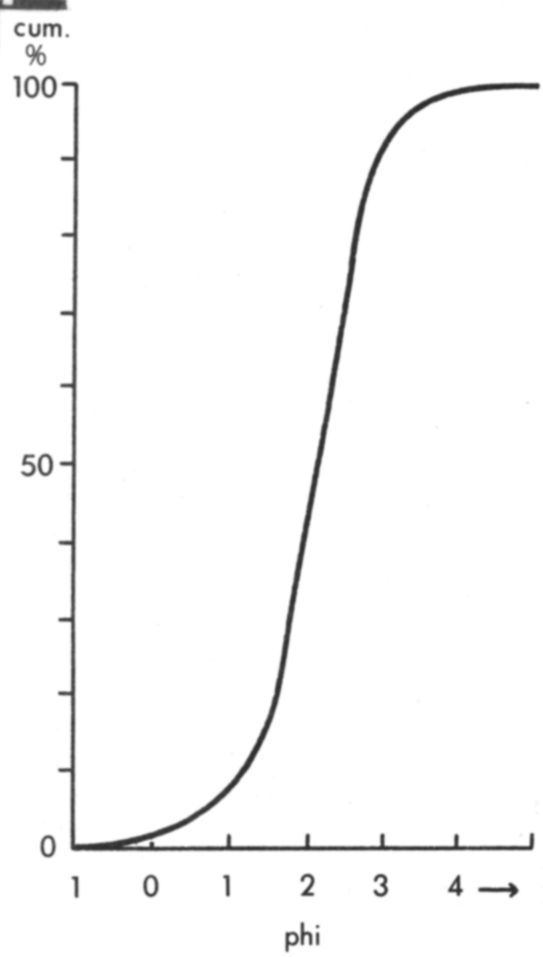
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the quartz grains; this is not the case. Thus these dunes seem an unlikely source for reasons of both lithology and wind pattern.

However, another explanation for the mineralogy of the cave sand, given a coastal origin, is possible - prolonged weathering prior to transport to the present location. Lowry (1970) describes ancient dune remnants along the top of the Hampton Range between Eucla and Madura, and also on the Roe Plains at their eastern end. The latter are certainly younger than the cliff-top occurrencees, which are insecurely proposed as Middle to Early Pleistocene age. The remnants are lithologically sandy clay and kankar (calcrete). Those near Madura are described as partly consisting of fine quartz sand. Such deposits could provide ready-made materials matching the cave deposits when the silt and clay frctions are separated by suspension as atmospheric dust.

A further possible source of sand is as a result of deflation of residual soils left after solution of considerable thicknesses of limestone. Lowry (1970) reports an acid insoluble fraction of up to 4.5% in surface limestones; this fraction is, of course, not necessarily quartz. However, two arguments against an hypothesis that the cave sand derives from the deflation of the former residual soil of the Nullarbor Plain appear to be powerful. Firstly any shallow caves which had openings to the surface at the time of deflation would likely be filled with wind transported materials. The sand deposits in question, though dissected, do not look like the remnants of complete or nearly complete chamber fills. Secondly with such a widespread source material, it is reasonable to expect many or indeed most caves near the surface would have received fills if these had in fact been the origin of the presently known occurrences.

A corollary of these arguments is that the Nullarbor caves we know must have opened to the surface subsequent to the deflation period.

CONCLUSION

None of the sources discussed is wholly satisfactory as a provider of the sands under discussion on presently available evidence, either because they are disposed laterally or downwind in relation to the present and former sand-shifting regimes as inferred from the dune patterns, or because they are too distant upwind in these terms or because transformation in mineralogical character between source and deposition is required.

Old leached dunes between the Merdayerrah Sandpatch and the head of the Bight would constitute a more likely source of origin but none are known to have been mapped as yet. One of us has seen what are possibly old dune remnants between the cliffs south of Wigunda Cave and the younger dunes emanating from the head of the Bight, but this needs verification. It must also be remembered that the Bunda Cliffs are under active erosion and significant loss of land has occurred since the formation of the degraded Pleistocene cliffline plainly visible behind the Roe Plains and buried at the Head of the Bight and behind the Merdayerrah Sandpatch. That old cliffline is pinched out by coastal erosion at the western and eastern ends of the Bunda Cliffs (Jennings, 1967). Old cliff-top dunes of a leached nature and suitably positioned upwind of the caves concerned may have been lost in this way.

More evidence is needed. In the field, caves need searching to see if there are similar cave deposits elsewhere, in particular the last, most speculative hypothesis needs testing by a search to the southwest and west-south-west of the presently known sites of cave dune sand. The known and newly found deposits need examining more closely, particularly as regards sedimentary structures, which may relate to the mode of emplacement within the cave(s). In the laboratory there is need for more thorough analysis of the cave sands and, for comparion of sands from the various possible sources discussed here.

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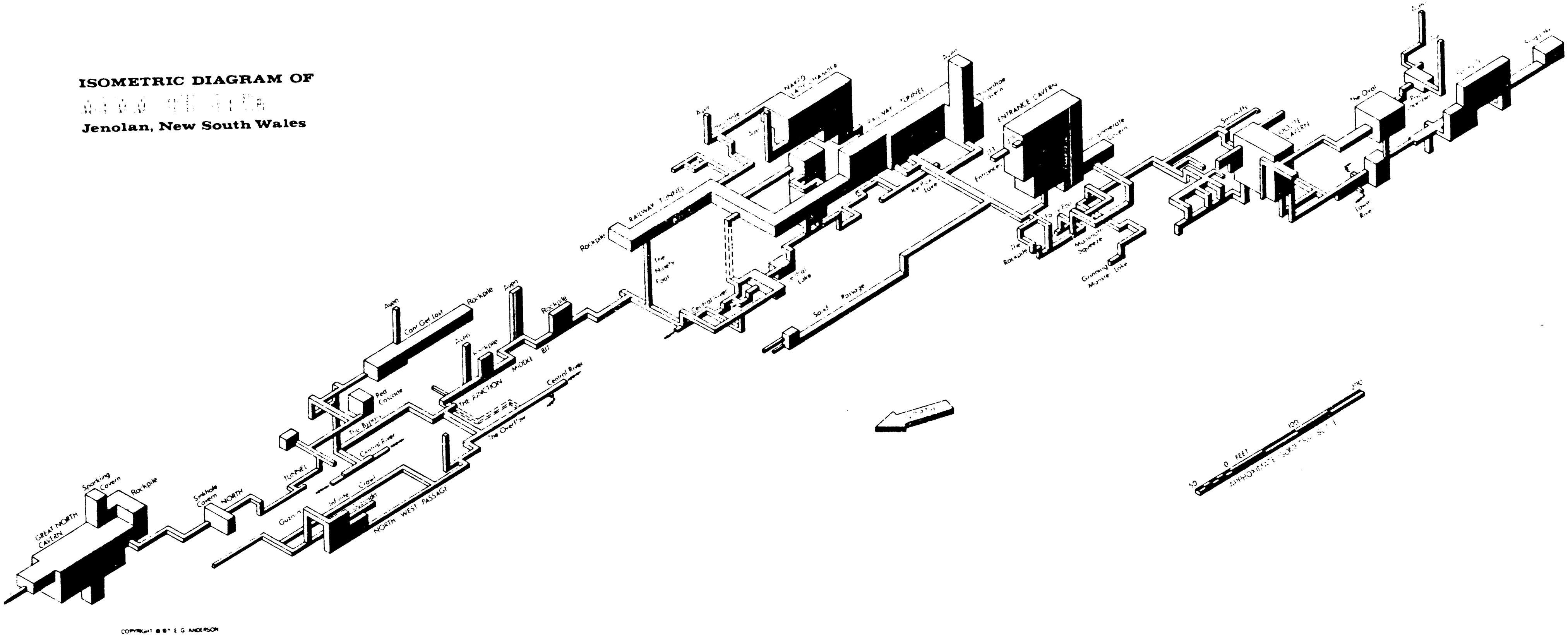

Block Diagram and Map opposite

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