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DISCUSSION - FORMATION AND AGE OF DUNES IN THE LAKE EYRE DEPOCENTRES, BY H. WOPFNER AND C.R. TWIDALE.

GEOLOGICAL SURVEY

by

R A CALLEN

and

G C NANSON

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R.A. CALLEN[1]
& G.C. NANSON[2]

DEPARTMENT OF MINES AND ENERGY
191 GREENHILL ROAD
PARKSIDE

Prior to the 1980's the central Australian dunefields lacked a chronology, and geomorphologists (Fig. 1) deduced ages based on Bowler's work on lunettes in the eastern Australian arid zone (Bowler 1976, 1978, 1982). Thereby arose the assumption in some quarters that source-bordering transverse dunes in the deserts were 15-21 000 years old and the longitudinal dunes much younger. The work of Wasson (1983, 1984 and references therein; Bowler & Wasson (1984) Gardner _et al_. (1987), Herczeg & Chapman (in press), Bowler and Magee (1988), Callen _et al_. (1983) and Nanson _et al_. (1988 and references therein) has demonstrated a much more extensive chronology for the Strzelecki Desert and western Queensland, and also that the Last Glacial phase of dune building was preceded by aeolian activity throughout the dunefield.

[1]Department of Mines and Energy, South Australia, 191 Greenhill Rd, Parkside.

[2]Geography Department, Wollongong University, New South Wales

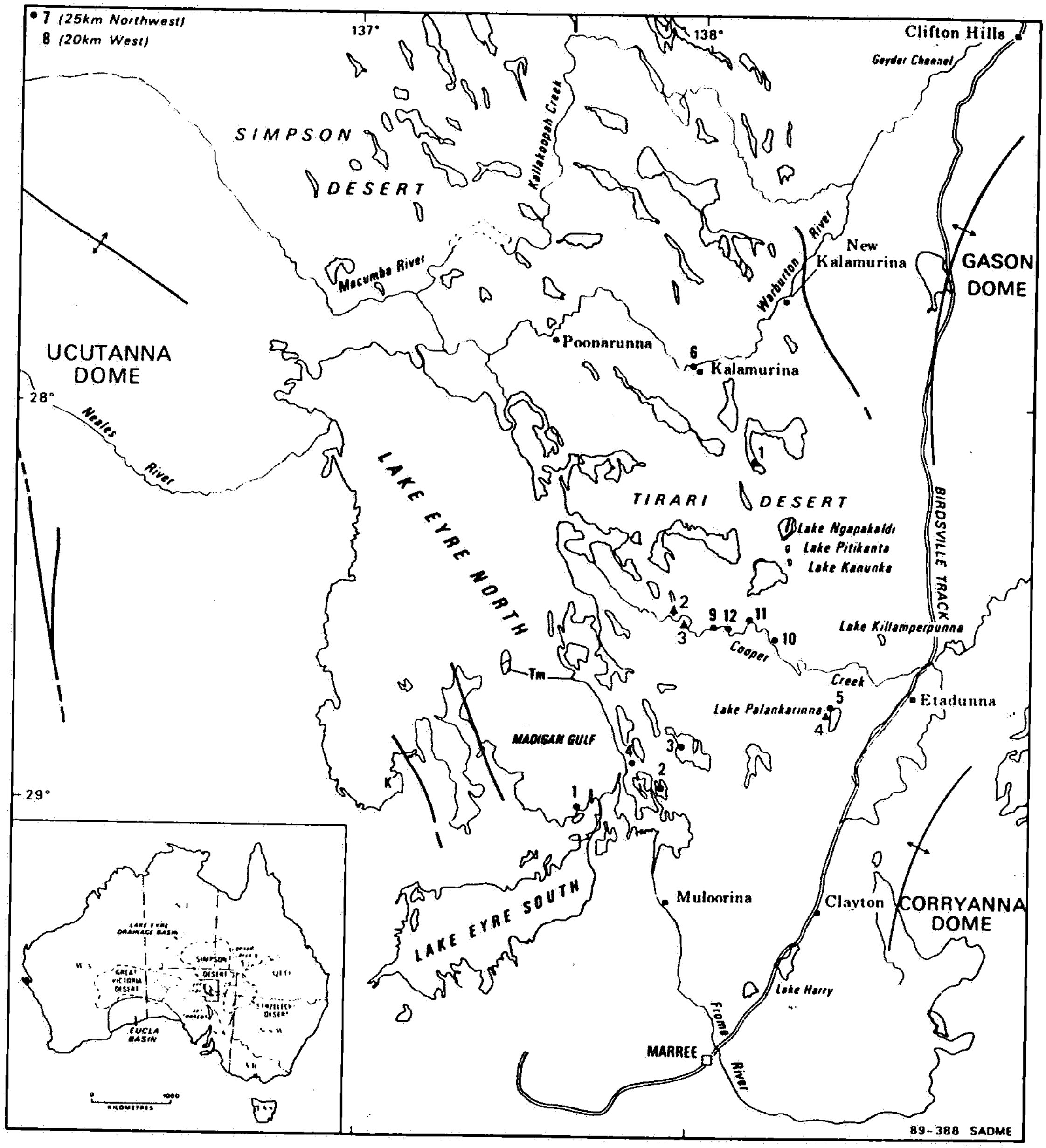

Figure 1. LOCATION MAP AND DATED SEQUENCES - LAKE EYRE BASIN

Location, shown by dots: 1 = ANU Drill site 83/6; 2 = "Fly lake"; 3 = Island in Lake "Hydra"; 4 = "East of Madigan Gulf"; 5 = Lake Palankarinna; 6 = Kalamurina Waterhole; 7 = Oolgawa Waterhole; 8 = Apalilla Waterhole; 9 = Intersection seismic line and Cooper Creek; 10 = Tilla Tilla stockyards; 11 = Pirranna Waterhole; 12 = Cuttupirra Waterhole.

Investigators: 1,2,4,5: D.L.G. Williams (ANU); 3,9: R.A. Callen (SADME), G. Nansen (Wollongong University), G.W. Krieg (SADME); 6: R. Twidale (AU); 7: G.W. Krieg and R.B. Wasson (CSIRO, Canberra); 8: R.B. Wasson; 10-12: G. Nansen.

Type Sections, shown by triangles. 1 = Wipajiri Formation; 2 = Kutjitara Formation; 3 = Katipiri Formation; 4 = Etadunna Formation, Tirari Formation and Mampuwordu Sand.

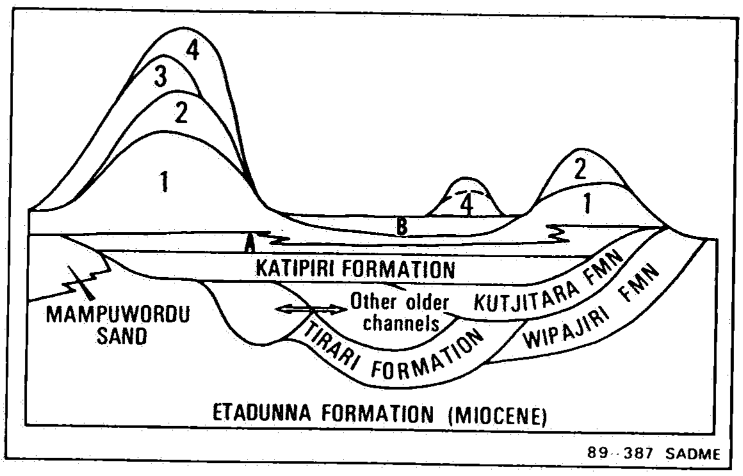

Figure 2. Rock stratigraphic units in the Tirari Desert - Schematic Sketch. A,B: younger alluvial phases. 1 to 4: dune phases (4=modern). Named units: fluvial deposits, excepting Etadunna Formation, which includes lacustrine and deltaic facies. See Fig. 1 for locations of type sections.

A geomorphic chronology for the Simpson/Tirari Desert however, is in its infancy, as hardly any dating has been done. This discussion presents some of the first dates from the Simpson and Tirari Deserts and it is in this context that it forms a reply to Wopfner and Twidale (1988).

Wopfner & Twidale (1988) are correct in drawing attention to the importance of Holocene dunes in the Simpson and Tirari Deserts of South Australia, (Fig. 1), but we believe they overstate the case in saying most of the dunes are intrinsically Holocene. Wells & Callen (1986) and Williams (1982) give evidence of earlier episodes of dune development in the Lake Eyre and Lake Torrens region respectively, supported by more recent radiocarbon and TL dating, giving ages of between 90 000 and 30 000 yrs BP. We believe these Late Pleistocene episodes are widespread, and may be at least as important as the Holocene episodes in depositing dune sediments and shaping landforms in these deserts. Thus, the dunefield pattern was probably already in place by the end of the Pleistocene.

Wopfner & Twidale (1988) regard the dune substrate as largely Late Pleistocene, marking the lower limit to Quaternary aeolian sedimentation. Although Wells *et al*. (in Wells & Callen, 1986, pp. 45-55) claim to have observed dunes equivalent to the Late Pleistocene Kutjitara and Katipiri Formations (Fig. 2), we have not observed this, and accept that possibly a large proportion are younger than the Katipiri Formation, though perhaps some are intercalated between earlier fluvial episodes. Wopfner & Twidale (1988) must assume deposition of the fluvial units continued to the end of the Pleistocene in order to use these pluvial units to define the dunes as mainly Holocene in age. They also assume no dunes were deposited between the various Pleistocene fluvial units. Wells & Callen (1986), Callen (in press) and Krieg *et* al. (in press), arguing from data obtained in the Strzelecki Desert and upper Cooper Creek (Wasson, 1984; Callen, in press; Nanson et al., 1988) suggest fluvial deposition of the Katipiri Formation ceased about 100,000 yrs BP, and this is supported by recent TL dating along the lower Cooper Creek (Table 1). These data produced consistent ages of between 130 000 and 100 000 yrs BP, in accord with data from the Channel Country of Cooper Creek in western Queensland (Nanson et al., 1988). This is supported by U/Th dates on associated gypsum carbonate rhizomorphs and gypsum deposits (LLR697, 696) corresponding with W803 and W813 respectively. It therefore appears the Katipiri Formation ceased deposition about 100 000 yrs BP, consequently the overlying dunes can date back to this period, unless one assumes a hiatus.

The data of Williams (1982) and Wells & Callen (1986, table 4) are from fossil eggshell of Genyornis and Dromaius (Williams, 1981), which produced ages beyond the lower limit of radiocarbon dating. These materials are all from the upper surfaces of dunes in the southwestern part of the Tirari Desert. We have recently obtained a similar background radiocarbon date (CS794, Table 1) on Genyornis eggshell from a dune flank at Lake "Hydra", overlying a sequence which is at least as old as 440 000 yrs BP (W809). Amino acid racemization determinations on CS794 and the sites from Wells and Callen (1986) are very similar, suggesting a similar age, which is calculated at c.45 000 yrs BP (R. Kimber personal communication 7.9.89). Observations from the Simpson Desert (Krieg & Callen, 1980; Wasson, 1983) indicate a similar stratigraphy to the Tirari Desert, hence it is likely that these dunes are neither local, as suggested by Wopfner & Twidale (1988), nor Holocene.

A probable younger episode of dune activity is suggested by a TL date of 32 500 ± 300 yrs BP from the base of a dune directly on top of the Katapiri Formation at Cuttupirra Waterhole, Cooper Creek. This represents the time at which this material was last buried - the dune could have been active for a long time and may have been reactivated from still older dune sand.

Wopfner & Twidale (1988) provide few dates to support their argument for a Holocene age - the bone date GX1872 on bone collagen is likely to be unreliable and should be taken as a minimum age only. The dates they provide from Oolgawa Waterhole are from Krieg (1985) and additional Holocene dates are provided by Wasson (1984) (ANU2836-8) which they do not mention. One other minimum date of 9,630 yrs BP (ANU2937) was obtained by Wasson from a calcareous palaeosol at Apallila Waterhole in the same area. This palaeosol is developed within the dunes, thus there were dunes prior to this. These data are all from a restricted area on the western margin of the Simpson Desert, whereas the older dates on eggshell are scattered over a wide area of the Tirari Desert. A single modern date has been obtained from root charcoal (CS 477) buried beneath 3m of dune sand overlying an inferred Holocene dune (no palaeosol development) in the southern Tirari Desert. This dune is a small longitudinal feature which has recently transgressed across a small playa. Veth & Hamm (in prep.) have obtained dates of around 11 800 yrs BP from aboriginal hearths in a dune in the lower Cooper Creek, comparable with Lampert & Hughes' (1988) TL and radiocarbon dates on dune sand and snail shell from Balcanoona Creek on the southern Strzelecki Desert margin.

Thus the Tirari Desert, and probably the Simpson Desert also, contain dunes of a variety of ages, indicating widespread Late Pleistocene episodes between 90 000 and 30 000 years BP, within the cooler part of the last interglacial epoch, and probably at least two Holocene episodes:- 10-11 000 years BP, and 3 000 years BP to modern. It is likely that the late Pleistocene episodes are at least as important as those of the Holocene in shaping the desert landforms. As yet, no dunes of Last Glacial age have been recorded, but their presence is expected. Although Wopfner & Twidale (1988) are correct in their contention that the dunes are not entirely relict features, equally these dunes cannot be regarded as essentially of Holocene age, as present data suggest a much longer and more complex history of formation probably over most of the desert. This is in keeping with quite extensive work in the Strzelecki Desert in eastern South Australia (Wasson 1983, 1984), and initial results from western Queensland (Nanson et al. 1988) and with the discovery of widespread longitudinal dunes containing massive and nodular calcrete in the margins of the Great Victoria Desert of western South Australia (M.C. Benbow, personal communication, 1989).

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R.A. CALLEN

TABLE 1

DATES FROM THE SIMPSON DESERT (see Figure 1 for locations)

DUNE SEDIMENTS

LAB. NO.	DATE	METHOD	MATERIAL	COMMENT	SOURCE	LOCATION
ANU2836	2 220 ± 100	RC	Charcoal	Holocene dune	Wasson (1983)	Oolgawa W/H
ANU2837	2 840 ± 80	RC	"	"	"	"
ANU2838	1 900 ± 200	RC	"	"	"	"
SUA1712	2 560 ± 90	RC	"	"	Krieg (1985)	"
SUA1713	2 670 ± 100	RC	"	"	"	"
SUA1714	2 720 ± 90	RC	"	"	"	"
ANU2937	9 630 ± 120	RC	Soil carbonate	Minimum	Wasson (1983)	Allapilla W/H
ANU1612	>32 000	RC	Ratite egg	on dune	Wells & Callen (1986)	E. of Madigan Gulf
ANU3540	37 700 ± 1 300	RC	*Genyornis* egg	Top of strand dune	"	S. shore, Madigan Gulf
ANU3706	34 700 ± 1 100	RC	"	Top of calcreted dune	"	Lake Palankarinna
ANU3707	40 000 + 1 800 - 1 450	RC	*Dromaius* egg	"	"	Same site as 3706
CS477	Modern	RC	Charcoal	Root now buried beneath 3 m high dune	Previously un-published	Lake "Medusa" area
CS794	Background	RC	*Genyornis* egg	Weathering from dune	"	Lake "Hydra" island
WK1509	11 830 ± 320	RC	Charcoal	Aboriginal hearth in dune	Veth & Hamm (in prep.)	Coopers Ck. between Cuttupirra W/H and the Birdsville track
WK1510	11 770 ± 180	RC	Charcoal	"	"	" "
W806	32 500 ± 3 000	TL	Quartz	Base dune rest-ing on Katipiri Fm.	"	Cuttupirra W/H, Cooper Ck.
-	c.45 000*	AAR	Emu & Genyornis eggshell	Weathering from dunes	Previously unpublished	Lake "Hydra" island.

* Estimate only: unlikely to be >80 000

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TABLE 1

DATES FROM THE SIMPSON DESERT (see Figure 1 for locations) Conventional Ages (cont)

FLUVIAL SEDIMENTS

LAB. NO.	DATE	METHOD	MATERIAL	COMMENT	SOURCE	LOCATION
W812	108 000 ± 9 900	TL	Quartz	4 m below top Katipiri Fm.	Previously unpublished	Intersection seismic line GE582RBF and Cooper Ck.
W811	>290 000 ± 4 800	TL	"	Tirari Fm.	"	"
W803	116 700 ± 13 900	TL	"	3 m below top Katipiri Fm.	"	S. of Tilla Tilla W/H Cooper Ck.
W804	220 400 ± 27 300	TL	"	4.3 m, prob. an older unit than Katipiri Fm.	"	"
W805	>400 000 ± 98 000	TL	"	Tirari Fm.	"	"
W813	132 100 ± 23 300	TL	"	2 m below top Katipiri Fm.	"	Pirranna W/H, Cooper Ck.
W814	101 300 ± 12 900	TL	"	"	"	"
W807	115 300 ± 18 500	TL	"	Point bar in Katipiri Fm.	"	Cuttupirra W/H
W808	114 700 ± 15 000	TL	"	"	"	"
W809	>440 000 ± 90 000	TL	"	Channel in Tirari Formation	"	L. "Hydra"
W810	>320 000 ± 71 000	TL	"	Tirari Formation	"	"
LLR696	112 000 ± 8 000	U/Th	Gypsum	Top of Katapiri F.	"	Pirranna W/H
LLR697	87 000 ± 7 000 6 000	U/Th	Calcite rhizhomporph	" " "	"	Tilla Tilla W/H

RC = radiocarbon, using conventional ages

TL = thermoluminescence

U/Th = uranium/thorium

AAr = Amino acid racemization

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