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Evidence of EARLIEST CRETACEOUS (NEOCOMIAN) MARINE INFLUENCE, northern Flinders Ranges.

*N.F. Alley and N.M. Lemon**

Mesozoic sediments onlap the Precambrian rocks of the northern Flinders and Willouran Ranges. Extensive erosion has formed numerous outliers of the sediments, which now lie within or cap the highest parts of the northern ranges. One such outlier forms a hill on the west bank of MacDonnell Creek, 4 km south-southwest of Trinity Well (Fig. 1). The hill is composed of approximately 23 m of Mesozoic sediments resting on an irregular palaeosurface eroded across steeply dipping Precambrian rocks.

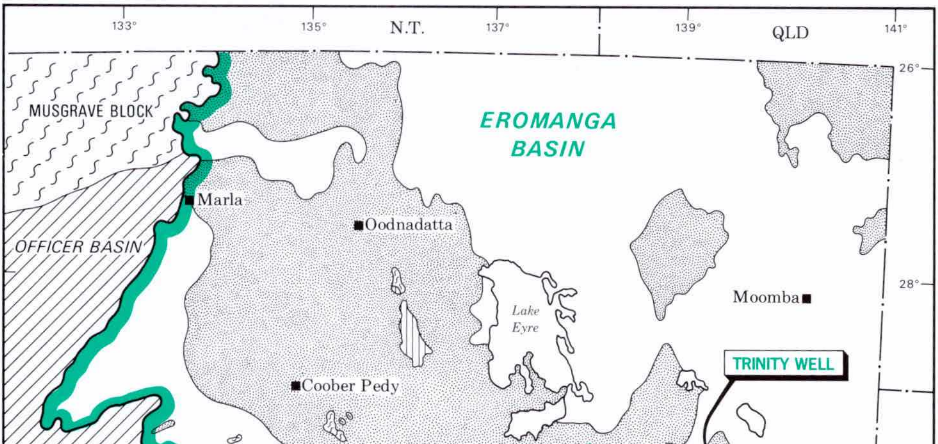

Figure 1 Map of the southern Eromanga Basin showing basin limits and location of the site.

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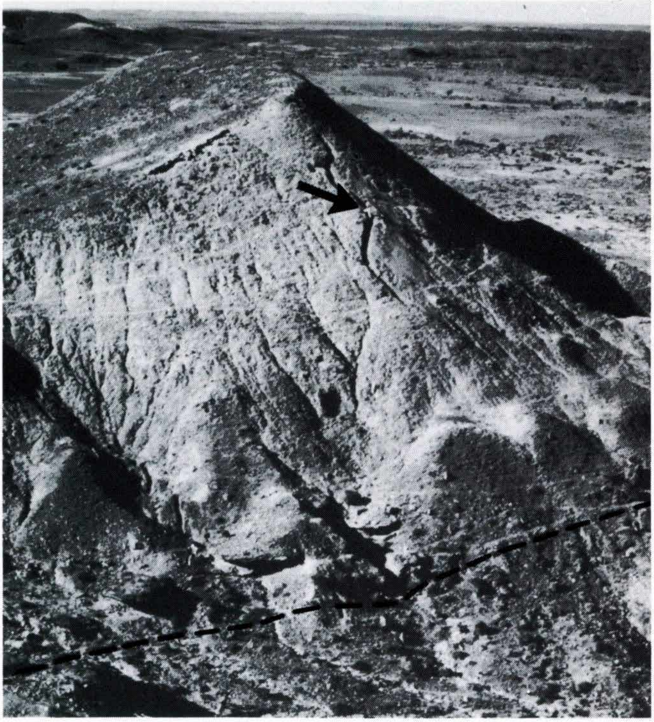
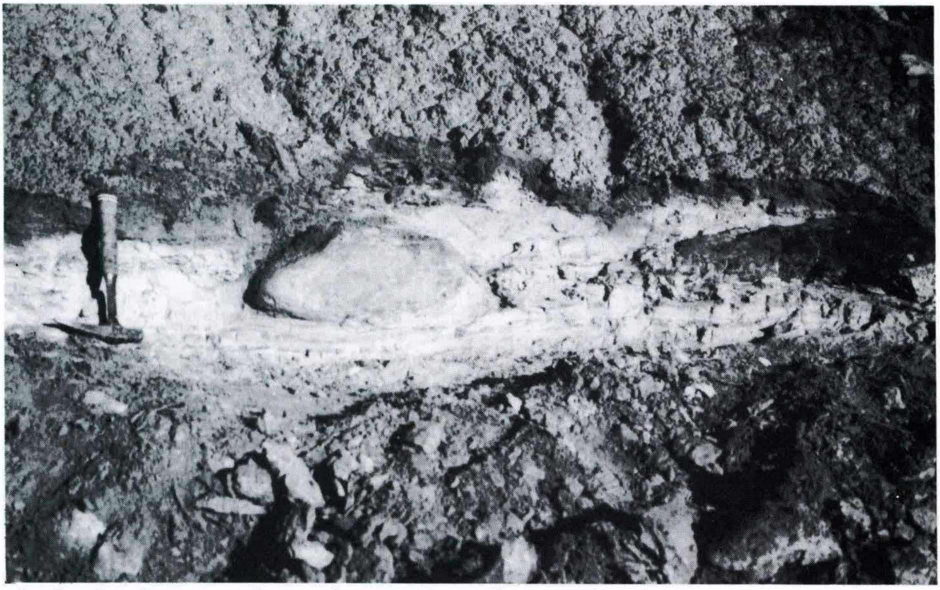
* National Centre for Petroleum Geology and Geophysics, University of Adelaide, P.O. Box 498, Adelaide S.A. 5001.



A general view of 'Recorder Hill'. Approximate position of the unconformity between Precambrian and Mesozoic rocks marked with a broken line. Channel cut down hillslope to expose fresh sediment for sampling. Figure (arrowed) for scale. (Neg. 36496)



Diamictite lens near base of Mesozoic sediments. (Neg. 36497)

From the base, the sediments comprise a few metres of pebbly, calcareous sandstone, overlain by 10 m of bioturbated, silty claystone containing fine to medium grained sandstone pods. The claystone is rich in particulate plant matter and occasional poorly preserved plants. Thin lenses of diamictite, pebbles and boulders, some as dropstones, occur sporadically throughout the claystone. Although the unit is strongly bioturbated, occasional layers of sand show small scale trough and hummocky cross-stratification (HCS). The claystone is succeeded by 12 m of weathered, finely bedded sandy siltstone containing isolated large boulders. This unit is capped by a few metres of gypseous gravels of probable late Cainozoic age.

The sand layers occurring at 9 m, 12 m, 17 m and 19.5 m (Fig.2) are quite continuous and are correlative with sands in other measured sections in an area of over 100 km^2. The layers consist of the coarser fraction (fine sand in this case) of the surrounding sediment. A pebble lag commonly marks the base of these layers and the scale of the HCS diminishes up section. Each layer, or tempestite, formed as storm generated waves reworked the bottom sediments. The finer fractions were lifted into suspension (layer to be deposited) and the coarser clasts left as a lag. Finer sand was deposited as the storm abated. Mud was winnowed from the sediment to be deposited elsewhere. Event stratigraphy generated by such storms allows very close correlation within and between areas and also strongly suggests that deposition occurred in a large body of water.

Although the age of the Mesozoic sequence until now was not clearly known, it was regarded as Pelican Well Formation, or Cadna-owie Formation equivalent (Forbes, 1986; Fig. 3). Samples were taken throughout the sequence but only samples from the basal claystone unit at 4 m and 8 m above the unconformity with the Precambrian bedrock proved useful for palynological dating.

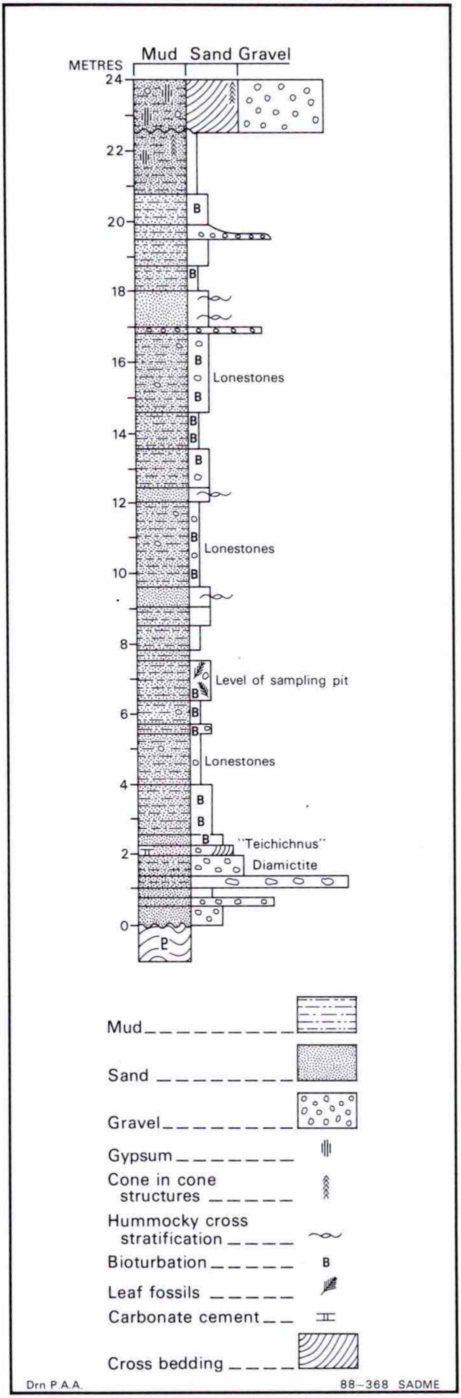


Figure 2 Lithological column for the Mesozoic sediments comprising 'Recorder Hill'.

These two samples produced diverse palynofloras of fair preservation, containing rare acritarchs and dinoflagellates (Alley, 1987).

By the presence of *Crybelosporites stylosus* Dettmann 1963 and *Cicatricosisporites australiensis* (Cookson) Potonie 1956 in the absence of *Foraminsporis wonthaggiensis* (Cookson & Dettmann) Dettmann 1963 the palynofloras are assigned to the *C. australiensis* Zone of Late Jurassic to Early Neocomian age (Fig. 3).

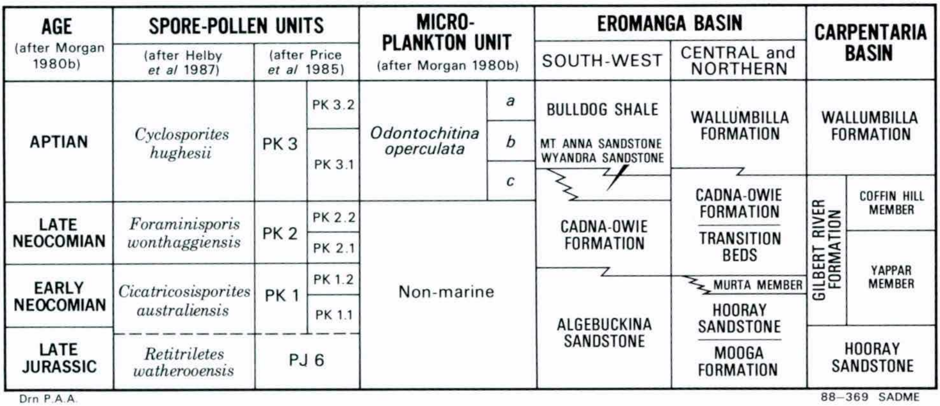


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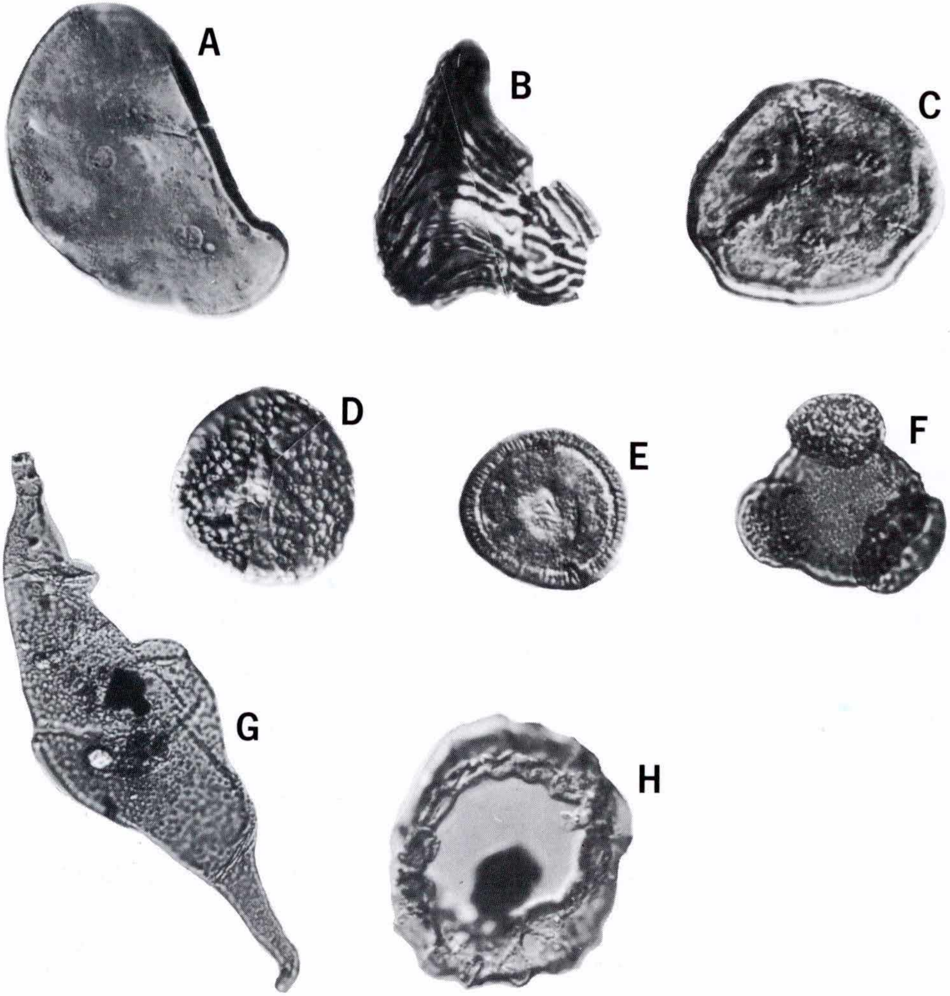
Figure 3 Late Jurassic and Early Cretaceous palynostratigraphic and lithostratigraphic units in the Eromanga Basin.

The very low frequency of microplankton in the assemblages implies that the sediments are likely to be equivalent to the basal marginal marine Cadna-owie Formation. Although evidence of a marine facies of the Algebuckina Sandstone is lacking around the southwestern margin of the Eromanga Basin, restricted microplankton assemblages have been reported from the Hooray Sandstone (upper Algebuckina Sandstone equivalent) from a few wells in deeper parts of the basin (Morgan, 1980a). This marine influence is now regarded as being far more widespread during the Neocomian, and restricted microplankton assemblages from the Mooga and Hooray sandstones are common along the eastern part of the Eromanga Basin (R. Morgan, personal communication). Thus the sediments near Trinity Well may also be a paralic facies of the upper Algebuckina Sandstone. This is the first evidence for marine influence in the southern part of the Eromanga Basin during the Neocomian and greatly extends the position of the shoreline at this time.

Neocomian microplankton assemblages have been reported from the Carpentaria Basin of northern Queensland (Burger, 1980, 1982). Three informal zones are recognised here including DK 1 (latest Jurassic-Berriasian), DK 2 (Valanginian) and DK 3 (Hauterivian). The *Cicatricosisporites australiensis* Zone thus encompasses DK 1 and the lower portion of DK 2 (Burger, 1982), although only one species of dinoflagellate (*Spiniferites ramosus ramosus* (Ehrenburg) Loeblich and Loeblich 1966, occurring in those zones is present in the palynofloral assemblages near Trinity Well.

Burger (1982) suggests that during the Valanginian the southward penetration of the sea was blocked by a basement high across the northeastern part of the Carpentaria Basin. However, the presence of restricted Neocomian microplankton assemblages as far south as the northern Flinders Ranges means that some form of marine influence had already penetrated the Eromanga Basin by the Valanginian or earlier. The presence of the tempestites, which are likely to have formed in a large body of water, supports the suggestion of marine influence. This conclusion agrees with a proposal that during the Early Neocomian a narrow arm of the sea had penetrated southwards through central Queensland into northeastern South Australia and northwestern N.S.W. (Frakes *et al.*, 1987).



Selected palynomorphs:

- A. *Laevigatosporites belfordii* Burger 1976.
- B. *Cicatricosisporites australiensis* (Cookson) Potonie 1956.
- C. *Foraminisporis dailyi* (Cookson & Dettmann) Dettmann 1963.
- D. *Retitriletes watherooensis* Backhouse 1978.
- E. *Classopollis chateaunovii* Reyre 1970.
- F. *Microcachryidites antarcticus* Cookson 1947.
- G. *Fusiformacysta salasii* Morgan 1975.
- H. *Microfasta evansii* Morgan 1977.

KEYWORDS: BIOSTRATIGRAPHY/Palynology/Microplankton/Marine environment/ Sedimentary geology/Early Cretaceous/Eromanga Basin/Flinders Ranges/MacDonnell Creek;/SH5405;6738II.

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REDEFINITION of the FULHAM SAND, Adelaide Plains Sub-Basin, South Australia.

G.M. Bowman and M.J. Sheard*

Firman (1966) assigned the name 'Fulham Sand' to the reddish dune sands that are scattered through the western suburbs of Adelaide, between Somerton Park and Port Adelaide. However, several workers had previously mapped and described these subcoastal sand deposits, refering to them as the 'Older Sand Dunes' (Fenner, 1927; Miles, 1952) or the 'Osborne Association' (Aitchison *et al.*, 1954). These writers assumed the dunes were associated with a Recent higher sea level, but Firman (1966, 1967) attributed them to aeolian reworking of the terrestrial Pooraka Formation during the Holocene and he extrapolated the unit to include the longitudinal dunes of the Northern Adelaide Plains (Firman, 1986; Belperio and Bateman, 1986).

Redefinition of the Fulham Sand has now become necessary for several reasons: new stratigraphic information has resulted from drilling by CSIRO and the Department of Mines and Energy during the Metropolitan Adelaide soils investigation; Belperio *et al.* (1983) have precluded sea level being higher than present in Gulf St Vincent during the Holocene; and a simplified redefinition of the marine St Kilda Formation by Cann and Gostin (1985) and extensive radiocarbon dating by Bowman and Harvey (1986) have effectively excluded Fulham Sand from this Holocene unit.

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* CSIRO Division of Soils, P.O. Box 639, Canberra City, A.C.T. 2601.

FULHAM SAND

Derivation of name: Following Firman (1966) the unit is named after the Adelaide suburb of Fulham, where yellowish red aeolian sands form low, irregular dunes (Cornelius and Stevens, 1945, plate 4, fig. 2). Grid reference 727317, Adelaide 6628-III, 1:50 000 sheet.

Distribution: The distribution of Fulham Sand on the Southern Adelaide Plains shown in Figure 1 was compiled from previously published maps and descriptions, recent field investigations and drilling by CSIRO and the Department of Mines and Energy.

Fulham Sand occurs in the western suburbs of Adelaide, between Somerton Park in the south and Port Adelaide in the north. It is associated with low, irregular dune topography and is considered to be of aeolian origin. Remnant dunes are found within a broad zone up to 3 km wide, which roughly parallels the present coastline. The dunes extend inland less than 2 km near Port Adelaide in the north and Somerton Park in the south, but over 4 km near Seaton, Lockleys and Plympton (Fig. 1).

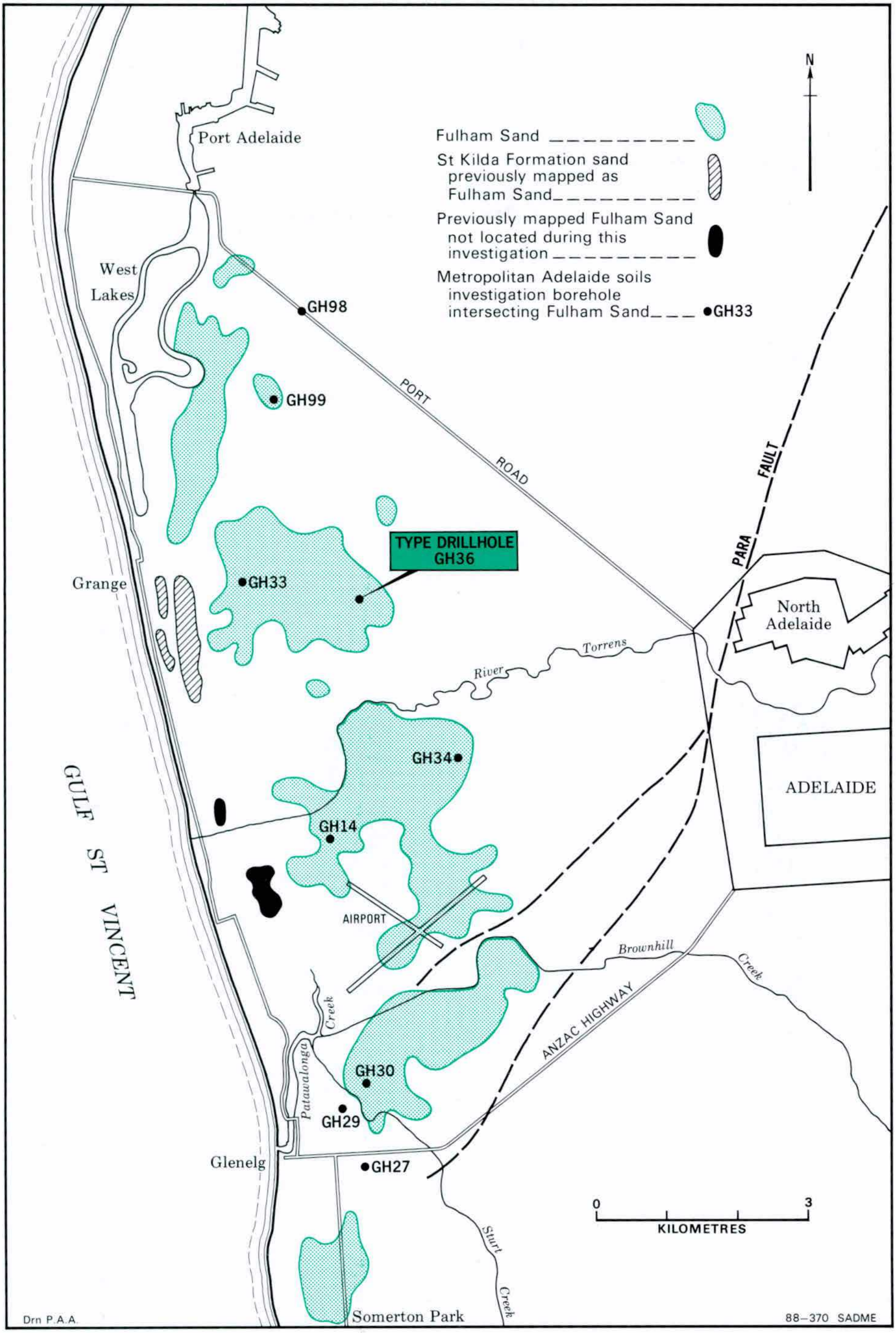
Although the 'Old (Red) Sand Dunes' have been shown on many maps (dating from as early as 1882 - see Taylor *et al.*, 1974), most portray only the larger dunes and ignore the extensive areas of thin drift sand. However, the deposit has been significantly modified during this century by market gardening, sand mining operations, residential expansion and industrial development. Although originally up to 15 m in height (Fenner, 1927), extensive areas of Fulham Sand dunes have been flattened and low lying swampy areas have been filled with this material (e.g. Adelaide Airport: Miles, 1952, plate XVII), so that the extent of the unit is now not readily discernible (Taylor *et al.*, 1974). However, field investigations indicate that some areas previously mapped as Fulham Sand by Forbes (1980) in fact consist of 7000-year-old St Kilda Formation barrier sands which have been intensively podzolized and hence bear a superficial resemblance to Fulham Sand. Some other small mapped occurrences of Fulham Sand that could not be located in the field are considered of doubtful validity (Fig. 1).

It should be noted that this redefinition of Fulham Sand excludes the longitudinal dunes of the Northern Adelaide Plains, for although the latter are similar in colour to Fulham Sand they differ in being very regular in plan (evenly spaced, linear and consistently oriented northwest-southeast) and contain calcareous soil profiles, including calcrete.

Type section: No readily accessible type section is currently available and none was described by Firman (1966).

Reference section: The proposed reference section is from a drillhole (GH36, Fig. 2) located in a small reserve off Telford Ave, Findon (section 428, hundred of Yatala. Grid Ref 73883460, Sheet 6628-41, 1:10 000 Series, S.A. Lands Dept). The drill site is situated on the crest of a prominent north-south trending dune ridge, previously mapped as 'Older Sand Dunes', 'Osborne Association' or 'Fulham Sand' by Miles (1952), Aitchison *et al.* (1954), Taylor *et al.* (1974) and Forbes (1980).

Figure 1 Distribution of Fulham Sand in the southern Adelaide Plains Sub-Basin, from the present investigation and after Cornelius and Stevens (1945), Cotton (1949), Miles (1952), Taylor et al. *(1974) and Forbes (1980). St Kilda Formation sands erroneously mapped as Fulham Sand by Forbes (1980) are also indicated. Locations also shown of those drillholes from the Metropolitan Adelaide Soils Investigation that intersected Fulham Sand, indicating that the unit is probably more extensive than previously mapped.*


N
Fulham Sand
St Kilda Formation sand previously mapped as Fulham Sand
Previously mapped Fulham Sand not located during this investigation
Metropolitan Adelaide soils investigation borehole intersecting Fulham Sand
●GH33
Port Adelaide
West Lakes
GH98
GH99
PORT ROAD
PARA FAULT
TYPE DRILLHOLE GH36
Grange
GH33
North Adelaide
Torrens River
GH34
ADELAIDE
GULF ST VINCENT
GH14
AIRPORT
Brownhill Creek
ANZAC HIGHWAY
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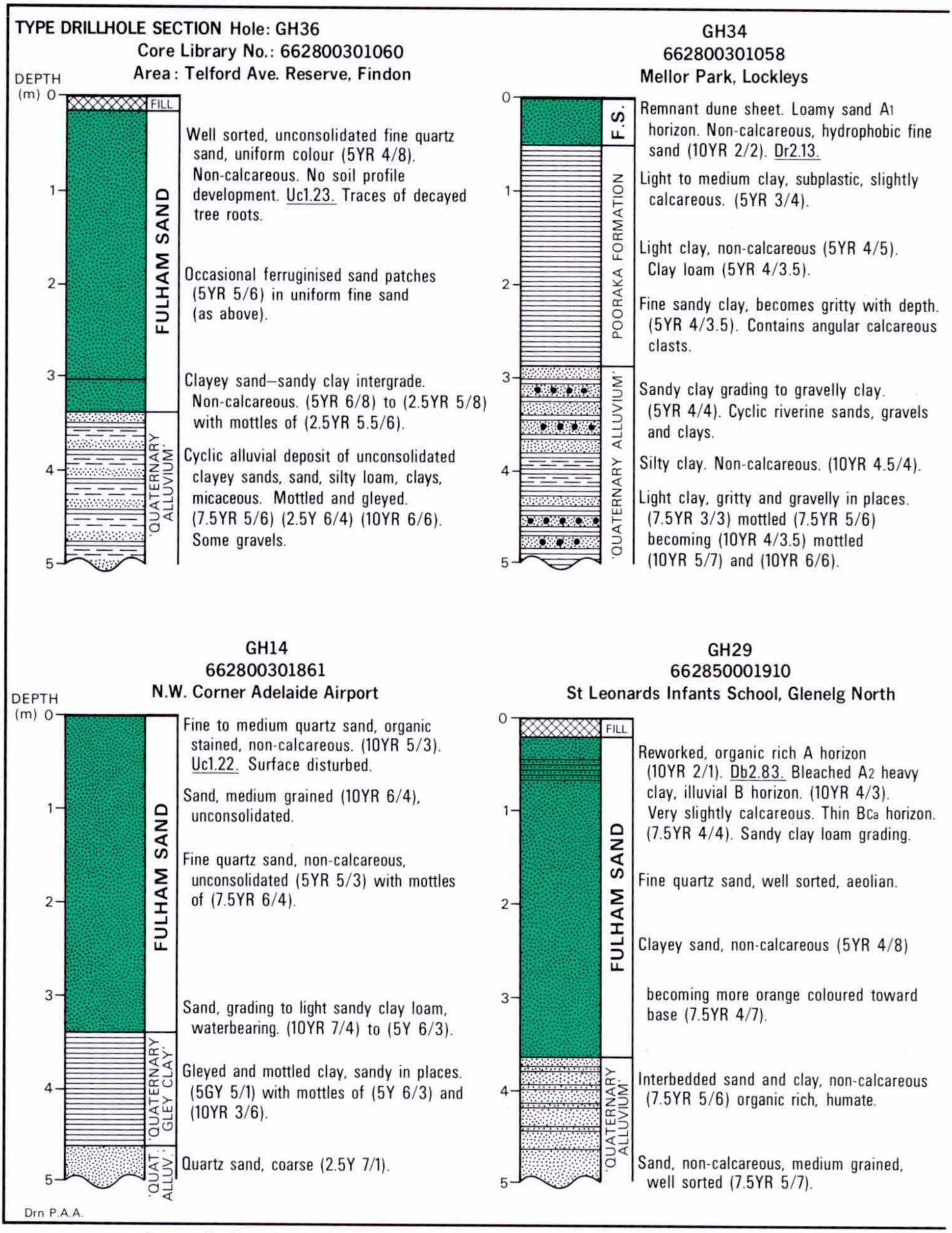
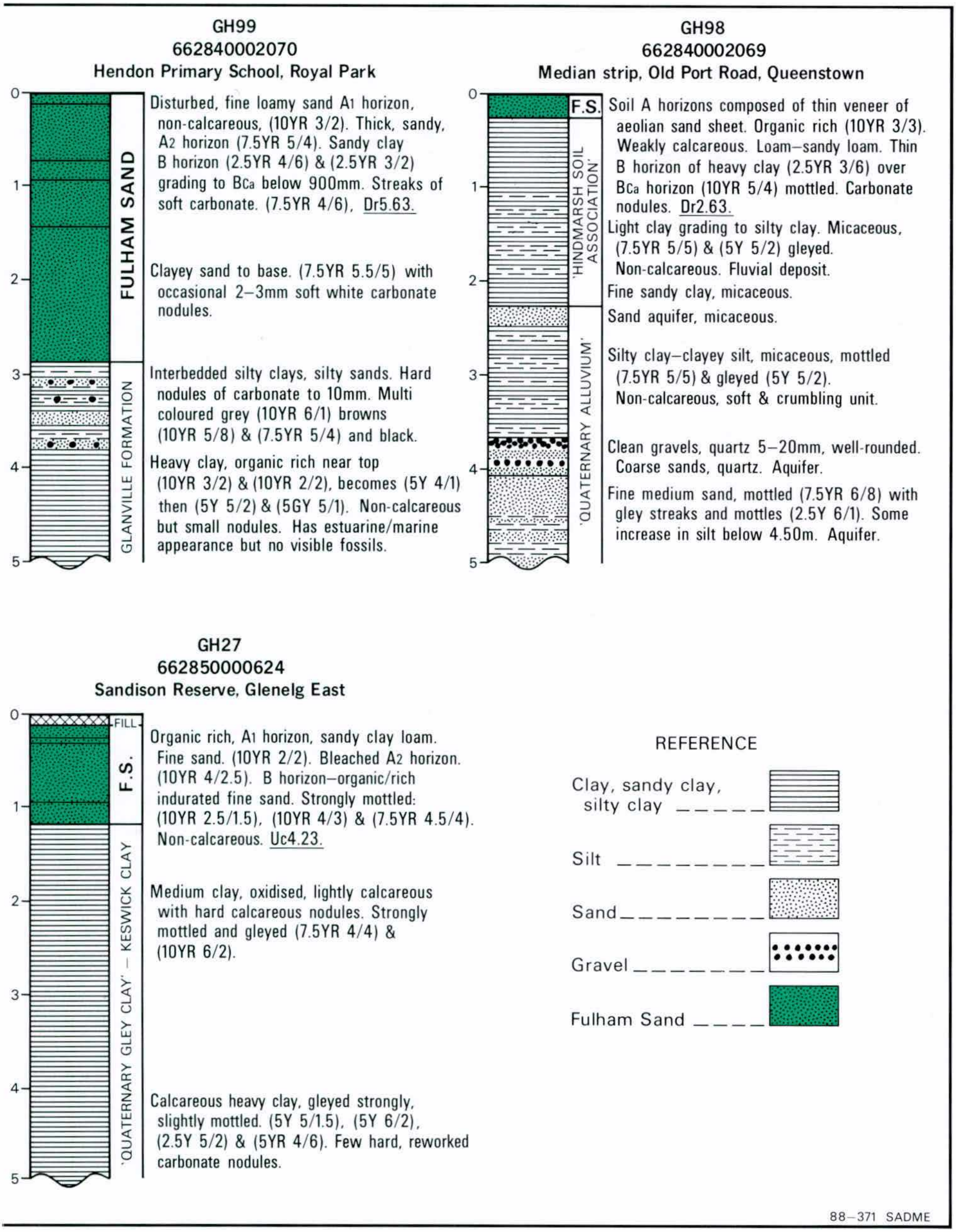


Figure 2 Selected drillhole sections displaying Fulham Sand and underlying units, southern Adelaide Plains Sub-Basin.

As indicated in Figure 2, drillhole GH36 penetrated 2.95 m of fine, very well sorted, quartz sand of consistent yellowish red (5YR 4/8) colour (Munsell Soil Color Charts, 1975). The sand is non-calcareous and unfossiliferous, with occasional ferruginous patches and a few traces of decayed root material, but otherwise the core shows no evidence of soil



GH99
662840002070
Hendon Primary School, Royal Park

Disturbed, fine loamy sand A1 horizon, non-calcareous, (10YR 3/2). Thick, sandy, A2 horizon (7.5YR 5/4). Sandy clay B horizon (2.5YR 4/6) & (2.5YR 3/2) grading to BCa below 900mm. Streaks of soft carbonate. (7.5YR 4/6), Dr5.63.

Clayey sand to base. (7.5YR 5.5/5) with occasional 2–3mm soft white carbonate nodules.

Interbedded silty clays, silty sands. Hard nodules of carbonate to 10mm. Multi coloured grey (10YR 6/1) browns (10YR 5/8) & (7.5YR 5/4) and black.

Heavy clay, organic rich near top (10YR 3/2) & (10YR 2/2), becomes (5Y 4/1) then (5Y 5/2) & (5GY 5/1). Non-calcareous but small nodules. Has estuarine/marine appearance but no visible fossils.

GH98
662840002069
Median strip, Old Port Road, Queenstown

Soil A horizons composed of thin veneer of aeolian sand sheet. Organic rich (10YR 3/3). Weakly calcareous. Loam–sandy loam. Thin B horizon of heavy clay (2.5YR 3/6) over BCa horizon (10YR 5/4) mottled. Carbonate nodules. Dr2.63.

Light clay grading to silty clay. Micaceous, (7.5YR 5/5) & (5Y 5/2) gleyed. Non-calcareous. Fluvial deposit.

Fine sandy clay, micaceous.

Sand aquifer, micaceous.

Silty clay–clayey silt, micaceous, mottled (7.5YR 5/5) & gleyed (5Y 5/2). Non-calcareous, soft & crumbling unit.

Clean gravels, quartz 5–20mm, well-rounded. Coarse sands, quartz. Aquifer.

Fine medium sand, mottled (7.5YR 6/8) with gley streaks and mottles (2.5Y 6/1). Some increase in silt below 4.50m. Aquifer.

GH27
662850000624
Sandison Reserve, Glenelg East

Organic rich, A1 horizon, sandy clay loam. Fine sand. (10YR 2/2). Bleached A2 horizon. (10YR 4/2.5). B horizon–organic/rich indurated fine sand. Strongly mottled: (10YR 2.5/1.5), (10YR 4/3) & (7.5YR 4.5/4). Non-calcareous. Uc4.23.

Medium clay, oxidised, lightly calcareous with hard calcareous nodules. Strongly mottled and gleyed (7.5YR 4/4) & (10YR 6/2).

Calcareous heavy clay, gleyed strongly, slightly mottled. (5Y 5/1.5), (5Y 6/2), (2.5Y 5/2) & (5YR 4/6). Few hard, reworked carbonate nodules.

horizonation. Structural features were not observed. The upper surface of Fulham Sand is confined in the reference section by 130 mm of recent anthropogenic and artificial fill. The lower boundary is sharp and the unit is underlain by a cyclic alluvial deposit of mottled and laminated sandy clays, clayey sands, micaceous sands and light clays ('Quaternary alluvium' of Fig. 2). Core from drillhole GH36 is stored in the Department of Mines and Energy Core Library, Glenside (reference number 662800301060).

Additional drillholes: Core from drillholes GH14, 27, 29, 34, 98 and 99 from the Metropolitan Adelaide soils investigation also contain Fulham Sand and indicate the homogeneity of the unit and the nature of the underlying strata (Fig. 2).

Pedology, lithology and granulometric characteristics: Soil profile development is of restricted occurrence in Fulham Sand deposits (Aitchison *et al.*, 1954; Taylor *et al.*, 1974): most remnant dunes were active until recently and earthwork activity has removed soil profiles from other areas. However, a zone of illuviated clay is usually present in the sand, often located towards the base of the deposit (e.g. GH14, Fig. 2). An undisturbed Fulham Sand soil profile is typically an incipient red-brown earth that consists of a sandy, organic-stained A horizon over a sandy clay to heavy clay (illuvial B horizon). The latter usually incorporates a thin Bca horizon (e.g., GH29, Fig. 2). This is underlain by a transitional B/C horizon and a C horizon of reddish brown sand (e.g., 5YR 5/3), the thickness of which depends on the thickness of the Fulham Sand deposit.

Several chemical analyses of Fulham Sand were presented in Cornelius and Stevens (1945, table 5): sample No. 12 was obtained from a sand pit close to the reference section described herein and consisted of 94.74% SiO_2, 1.81% Al_2O_3, 1.06% Fe_2O_3, 0.22% MgO, 0.80% CaO, 0.14% Na_2O, 0.62% K_2O, 0.19% TiO_2, 0.44% H_2O and 0.0% CO_2.

Binocular microscope observations indicate that Fulham Sand is composed of about 98% quartz, with minor amounts of lithics, feldspars and heavy minerals (metamorphics, ferromagnesians and garnet (Aitchison *et al.*, 1954, p.126)). In contrast to the St Kilda Formation dune sands (Bowman and Harvey, 1986), comminuted marine shell carbonate was not observed in any sample of Fulham Sand. Sand grains were moderately to well rounded, with the surface of many quartz grains being frosted. An irregular coating of iron oxide and clay is concentrated in surface depressions and colours most Fulham Sand grains yellowish red. In contrast, the St Kilda Formation dune sands are typically light grey to very pale brown (10YR 7/2 - 10YR 7/3: Munsell Soil Color Charts, 1975), except where the oldest 7000-year dunes (Bowman and Harvey, 1986) have been affected by pedogenesis.

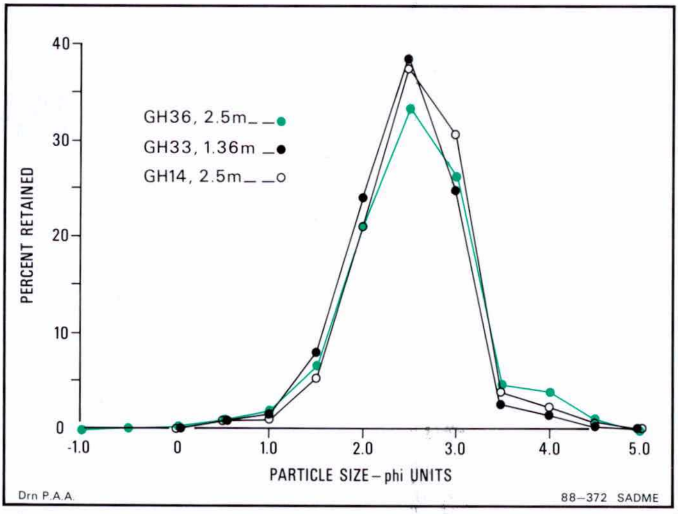


Figure 3 Grain size distribution for selected samples of Fulham Sand. Phi scale after Griffiths (1967).

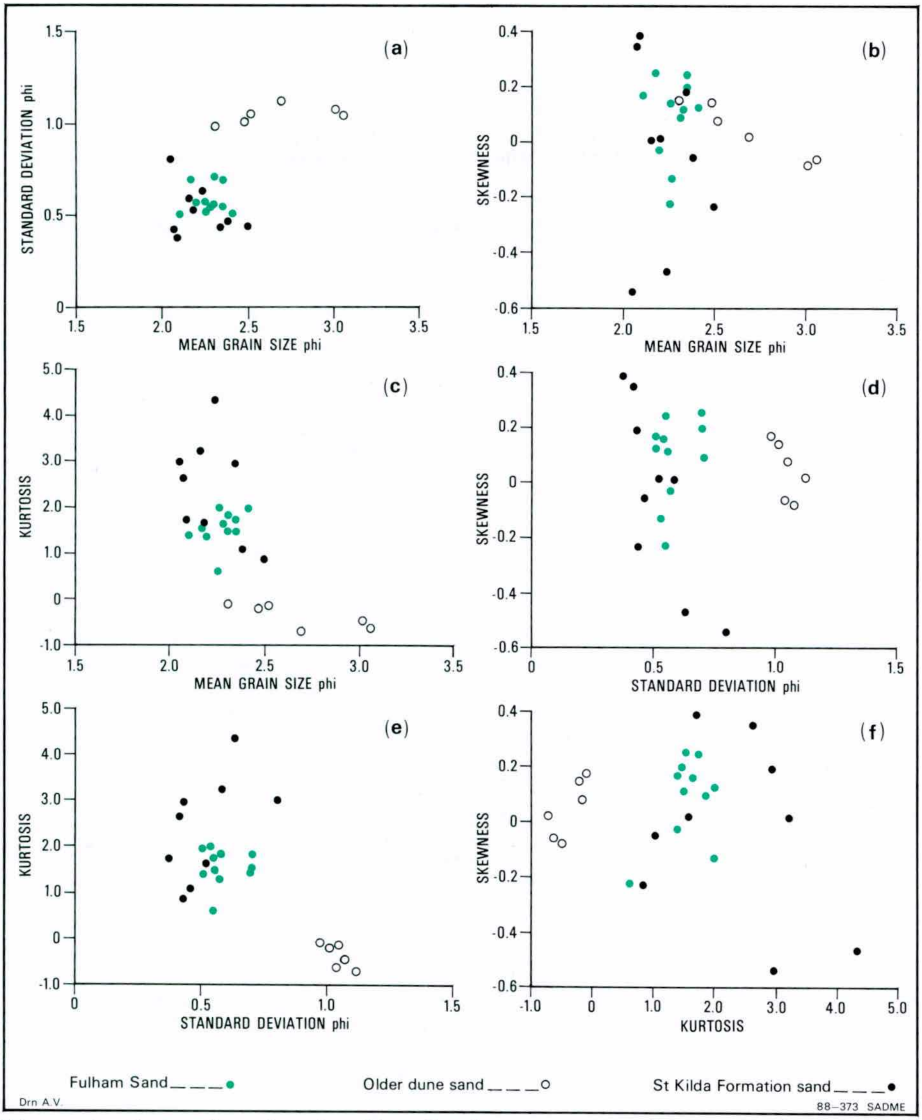


Figure 4 Plots of grain size distribution parameters for 11 samples of Fulham Sand (from drillholes GH14, 33 and 36), nine samples of St Kilda Formation dune sand from drillholes at Henley Beach, and six samples of an older dune sand from the Gepps Cross area.

Fulham Sand consists of fine, well-sorted sand (Fig. 3), with a mean grain size, except where affected by pedogenesis, in the range 2.00 to 2.50 phi units (250-177 microns) (Griffiths, 1967) and a standard deviation of between 0.50 and 0.70 phi (Fig. 4a). In comparison, dune sands of the (Holocene) marine St Kilda Formation display a similar range in mean grain size but a slightly greater range in standard deviation (0.37 to 0.80 phi: Fig. 4a). However, older aeolian sands from further inland on the Adelaide Plains (near Gepps Cross: Sheard and Bowman, in prep.) are generally finer than Fulham Sand (mean = 2.30 to 3.00 phi) with poorer, but very consistent, sorting (st.d. ~ 1.00 phi).

Skewness of the Fulham Sand grain size distribution ranges from slightly positively to slightly negatively skewed (Fig. 4b). This is similar to the skewness of the older dune sands, but the St Kilda Formation dune sands show a wider range in skewness, possibly reflecting more diverse depositional processes and environments (Fig. 4b).

Kurtosis (peakedness) of the Fulham Sand grain size distribution ranges from mesokurtic to leptokurtic (K = 0.60 to 2.00), whereas the older sands are all platykurtic (K = -0.10 to -0.70) (Fig. 4c). In contrast, the St Kilda Formation dune sands range from mesokurtic to markedly leptokurtic (K = 0.85 to 4.32).

Relationships and boundary criteria: Firman (1966, 1967, 1986), Daily *et al.* (1976) and Forbes (1980) claimed that Fulham Sand overlies the marine Holocene St Kilda Formation. The present investigation does not support this assertion. Fulham Sand was found to overlie a variety of units but, with the exception of the marine Glanville Formation (Firman, 1966; Cann, 1978), all other substrates were alluvial or fluvial in origin, the most common being undifferentiated 'Quaternary alluvium' and Pooraka Formation (Fig. 2). The upper boundary of Fulham Sand was unconfined, except where overlain by anthropogenic deposits and artificial fill.

Although St Kilda Formation sediments were not encountered overlying Fulham Sand during the current investigation, this is not surprising as the Fulham Sand dunes are mostly located landward of the early Holocene shoreline. Those located to the west of this shoreline would have been severely eroded during the postglacial marine transgression. However, reports of an excavation in the Reedbeds at Fulham indicate that the marine and estuarine lithofacies of the St Kilda Formation overlie a wind-blown sand sheet that extends below present sea level (White, 1919; Howchin, 1919). Although this sand differs from the Fulham Sand in its white colour and lack of clay content, these differences probably reflect the inundation of Fulham Sand and the subsequent reducing environment.

The longitudinal dunes of the Northern Adelaide Plains may also consist of Fulham Sand, but there is no evidence that they are stratigraphic equivalents of those of Metropolitan Adelaide, and their distribution, orientation and morphology would seem to indicate otherwise.

Depositional environment: The granulometric characteristics of Fulham Sand, as well as the distribution, morphology, and topographic and stratigraphic position of the dunes, indicate that it was aeolian in origin. The subcoastal location and the orientation of the remnant dunes suggest that they were reworked from a pre-Holocene coastal sand barrier, rather than directly from the Pooraka Formation during the Holocene as suggested by Firman (1966) and Daily *et al.* (1976). The original source of the sediment was probably from streams debouching onto the Adelaide Plains.

Age and evidence: Fulham Sand is not fossiliferous. It stratigraphically overlies the marine Glanville Formation, which is last interglacial in age (110 kA, Belperio *et al.*, 1984), and it also overlies the Pooraka Formation, which has been dated as Late Pleistocene (e.g. 35 kA, Williams, 1969; 20-30 kA, Belperio and Bateman, 1986). It probably underlies Holocene St Kilda Formation sediments (White, 1919; Howchin, 1919), which date to at least 7kA years BP (Bowman and Harvey, 1986).

Although some deposits of Fulham Sand have remained active up to the present time, its stratigraphic context, the lack of organic or carbonate detrital material in the sand compared with the dune sand of the St Kilda Formation, and the degree of soil profile development in the undisturbed

Fulham Sand, all indicate that it is pre-Holocene in age. It seems probable that the Fulham Sand dunes were initiated during a period of aeolian landscape instability during the last glacial (about 16-20 kA) recognised from Northern Spencer Gulf by Belperio *et al.* (1984), from the Flinders Ranges piedmont plain by Williams (1973), and generally across semi-arid southern Australia by Bowler *et al.* (1976).

Synonmy: Fulham Sand has been informally referred to as the 'Older Sand Dunes' by Fenner (1927) and Miles (1952), and the 'Osborne Association' by Aitchison *et al.* (1954).

KEYWORDS: STRATIGRAPHY/Stratigraphic definition/Fulham Sand/Aeolian sands/Dunes/Lithology/Grain size analysis/Holocene/Adelaide Plains Sub-Basin/'Old sand dunes'/'Osborne association'/SES409; 6628.

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The LATE PROTEROZOIC KILROO FORMATION of the POLDA BASIN.

R.B. Flint, C.M. Fanning and L.R. Rankin*

A narrow intracratonic graben on the southern Gawler Craton extends for more than 350 km from near Cleve in the east, past Elliston westwards to the continental margin in the Great Australian Bight (Fig. 1). The graben is fault-bounded, contains up to 5000 m of sediments and is totally covered by Cainozoic sediments. Sediments associated with the graben include the possible Middle Proterozoic Blue Range beds (Flint and Parker, 1981), volcanics, halite and evaporite-bearing clastics of previously assumed early Palaeozoic age (McClure, 1982a and 1982b; CRA Exploration Pty Ltd, 1984), Carboniferous-Permian Coolardie Formation (Cooper *et al.*, 1982), Jurassic Polda Formation (Gatehouse and Cooper, 1982), Eocene Poelpena Formation (Harris, 1964) and unnamed Pliocene and Pleistocene sediments. Of these, only the volcanic-evaporite sequence, and Palaeozoic and Mesozoic sediments are totally restricted to the graben. Sediment thicknesses of the Blue Range beds and Tertiary sequences are much greater within the graben, but the units also laterally extend onto Archaean-Early Proterozoic granitoids and metamorphics of the neighbouring craton.

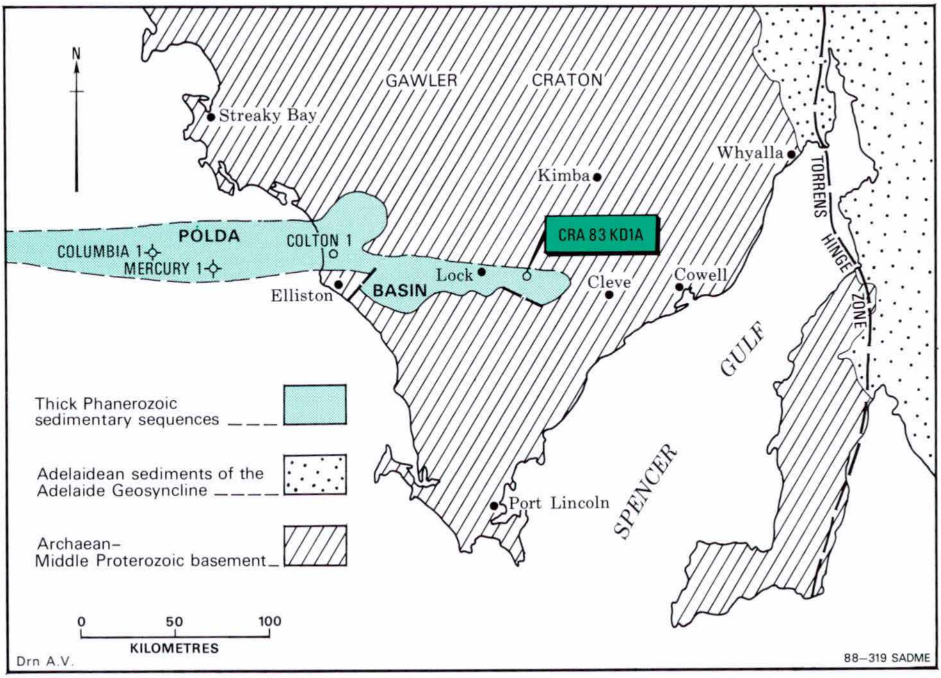

Figure 1 Locality plan and regional geology

Basin terminology has varied considerably. The term 'Polda Basin' (Jack, 1914) initially applied to a groundwater basin in Quaternary sediments, but subsequent discovery of Tertiary and Mesozoic sediments led Wopfner (1970) to include all Mesozoic-Recent sediments. A graben offshore was named

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* Amdel Ltd, 31 Flemington Street, Frewville, S.A. 5063

'Elliston Trough' (Hammons, 1966; Smith and Kammerling, 1969) while 'Polda Trough' was used for both offshore and onshore grabens (Parkin, 1969). Both 'Polda Basin' and 'Polda Trough' were used by Nelson *et al.* (1986). In this paper, Itiledoo Basin (new name) is used for the areally more extensive Middle Proterozoic Blue Range Beds and Polda Basin for all younger sediments deposited within the fault-bordered graben. Sedimentation from the possible Middle Proterozoic to Tertiary was episodic and controlled by rejuvenation of tectonism along the same fundamental fault planes.

Reviews of general stratigraphy for the Polda Basin are presented in Cooper and Gatehouse (1983) and Parker *et al.* (1986), whereas a summary of geophysical exploration and interpretation is documented by Nelson *et al.* (1986). Drilling throughout the basin is extensive but shallow (<200 m) and has been targeted on groundwater, coal and uranium in Cainozoic and Mesozoic sediments. Stratigraphic information is poorly known for older sequences, especially prior to the late Palaeozoic Coolardie Formation, despite the fact that gravity and aeromagnetic data suggest a total basin thickness approaching 5000 m. For the entire Polda Basin only four drillholes have intersected pre-Carboniferous-Permian sediments. They are: Australian Occidental Pty Ltd Columbia 1 and Mercury 1, Department of Mines and Energy Colton 1, and CRA Exploration Pty Ltd 83KD1A. The sequence in the latter drillhole was fully cored and, based on petrological, geochemical and geochronological investigations, is here defined as the Kilroo Formation (new name).

KILROO FORMATION

Derivation: Adapted from Kilroo Corner, a prominent road junction 14 km southwest of Darke Peak township on the KIMBA 1:250 000 topographic map.

Type section: Interval 605.3-1398.2 m in drillhole CRA 83KD1A (Fig. 2) which is stored in the Department of Mines and Energy Core Library at Glenside.

Distribution: Probable correlatives of the formation occur to the west in Colton 1 (110.0-124.65 m), and further west (offshore) in Mercury 1 (886-3100 m) and Columbia 1 (771-1701 m) (Flint, in press). The unit is probably widespread throughout deeper portions of the Polda Basin.

Thickness: Ranges from at least 793 m in CRA 83KD1A to possibly 2214 m in Mercury 1.

Lithologies: The formation has not been subdivided into members and thus contains a variety of rock types including both volcanics and sediments.

In CRA 83KD1A, basalts are medium to coarse grained and consist of subophitic albitic plagioclase laths, clinopyroxene, pseudomorphed olivine, and opaques. Interstitial material is either chlorite or intensely altered, very fine grained basalt comprising skeletal plagioclase laths, chloritised pyroxene, opaques and epidote. Amygdales up to 10 mm in diameter are abundant, consisting of either chlorite or chlorite rims with centres of calcite and/or large clusters of radiating prehnite. A possible andesite crystal tuff contains probable pumice and glass shards, and very angular fragments of quartz and feldspar in a chlorite + calcite + opaque matrix. Within the tuff, ellipsoidal (amygdales) are common; constituent minerals are chlorite, calcite and anhydrite. Associated sediments are dominantly reddish-brown, laminated siltstones and mudstones. Characteristics include thin bedding, graded bedding, detrital quartz, feldspar and mica, and anhydrite aggregates, layers and veins.

In Columbia 1 and Mercury 1, volcanics are absent but similar laminated reddish brown mudstones are associated with medium grained sandstones, carbonate-cemented sandstones and siliceous siltstones. Evaporites are also present, particularly in Mercury 1 which contains a 1707 m thick interval of predominantly massive rock salt.

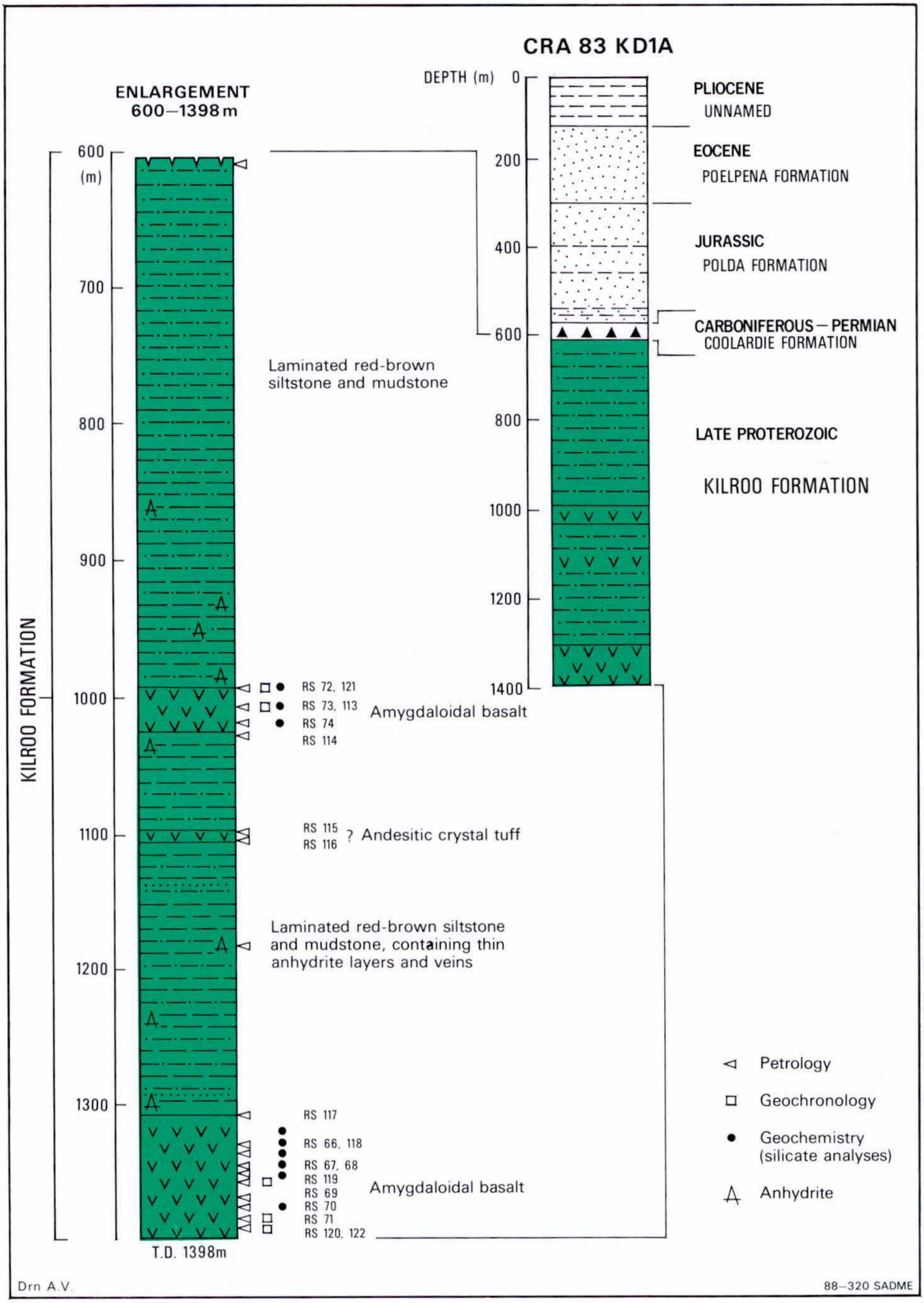

Figure 2 Log of drillhole 83KD1A

Environment of deposition: The abundance of reddish-brown clastics and evaporite minerals infer deposition in an arid, terrestrial, fluvial system. Massive rock salt suggests a continental, playa lake environment. Multiple basaltic lava flows and a possible andesitic crystal tuff indicate active tectonism and volcanism synchronous with sedimentation. Collectively, the environmental setting was probably an intracratonic graben or rift valley with predominantly basic volcanism associated with sedimentation in arid, terrestrial fluvial systems and playa lakes.

Boundary relationship: The Kilroo Formation is unconformably overlain by diamictites of the late Palaeozoic Coolardie Formation. Basalt clasts occur within the diamictites. The lower contact is ambiguous, and absent in CRA 83KD1A and Colton 1. Within Mercury 1 and Columbia 1, brecciation, secondary silicification and discontinuity in bedding orientation suggest a stratigraphic break. Importance of the break is unknown; lower white quartzose sandstones may represent either a continuation of the succession or an older clastic sequence like the possible Middle Proterozoic Blue Range beds (Flint, in prep.).

GEOCHRONOLOGY

K-Ar geochronology was attempted on five basalt samples from CRA 83KD1A, two from the upper volcanic unit and three from the lowermost basalts. All the specimens are amygdaloidal, thus isotopic analyses were performed on plagioclase and clinopyroxene mineral separates. Procedural methods are outlined in Webb *et al.* (1986). Plagioclase concentrates contained significant quantities of carbonate in addition to iron stained feldspar, and were acid leached in dilute HCl and very dilute HF to obtain carbonate-free, clouded plagioclase concentrates. The K-Ar data are presented in Table 1.

Plagioclase analyses yield ages of 768 ± 9 and 764 ± 42 Ma which are within analytical uncertainty of each other. A higher uncertainty (±5.5%) for sample 6130 RS 122 results from imprecision in the duplicate K determinations, whereas the age for 6130 RS 121 is artificially more precise since there was only sufficient feldspar for a single K determination. Both plagioclase concentrates have significant radiogenic Ar (87.6 and 70.3%) and K contents are within the normal range for feldspar.

K contents in clinopyroxene concentrates are abnormally low, especially 6130 RS 122 for which no age is calculated. The pyroxene ages range from 235 ± 15 to 884 ± 97 Ma. Although the precision of the duplicate K analyses appears good, internal replication of each analysis is poor and overall precision is >10% (standard deviation). The older ages of 884 ± 97 and 817 ± 12 Ma suggest a Late Proterozoic age for extrusion of the basalts. Younger clinopyroxene ages may result from clinopyroxene crystals not remaining as closed systems with respect to K and Ar since crystallisation.

The plagioclase K-Ar ages of 768 ± 9 and 764 ± 42 Ma provide a better estimate than the pyroxene ages for the minimum time elapsed since crystallisation of these amygdaloidal basalts. Both the plagioclase and older pyroxene ages are similar to the age of the Rook Tuff in the Willouran Ranges of the northern Adelaide Geosyncline. The Rook Tuff formed contemporaneously with early Adelaidean sedimentation and has a U-Pb zircon age of 802 ± 10 Ma (Fanning *et al.*, 1986). Collectively, K-Ar mineral ages from drillhole 83KD1A imply that evaporitic red beds and interlayered amygdaloidal basalts in the eastern Polda Basin are also Late Proterozoic (Adelaidean).

GEOCHEMISTRY

Silicate and trace element analyses of nine basalts from CRA 83KD1A (Table 2) were compared with assumed Cambrian amygdaloidal basalts of the Kulyong Volcanics from the northern Officer Basin (4742 RS 1-5), altered basalt of unknown age from drillhole Mallabie 1 on the eastern Nullarbor Plain (5034 RS 1), amygdaloidal basalts from the Stuart Shelf and basal successions in the Adelaide Geosyncline (6333 RS 45, 6334 RS 94-99, 6434 RS 1-10, 6041 RS 161-164, 6737 RS 1167-1169) and altered basalts of the Middle Proterozoic Roopena Volcanics (6332 RS 476-487).

On the Pearce and Cann (1973) Ti/100-Zr-3Y triangular diagram often used to determine the tectonic setting of basalts, analyses of basalts from both the Polda Basin and Adelaide Geosyncline plot within the field for 'within-plate basalts'. Analyses for the Kulyong Volcanics from the Officer Basin plot within the 'volcanic-arc basalt' field.

On the chondrite-normalised diagram (Fig. 3), basalts from the Polda Basin and Adelaide Geosyncline show a similar pattern but with the former having consistently lower chondrite-normalised values. Sr, a relatively mobile element, is the only exception. The Kulyong Volcanics and Roopena Volcanics exhibit very different patterns which are also illustrated in the Ti-Zr discrimination diagram (Fig. 4). Geochemical similarities between basalts from the Polda Basin and Adelaide Geosyncline are further supported. A comparison of basalt from Mallabie 1 with the other volcanics is inconclusive, probably due to the high degree of alteration in the only sample, which may also not be representative.

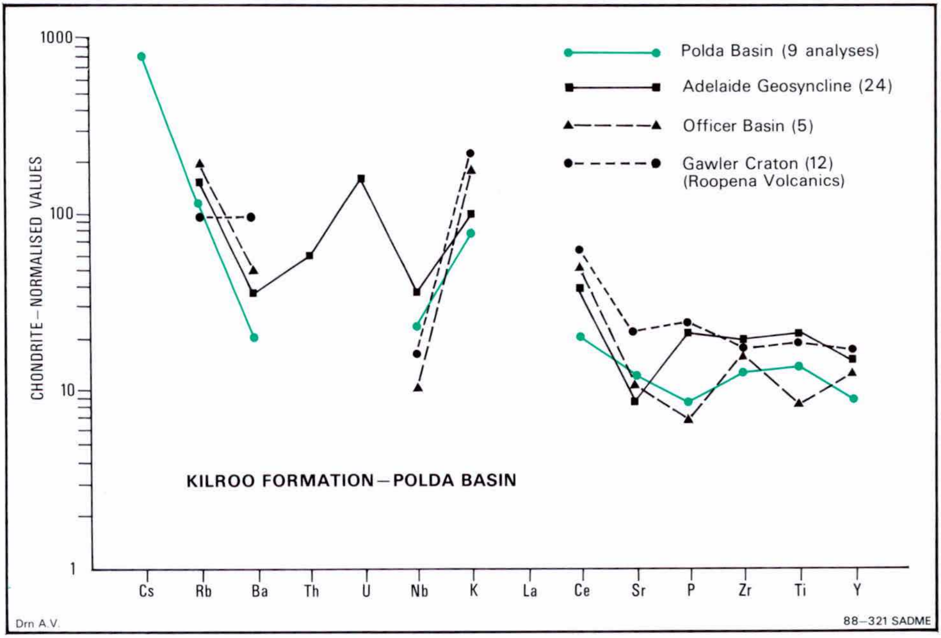

Figure 3 Mean basaltic analyses

DISCUSSION

The possible presence of Adelaidean sediments within the Polda Basin has not been previously suspected. The K-Ar isotopic and geochemical data for basalts from CRA 83KD1A in the eastern Polda Basin imply that some (possibly a majority) of the sediments in deeper portions of the basin are of Adelaidean age, rather than the previously assumed early Palaeozoic age which was based on regional lithological correlations with the Officer Basin.

Some, but not all, features of the Polda Basin are consistent with it being an aulacogen of the Adelaide Geosyncline. Aulacogens are 'elongated basins (of the order of ten times as long as wide) closely associated with geosynclines, from which they branch and penetrate far into the craton' and 'are bounded by deep-seated faults' (Preiss, 1987). Typically the mouths of aulacogens merge with the geosyncline; however the Polda Basin and Adelaide Geosyncline are disjoint and the corresponding portion of the geosyncline lacks any early Adelaidean, rift-related sediments. Tectonic activity, aulacogen width and thickness, and diversity of sediments typically increase towards the geosyncline (Preiss, 1987). Insufficient data are known about the Polda Basin to make definitive statements on easterly or westerly trends, however volcanics are only known from the eastern end of the basin.

Hydrocarbon and mineral potential of the Polda Basin require re-assessment because of the revised stratigraphic interpretation. During exploration for hydrocarbons in the western Officer Basin, a thick Late Proterozoic, evaporite-bearing sequence (Browne Beds) was discovered below both Cambrian sediments and basalts and Late Proterozoic glacial sediments (Townson, 1985). It is possible that early Adelaidean sediments, evaporites and volcanics exist, not only in deeper portions of the Polda Basin, but also within the western and eastern Officer Basins.

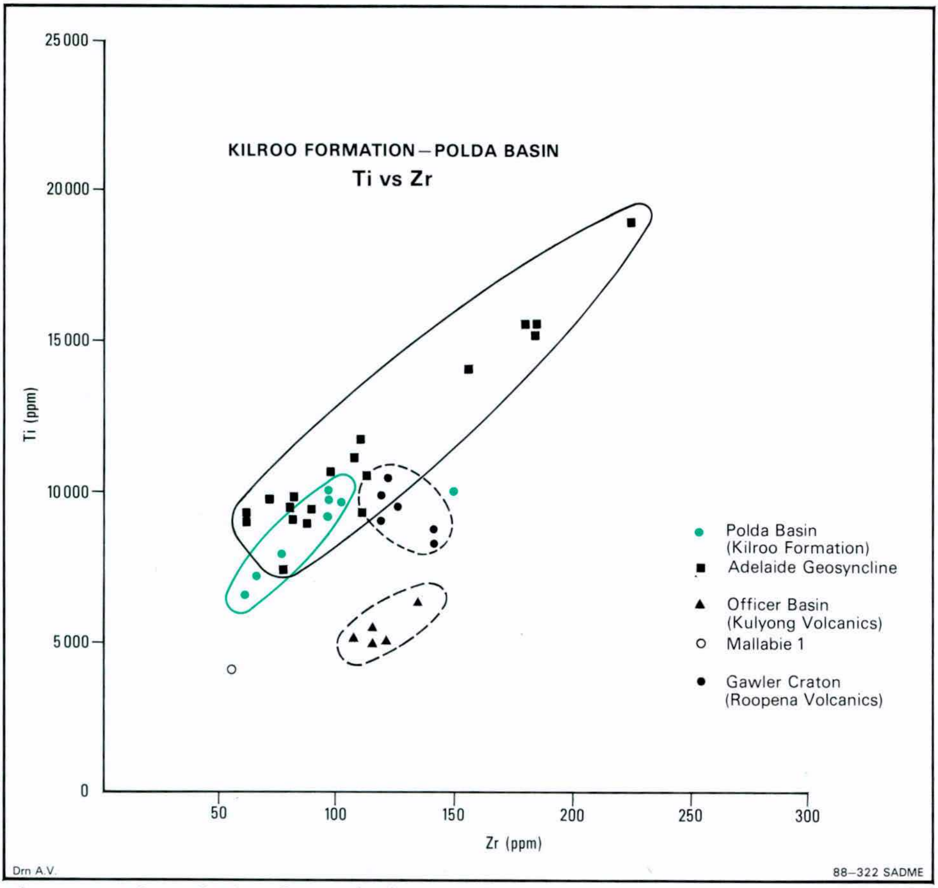

Figure 4 Plot of Titanium and Zircon values

Table 1 K-Ar data for basalts within drillhole CRA 83KD1A

DEPTH (m)	SAMPLE	MINERAL	%K	^{40}Ar* (X10^{-10} moles/g)	^{40}Ar*/ ^{40}Ar total	AGE#
Upper volcanic unit:						
991.85-993.80	6130 RS 121	Plagioclase	0.448	7.4508	0.876	768±9
"	"	Clinopyroxene	0.016 0.015	0.0678	0.157	235±15
1007.6	6130 RS 73	Clinopyroxene	0.004 0.004	0.03342 0.03322	0.235 0.196	427±51 425±60
Lower volcanic unit:						
1354.9	6130 RS 69	Clinopyroxene	0.007 0.007	0.1385	0.374	884±97
1379.6	6130 RS 71	Clinopyroxene	0.044 0.043	0.7793	0.761	817±12
1385.9-1387.0	6130 RS 122	Plagioclase	0.105 0.112	1.7828	0.703	764±42
"	"	Clinopyroxene	0.001 0.001	0.0501	0.239	-

*Radiogenic ^{40}Ar

Error limits for analytical uncertainty at one standard deviation

Constants: ^{40}K = 0.01167 atom %
= 4.962 x 10^{-10} y^{-1}
= 0.581 x 10^{-10} y^{-1}

Table 2 Silicate and trace element geochemistry for basalts within CRA 83KD1A

SAMPLE	6130 RS 71	6130 RS 75	6130 RS 76	6130 RS 77	6130 RS 78	6130 RS 79	6130 RS 80	6130 RS 81	6130 RS 82
DEPTH (m)	1379.6	997-998	1007-1008	1017-1018	1324-1325	1329-1330	1334-1335	1339-1340	1344-1345
SiO_2	49.10	49.20	48.30	48.20	47.10	49.30	49.20	49.40	49.00
TiO_2	1.67	1.31	1.08	1.19	1.52	1.61	1.64	1.61	1.60
Al_2O_3	13.30	13.90	13.90	13.50	13.80	13.40	13.70	13.60	13.50
FeO*	13.00	12.00	11.10	11.50	11.90	12.70	12.70	12.60	12.60
MnO	0.23	0.20	0.16	0.17	0.18	0.17	0.16	0.16	0.16
MgO	6.75	7.20	8.45	10.40	7.55	7.20	7.00	7.05	7.00
CaO	8.80	8.80	9.65	6.10	7.95	7.45	8.75	9.05	9.05
Na_2O	3.12	4.54	3.94	3.58	4.92	4.88	3.18	3.20	3.12
K_2O	1.90	0.18	0.14	1.53	0.24	0.74	2.06	1.87	1.78
P_2O_5	0.13	0.07	0.06	0.08	0.10	0.12	0.10	0.08	0.11
LOI	1.95	3.26	3.60	4.48	4.56	2.84	2.12	2.14	2.02
TOTAL	99.95	100.66	100.38	100.73	99.82	100.41	100.61	100.76	99.94
Ba	270	<10	<10	230	60	95	300	170	140
Ce	25	20	20	<20	20	<20	30	<20	20
Co	80	26	32	30	38	28	22	22	20
Cr	180	6	6	6	14	8	6	6	6
Cu	<10	20	18	20	26	42	16	12	12
Nb	8	7	5	6	10	10	10	9	8
Ni	110	38	60	50	60	48	36	36	34
Pb	<50	8	8	6	4	4	6	6	4
Rb	52	6	8	55	9	32	85	75	60
Sr	170	44	38	150	90	120	230	220	220
V	410	220	160	180	230	210	200	220	230
Y	40	14	8	12	20	18	20	16	18
Zn	150	80	65	36	90	95	32	48	65
Zr	150	75	60	65	95	95	95	95	100

*Total Fe as FeO

KEYWORDS: STRATIGRAPHY/Stratigraphic definition/Type section/ Geochronology/Potassium-argon dating/Rock geochemistry/Silicate analysis/Multi-element analysis/Late Proterozoic/Polda Basin/Kilroo Formation/CRA 83KD1A/S15307; 6130IV

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