DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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PROGRESS REPORT
CURNAMONA 1:250 000 SHEET - PLATFORM ROCKS, BENAGERIE RIDGE AND THEIR MESOZOIC AND CAINOZOIC COVER

GEOLOGICAL SURVEY

by

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DME.NO. 669/76

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ABSTRACT

The report discusses the Benagerie Ridge, platform rocks, and their younger sedimentary cover, on the CURNAMONA 1:250 000 geological map area. The Benagerie Ridge is a basement high running in a northerly direction across the middle of the map area, and has been actively shedding detritus since Adelaidean times. Its geology is poorly known, but includes porphyry, possibly equivalent to the Gawler Range Porphyry, with a thin cover of Adelaidean Rocks. The Benagerie Ridge is flanked by flat-lying or gently folded Cambrian and possibly Adelaidean sediments, of which the Middle Cambrian red bed are similar to that in the type area. These are underlain by metamorphically low grade basement of variable dip.

Along the northern margin of the map area are lobes of marine Mesozoic sediments, largely Marree Subgroup, part of which has been stripped.

The Cainozoic sequence blankets the entire area, apart from the Olary hills region in the south. It is represented by carbonaceous uraniferous non-marine sands of the early Tertiary Eyre Formation, which are absent over parts of the Benagerie Ridge, and essentially confined to palaeochannels. The Middle Miocene Namba Formation forms a blanket of fluviatile and lacustrine fine clastics, with carbonate lenses essentially confined to the west of the Benagerie Ridge.

The Late Cainozoic sequence is well-represented. There are Plio-Pleistocene fan deposits and gravels around the margins of the ranges, and extensive channel deposits in the western part of the map area. These are overlain by other fluviatile sequences, which alternate with or give way to, aeolian episodes in the Strzelecki Desert. The aeolian sequences include deposits of last glacial age. Pleistocene beach ridges and Quaternary lake deposits are associated with the Lake Frome playa.

INTRODUCTION

The CURNAMONA 1:250 000 geological sheet is located between latitudes $31^{0}00'$ to $32^{0}00$ and longitudes $139^{0}30'$ to $141^{0}00'$ (Fig. 1) and covers the area between Lake Frome and the Olary hills. A southern extension of the Strzelecki Desert covers the northeastern corner of the area.

The southern part of the Tarkarooloo Basin dominates the CURNAMONA sheet and has considerable economic importance because of the discovery of three uranium prospects within the Tertiary sequence.

Considerable progress in differentiating and correlating Cainozoic rock units has been made since publication of the adjoining ORROROO and PARACHILNA sheets, hence there are differences in treatment; rock unit boundaries do not coincide across these sheet borders, although colours match from similar units on the more recently published FROME sheet and will, also, on CURNAMONA.

This report should be read in conjunction with the black & white preliminary geological sheets at 1:100 000 scale (prepared by J. Bradford from mapping by R. Callen - see back pocket).

Main access roads are the Barrier Highway, Yunta-Frome Downs, Hawker-Frome Downs, and the Broken Hill-Tibooburra road (Fig. 1). A track along the New South Wales side of the border fence gives access to the eastern portion of the sheet.

"Frome Downs" homestead is located immediately south of the Lake Frome in the northern part of the sheet. Other plains homesteads are "Curnamona" and "Mulyungarie", and there are others along the margins of the Olary hills.

The climate is dry, hot in summer, with cold winds and occasional frost in winter. The boundary between summer and winter-dominated rainfall lies in the northern part of the sheet.

Winds are dominantly from the southern quarter. Rainfall is low and erratic in the north (100-125 mm/yr) falling mostly in brief storms with heavier rains of 350-625 mm at 10-20 year intervals. Falls occur mainly during February, March, May, June and December, with April being the driest month. Within the Olary hills rainfall is higher and more reliable, coming in winter storms following strong northeast winds. Some of the homesteads along the central northern margin of the hills depend entirely on runnoff from these storms for their water supply.

The nomenclature used for basins follows Wopfner (1972): the term "Frome Embayment" (Ker 1966, Freeman 1966, Wopfner 1966) refers to the Mesozoic sedimentary basin. "Lake Frome area" refers to the region bounded by the Flindes Ranges to the west, Barrier Ranges to the east and Olary Ranges to the south. The northern limit is taken as an approximate east-west line through the southern portion of Lake Blanche on CALLABONNA. Within the Frome Embayment, the blanketing Cainozoic sediments are unconformable on the Cretaceous and relate to a different cycle of events, hence the basin of Cainozoic deposition is named the Tarkarooloo Basin (after Lake Tarkarooloo on CURNAMONA). The Poontana Subbasin (after Poontana Ck) is the deeper western portion of the Tarkarooloo Basin.

The maps were prepared from Department of Lands (1: 59,500, Svy. 358, 359, 361) black and white photography supplemented by 1: 83,900 colour photography (Svy. 1206, 1207, 1209). Landsat band 7 imagery is available (1565-000-BW7, see Callen 1977).

Petrological reports, rock samples and core are on computer file; Core and samples are stored at the SADME Core Laboratories, Frewville. Plans of drillhole distribution (Annual Report of the South Australian Department of Mines and Energy 1973/4, p. 26,) and spot height data (plan 76/39) are available.

1: 63 360 scale sheets are referred to thus: Curnamona and 1: 250 000 scale sheets thus: CURNAMONA

PREVIOUS WORK

Early geological and geophysical exploration is summarized in the FROME explanatory notes (Callen in press). The most important of these are the works of Jack (1930), Kenny (1934) and Ker (1966, especially the appendix of Ludbrook, therein).

This report has been compiled from results of recent studies on the Frome Embayment and Tarkarooloo Basin by Callen (1974a, 1975, 19765a, 1977) and Callen & Tedford (1976). Other studies relevant to the stratigraphy were made by Firman (1970b).

Regional interpretations of geophysical data covering the Frome Embayment and adjoining areas have been compiled by Milsom (1965), Westhoff (1968), Parker (1973), and Tucker & Brown (1973).

PHYSIOGRAPHY

Dominant physiographic regions are shown in Fig. 2.

The Olary hills (region A) are remnants of early Tertiary topography, partly buried by Miocene sediments.

The extensive Curnamona plains (region B) have a very gentle slope to the north, and consist of Pleistocene fan deposits, except in the vicinity of the Olary hills, where younger fans may cover them. Within this region is the patch of degraded dunes and distinctive claypans (region B_1) which was once part of the active dunefield to the north. To the south, in regions marginal to the Olary Ranges (B_2), gilgai (stone mounds) are well developed, whereever basement is in shallow proximity. The stone mounds develop from coarse facies of older fan deposits, much of which is calcreted at depth.

Region C is of very limited extent, being the outcrop of the Karoonda silicified and ferruginized material of probable Late Pliocene-Quaternary age. The exact relationship between the silcrete, laterite and the actual landsurface of the time is unknown. It forms subdued stony rises among the sand dunes.

Lake Frome (region D) is a playa, probably with some tectonic control (Draper & Jensen 1976). Mound springs are distributed along a straight line near its eastern shore. Islands consisting of stabilised gypsum dunes, belonging to region F, occur in the southern part of the lake. Elevation of the lake bed varies from 0.5 m above to 3.0 m below sea level. Pleistocene shoreline deposits occur sporadically along its southern edges. Streams, with watersheds in the Flinders Ranges, contribute detritus to fans along the southwestern shore.

The southern margin of the Strzelecki Desert, region E, occupies the northeastern corner of the sheet. It is dominated by the longitudinal east-northeasterly-trending dunes and northerly-trending claypan chains, of which Lake Tarkarooloo, Long Swamp, etc., are examples. There is a prevalance of steep western shores on the lakes and claypans, whereas the eastern shores are shollow and flanked by lunettes. A distinctive area of claypans (region E_1) is bounded by a lower ridge to the south, capped by Miocene dolomite.

Region F is the southern limit of the large area of gypsum lunettes which flank the eastern shore of Lake Frome. These lunettes have a karst-like morphology developed upon them. They form a distinctive bare rugged landscape of large mounds.

Three major streams cross the sheet area, draining into Lake Frome. The Billeroo and Eurinilla Creeks are headed in the Barrier Ranges and eastern Olary hills area, whereas the Pasmore River drains from the Flinders Ranges. The Pasmore River (known locally as Wirrealpa Creek) divides upstream into two major tributaries, the Siccus River and Wirrealpa Creek. The area around the Pasmore River is marked by a series of shallow depressions, and numerous calcreted remnants of former channel systems, hence its designation as a distinct geomorphic unit (region G).

STRATIGRAPHY

PRECAMBRIAN

The Precambrian stratigraphy is discussed by G. Pitt in another report.

In the subsurface, numerous exploratory sedimentary uranium drill holes (Fig. 2) intersect basement rocksd. Fig. 3 shows the distribution and type of basement material. The Curnamona Cratonic Nucleus (Thomson 1974, Thomson et. al. 1976) probably occupies most of the Benagerie Ridge area (see also Sprigg's "Paralania", Sprigg et. al. 1958). An extensive porphyry body occupies the northern part of the Benagerie Ridge on CURNAMONA and is best represented in Dud Bore. It extends to the north onto FROME sheet, beneath the Mesozoic cover. The porphyry is not reflected by features in the gravity map but can be interpreted from the character of magnetic anomalies in the vicinity (A. Mills personal communication, 1980). An attempt to identify the contacts on seismic line CFA was unsuccessful - "reflections" seemed to pass straight through the region occupied by the porphyry, and resolution was so poor that shallow reflections could not be identified.

Thomson (1966, p. 216) noted similarities to the Gawler Range Volcanics (Blissett 1975), but ages are younger (1160-1500Ma, Webb et al 1978) and of the same order as those on basaltic volcanics in Bumbarlow 1 bore (Youngs 1978b). The ages are tenative, and probably represent a metamorphic event.

PALAEOZOIC

There is no exposure of Palaeozoic rocks, but company drilling for uranium and petroleum, and some water bores, intersect the Middle Cambrian red-bed sequence of Daily (1956), Dalgarno (1964). The poor quality of material available in some of the bores, particularly marginal to the Benagerie Ridge and Olary Hills, permits the possibility that some of these redbeds are Precambrian. A number of bores intersected the Wirrealpa Limestone.

Delhi-Santos Lake Frome 1,2 and 3 bores were drilled along the southern edge of the Lake Frome. They intersected 780 m of Middle Cambrian strata, and by comparison with exposed sections on PARACHILNA, almost penetrated to the base of this sequence.

MESOZOIC (Table 1).

Terminology for the Mesozoic of the Frome Embayment was first introduced by Forbes (1966). The following information is from subsurface data, there being no outcrop.

The Mesozoic strata on CURNAMONA are restricted to thin lobes marginal to the Frome Embayment. The best development of these are to the west and east of the Benagerie Ridge (Fig. 3).

The Cadna-owie Formation (Wopfner 1969, Wopfner et. al. 1970) is now used in preference to Pelican Well Formation in the Frome Embayment), is gradational with the Marree Formation. However, in Yalkalpo 1 bore it can be identified using the petrophysical logs. The Cadna-owie Formation is represented by shale, sand, and silt with lenses of coarse clasts ranging in size from pebbles to large boulders. Sandy beds are common, especially near the base. The units have been recognized in Black Oak bore (Truelove 1980).

The Marree Formation constitutes a monotonous sequence of dull greenish grey to bluish-grey finely laminated micaceous shale and siltstone, intraformational breccia and minor polymictic conglomerate. Much plant leaf and stem material and numerous invertebrate burrows or traces are present. Bivalves, foraminifera and microflora are common. No weathering horizon is developed on the Cretaceous in subsurface. Unlike some other areas (e.g. Oodnadatta region) the Marree Formation in the Frome Embayment cannot be subdivided at present. It is the only unit present in most of the bores.

CAINOZOIC (Table 2)

Several new names have been used for rock units in the eastern side of the Flinders Ranges, north of the Olary Block. These units are defined elsewhere (Wopfner et. al. 1974, Callen & Tedford 1976, Callen in prep.).

Paleocene-Eocene

Deposition during these epochs is represented by the Eyre Formation (Wopfner et. al. 1974, formerly Murnpeowie Formation of Forbes 1966), recognised over a wide area of the Great Artesian Basin and well-developed in the Lake Frome area. Supplementary reference sections for the Eyre Formation in the Tarkarooloo

Basin are Mines Administration LC1A bore on Paralana (FROME) and the Reedy Springs section on MARREE (Wopfner et. al. 1974). Yalkalpo 1 bore is a third important section, representative of the reduced sequence on the Benagerie Ridge.

The lithology of the Eyre Formation on CURNAMONA differs from that on FROME except along the northern margin of CURNAMONA. The more typical lithology of fine to very coarse-grained, (dominantly medium), sub-mature to mature sands, moderately to poorly sorted and frequently bimodal, is replaced by angular quartz sand, often pyritic and carbonaceous, becoming micaceous and kaolinitic towards the Olary Ranges. The characteristic bed of multicoloured siliceous pebbles with fossil wood is absent at the base in the southern part of the sheet, being replaced by a bed of rough milky quartz or granitic and occasional metamorphic pebbles.

The Eyre Formation reaches its maximum thickness in the stream valleys such as the Billeroo West and Yarramba Palaeochannels (Brunt 1978, Ellis 1980) cut into the underlying rocks, and is absent over the Benagerie Ridge in the eastern part of the sheet. Structure contour and isopach maps using a selection of extensive company drilling are included (Figs. 2,3,4,7).

In the Lake Frome area there is good biostratigraphic control (Harris in Wopfner et. al. 1974), discussed in detail for the Mooloowatana-Reedy Springs area by Callen (1975, esp. Fig. 15). A disconformity may occur within the unit, the Late Paleocene-Early Eocene being unrepresented. The Eocene is typically finer grained and of a characteristic dark brown colour, with occasional leaf remains, in contrast to the coarse sandy Paleocene deposits with black carbonaceous matter.

In subsurface, the contact with the Cretaceous strata is well defined: coarse quartz sand overlies dull green-grey silty shale of the Marree Formation. The upper contact may be difficult to identify because sands may occur in the overlying Namba Formation (Wopfner et al 1974, Callen & Tedford 1976, Callen 1976a) as in Yalkalpo 1 bore. In general, the first sands encountered below the black clays or carbonate horizons of the Namba Formation are those of the Eyre Formation, though in the eastern part of the sheet electric log interpretation suggests a "sand-on-sand" situation. Brunt (1978), on the other hand, places all the sands in the Eyre Formation.

Both the lower and upper contacts show regional disconformable relationships. Channelling is well developed at the lower contact on CURNAMONA and channel sands of the Namba Formation may also cut into the Eyre Formation.

Deposition of the Eyre Formation ceased during the Late Eocene - Early Oligocene.

Oligocene-Early Pliocene

Silcrete and bleaching of ?Oligocene age, occur to a limited degree on dipping sequences around the margins of the Tarkarooloo Basin, but have not been definitely identified on CURNAMONA.

The Namba Formation (Callen & Tedford 1976) was deposited during the Early to Medial Miocene times, and may extend into the Late Miocene. The name is derived from Lake Namba, and the type section is in Yalkalop 1 bore on FROME, with an important supplementary section located at Wooltana 1 bore. The outcrop supplementary section is in a cliff on the central western shore of Lake Tarkarooloo and most outcrop occurs in this region on Eurinilla and Siccus. The unit is the time equivalent of the Etadunna Formation (Stirton et. al. 1961), as shown by the similarity of the microfloras (Harris 1972).

An Early to Medial Miocene age (?Balcombian-Betesfordian) was determine palynologically (Harris, personal communications 1972, 1973; Lindsay & Harris 1973), the flora being comparable with that of the Munno Para Clay Member (Lindsay & Shepherd 1966, Lindsay 1969) of the St. Vincent Basin. Correlation with forminiferal zones of the Murray Basin and southern Victoria has been obtained through Tricentrol Aust. Ltd bores near Mutooroo, OLARY (Lindsay & Harris 1973). Vertebrate fossils of considerable evolutionary and palaeogeographic significance are described by Tedford et. al. (1977), Archer (1976), Archer & Rich (1979), Rich et al (1978), Rich & Archer (1979) and Woodburn & Tedford (1975). Although the possible age range of the Namba Formation is Late Oligocene to Late Miocene the unit was probably deposited in a relatively short time interval in the Early to Medial Miocene.

Clays are rich in smectite, and a rather poorly defined cyclic deposition is present involving black clay, cross-bedded sand, finely laminated silt and thin carbonates. The upper unit (Tmb_2), also containing carbonates, is dominated by fine laminated silt and cross-bedded fine sand with prominent bioturbation. Muds are dominanted by illite and are light green grey or olive. The coarser sands are frequently matrix supported as a result of bioturbation of primary layering.

The carbonates (dolomites) are interbedded with clays, which are rich in palygorskite, especially beneath the base of each major carbonate horizon. Clay mineralogy was determined by Brown (see list of Brown's work in Callen 1975, Appendix 2), and is discussed in Callen & Tedford (1976) and Callen (1977). The dolomite crops out low north-facing rises in the northern part of the sheet, and is essentially restricted to the west of the Benagerie Ridge (Figs. 5,6,7).

Sand distribution is shown on Fig. 5. This facies map, coupled with isopach and structure contours (Figs. 3,4,5,6,7), indicate the Namba Formation sediments are much more extensive than the Eyre Formation, and show channels have some compliance with those in the Eyre Formation. To the south, mica and angular quartz content increase, and the unit becomes lithologically identical to parts of the Eyre Formation. Matrix-supported fabric is typical of this lithology.

Apparently these channels were concentrated in structural depressions in the basement, which were gradually filled. There was also later faulting along the edges of the depressions, as shown by the distribution of the dolomite layers, but it is not known whether this was a contemporaneous or subsequent deformation.

Late Miocene - Early Pleistocene (Fig. 8).

There is a ferruginous horizon resembling the Karoonda Palaeosol (Firman 1971) developed on the Namba Formation. This is included with unit CzSi on the map.

Upon the Namba Formation clays is developed a siliceous horizon, consisting of microcrystalline quartz, with numerous cavities of pedogenic origin infilled by opal chalcedony. On sandstones of this unit and of the Eyre Formation, this cement is represented by quartz cement, producing massive brown to grey silcrete. This silicification came after ferruginisation, hence the silcrete duricrust generally has a red and white or brown appearance.

The Willawortina Formation (Czw) constitutes a wedge-shaped deposit, recognized in the Pasmore River area, of poorly sorted conglomerates, nodular to massive carbonates, and red and green mottled clays, interpreted as distal fan and stream deposits. Its type section is WC2 bore on the Paralana High Plains (FROME) with an outcrop supplementary section, south of "Wertaloona" on Balcanoona (COPLEY). Another supplementary section is Wooltana 1 bore on FROME. The Willawortina Formation has an apparently gradational contact with the Namba Formation, though the base of the unit is well defined by petrophysical logs. The unit has been recognized in the Yarramba area, east of the Benagerie Ridge.

The Millyera Formation comprises laminated light green to bluish green clay with thin fine sand beds and thin charophyte stem-mould limestone and gypsum laminae at the top. The unit is disconformable on the Namba Formation. Abundant ostracods, charophytes (see Burne et al 1980), gastropods, bivalves (M. Buonaiuto, personal communication, 1978), and worm burrows are present. The unit was named after Lake Millyera on Siccus, where it is best exposed. The clays are less indurated and have a characteristic subconchoidal fracture, distinguishing them from the Miocene sequence.

The Coombes Springs Formation (new name, Unit 'Qp_5' of FROME) crops out along the northeastern shore of Lake Millyera and along the Eurinilla-Billeroo Creek system and in Lake - Tarkarooloo. Lithologically it is fine to coarse fossiliferous sand. Fine cross-bedding and wavy horizontal bedding is typical, and abundant charophyte stem mould fragments and oogonia occur. Bright reddish-orange gypsum-impregnated silt is present, grading to coarse sand at the base, and closely resembling the Eurinilla Formation (described below). At Lake Millyera, and along Billeroo Creek the red facies is dominant. In Lake Tarkarooloo the lateral gradation between the two facies can be observed.

At Lake Millyera and the fossiliferous sands grade up into alternating fine sand and green clay like those of the Millyera Formation.

The Millyera Formation of Callen & Tedford (1976) constitutes the Millyera Beds ('Qp_6' of FROME) and Coombes Springs Formation combined; though recent work shows the original practise (Callen 1974b) of separating them as distinct stratigraphic units is probably correct, because a disconformity exists between them. However, they are mapped together on 1:250 000 scale.

The shelly coarse strandline deposits along the base of the cliffs at the southern end of Lake Frome are probably of similar age to the Coombes Springs Formation, though the feature may be composite, including some younger shoreline deposits. A date on shell indicates these sediments are beyond the the range of radiocarbon dating.

The Pasmore Conglomerate (new name, CZpc) consists of extensive channel deposits of planar cross-bedded conglomerate and sand, exposed along the southern shore of Lake Frome and the Pasmore River. The unit is solidly cemented with secondary white or buff carbonate. It contains boulders and pebbles derived from the Olary and southern Flinders Ranges, with a local admixture of carbonate nodules derived from the Willawortina

Formation. The Willawortina Formation contains numerous similar lenses of conglomerate, also cemented, which may be difficult to distingusih in isolated outcrops. The conglomerate grades laterally into the red facies of the Coombes Springs Formation in Lake Tarkarooloo. In the vicinity of the Pasmore River, channel deposits are readily recognized in aerial photographs and are distinguished on the map. Some of them are probably younger channels, which cannot be identified as such without good outcrop.

Upon these units is developed the calcrete horizon Qca, a white to pinkish, massive carbonate which cements the Coombes Springs Formation or sands of the Namba and Willawortina Formations. Iron and manganese oxide crusts, forming pipe-like structures and spherical bodies or sheets, are associated, especially east of Lake Frome.

Pleistocene-Holocene

The works of Williams & Polach (1971), Wasson (1979) and Callen & Tedford (1976) are useful for an understanding of the Quaternary geology discussed here.

The Eurinilla Formation (Qp_4, Callen & Tedford 1976) has its type section at Lake Moko on Coonarbine (FROME) with supplementary sections at Lakes Millyera and Koorka (the latter on Coonarbine). It is of late Pleistocene age, and contains basal channel sands with Diprotodon sp., Procoptodon goliah, and other species similar to those of the "Callabonna fauna" (Tedford 1973). It is regarded as at least partly equivalent to the Tirari Formation (Stirton et. al. 1961). Radiocarbon dating (Callen et al, in prep.) shows it to have ceased deposition probably at least 95 000 yrs ago.

The formation consists of fine to medium, clayey, poorly sorted sands, of orange brown colour, impregnated with gypsum at the base, and with interbedded green clays and silty clays. The upper portion often lacks sedimentary structures, or is horizontally laminated, whereas the lower portion is trough cross-bedded.

The unit has a strongly disconformable contact with the underlying units. East of Lake Frome it is generally cut into the Namba Formation or Millyera Formation, and south of the Lake into the Willawortina Formation or Coombes Springs Formation.

The next youngest unit is gypcrete (Qcs, map section D-D'), which forms massive to nodular crystalline sheets of wedgeshaped or fibrous gypsum crystals; it is present in the basal Eurinilla Formation or older units and is related to old pietzometric surfaces. There may be more than one horizon. Gypcrete frequently forms hard caps, permitting the development of finely patterned indented marginal cliffs along lake- and watercoarse-edges. This pattern is readily distinguished from silcrete and usually also from calcrete.

The Pinpa Palaeosol (new name), a calcareous palaeosol horizon, is typically developed on the Eurinilla Formation as widely developed horizons of soft white carbonate patches or nodules, which are hard when weathered. Orange, brown and black ochreous mottling is associated. The unit appears as white patches on aerial photographs, difficult to distinguish from gypcrete. Its age is probably at least 95 000 yrs BP (Callen et al, in prep.).

The Coonarbine Formation (Qp_1, Callen & Tedford 1976) sediments are moderately sorted sands, forming a thin widespread blanket east of Lake Frome. Cross-bedding is present in some sections. Several mottled white carbonate palaeosol horizons are present (Billeroo and Moko Palaeosols, new names), weaker in development than the palaeosol on the Eurinilla Formation. A characteristic large scale rectangular jointing or pedality produces a columnar weathering pattern. Locally, characteristic shells of the land snails Thersites and Meracomelan (Buonaiuto op. cit.) are present. Although radiocarbon dating of the palaeosols gives a finite age, all are believed to be at least 3-5 000 yrs too young (Callen et al, in prep.). Each palaeosol is developed on an aeolian phase, forming the longitudinal dunes comprising the indurated cores of the Strzelecki Desert dunes. The youngest of these is believed to represent the 15-21 000 yrs BP arid dune-building episode of Bowler (1971, 1976). Loose sandy crests form the modern dunes (Qrs).

Gypsum and sand/clay pellet leeside mounds (Qps) are developed along the eastern margins of many depressions. They are particularly well developed on the Benagerie sheet area. Gypsum sand is present only near Lake Frome. These mounds correspond to phases of longitudinal dune formation, and are included in the Coonarbine Formation.

As mapped, the Coonarbine Formation includes some younger material of similar aspect, but without calcareous palaeosol - development. The palaeosols may also be absent in the upper unit of the Coonarbine Formation, which then becomes indistinguishable from younger deposits at the scale of mapping (lithology is otherwise identical).

The Coonarbine Formation and Eurinilla Formation cannot always be distinguished on the scale of aerial photography used for this map, so are included in units Q and Qrs/Qc. On COPLEY and OLARY (Fig. 1) the units mapped as Pooraka Formation are essentially Eurinilla Formation with a cover of younger fan deposits. The Pooraka Formation as shown on adjacent maps constitutes the Coonarbine Formation and Eurinilla Formation combined, together with younger fan deposits. It is likely that the Pooraka Formation is missing from the desert area and plains in the northern half of CURNAMONA.

Fan deposits formed along the margins of the Barrier and Flinders Ranges in the interval 7 000 yrs BP to present (Williams & Polach 1971, Wasson 1979). Presumably such fans exist around the Olary Hills, but have not yet been identified. Unit Qht and Qh_2 probably belong to this interval. Unit Qht represents scree deposits and high angle fans. Unit Qh_2 has a prominent and characteristic surface texture of stone mounds aligned parallel to topographic contours. The material is largely ironstone and angular quartz derived originally from the basement, and then reworked from fans of the Eurinilla Formation by gilgai processes. Its relationship to the Coonarbine Formation is unknown. Other younger fans have been included in unit Q.

The Holocene dunefield (Qrs) of the Strzelecki Desert and part of the Lake Frome Plains consists of red brown loose sands and longitudinal dunes (Qrs, Simpson Sand of Firman 1970b in part). These have been largley reworked from the Coonarbine Formation dunes and Eurinilla Formation, and are partly active today. They have steep north faces, and are sometimes linked to transverse dunes along pan and lake edges. The unit dominates the northeastern portion of CURNAMONA. As mapped, Qrs probably includes residuals of older Tertiary deposits, exposed in interdune areas in the northeastern corner of the sheet, and the Coonarbine Formation. Eurinilla Formation is present along the watercourses.

Soft blue-green to brown and black clays of Holocene age (Qrl; Draper & Jensen 1976; Bowler 1976) form the uppermost playa sediments. They are very similar to Millyera Formation clays. Low angle fans (Qra) occur along the lake shore at creek outlets.

Since deposition of unit Qp_2, a gypsum karst structure has developed on the larger mounds along the eastern edge of Lake Frome. Modern gypsum/sand lunettes of small size are accumulating along the eastern edge of the present lake shore, and on some of the smaller lake shores.

STRUCTURE AND ISOPACH DATA

Seismic work by the South Australian Department of Mines and Crusader Oil N.L. indicates gentle folding in the Middle Cambrian rocks, with an overall westerly dip in the western third of the map area. Crusader's work indicates a narrow horst-like fault structure affecting the Cambrian, in the northeastern corner of the sheet area. Topographic features and drilling in the Cainozoic indicate it continues to the south, and may merge into or intersect the continuation of the MacDonald fault shown on the structural interpretation, included in the palaeogeographic maps (Fig. 7).

Figure 3 shows a structure contour map of the pre-Paleocene surface with interpreted rock-type distribution determined from cuttings. The Benagerie Ridge is prominently displayed, as are the channels. The isopach map of the Eyre Formation (Fig. 4) indicates the depressions are filled by sands of this unit, thickening away from the Benagerie Ridge, and generally to the north. The interpretation of these maps is presented in Figure 7, which also shows relevant structural data. The direction of flow of streams is indicated. In the Yarramba region; the direction depends on the interpretation of C7 bore, for which there are 3 possibilities for depth to basement and thickness of Eyre Formation. The other two interpretations give a greater thickness of Eyre Formation, and indicate an opposite flow direction towards L. Mulyungarie bore to the northeast.

The structure contour map of the pre-Miocene surface and isopach map fo the Namba Formation and its dominant sandy intervals are presented in Figs. 3,4,5. Both indicate a strong northeasterly topographic trend within the buried Benagerie Ridge, as does the Eyre Formation data. Isopachs of the dolomite content (Fig. 5) and structure contours (Fig. 6) of the Namba Formation indicate a suddent thickening to the northwest, and show dolomite is restricted to the west of the Benagerie Ridge. The structure contour map of the top of the upper dolomite is especially useful in determining Cainozoic faulting (Figs. 6, 7), which also incorporates other relevant structural data. It is evident that the Gould's Dam (Curnamona) channel has continued to be manifest as a depression, whereas trends are much less clear for the Yarramba channel east of the Benagerie Ridge. It seems that much of the earlier basement topography had been smoothed over by this time, except in the Goulds Dam channel, where further down-faulting probably controlled sedimentation.

It is significant that the topography of the pre-Miocene and pre-Paleocene surfaces are almost identical, suggesting there was not a major phase of deformation in Late Eocene to Oligocene times (Wopfner 1972).

The possible fault indicated at $140^{0}33'$ on the northern margin of the sheet is interpreted from a ridge of silcreted Tertiary sediments, which has probably been upfaulted to the west. The structure also corresponds approximately to the edge of a major magnetic feature separating a magnetic high to the west from a linear northerly oriented magnetic low to the east. The latter is possibly the effect of gently folded Cambrian rocks or older intrabasement features. Extended north, the trend of the fault passes between Mudguard 1 and Yalkalpo 1 bores on FROME. A thick sequence of Cambrian rocks lies to the east and shallow Precambrian rocks to the west.

SEQUENCE OF EVENTS

1. The major portion of the Lake Frome area probably persisted as a stable cratonic block during deposition of the Adelaidean (Thomson 1974). The Precambrian is represented on FROME and CURNAMONA by shales, red-beds and conglomerates with interbedded basaltic lavas. The extensive rhyolitic porphyry flows may have take place at this time or during the Cambrian.
2. Lower Cambrian marine carbonate sediemntation took place, at least flanking the eastern part of the Benagerie Ridge on FROME. During Middle Cambrian times a sequence of redbeds accumulated, directly related to those of the central Flinders Ranges. These are essentially continental arid fluviatile and deltaic deposits, with a marine transgression represented by the Wirrealpa Limestone (Youngs 1978c, Moore 1979a,b).
3. During Middle Cambrian to Ordovician time the Adelaidean and Cambrian rocks of the mobile belt were folded and intruded by granites in the Willyama Complex area as a result of the Delamarian Orogony (Thomson 1969). Further north the basement acted as a stable cratonic nucleus (the Curnamona Cratonic Nucleus), where Delamarian folding is effectively absent.

4. The next depositional event was in Early Jurassic times, when epeirogenic movements initiated formation of the Great Australian Basin of which the Frome Embayment is part. The Embayment comprises a lobe of sediments open to the main basin to the north. Crystalline basement areas were exposed in the Mount Painter area and along the Benagerie Ridge (Callen 1975). Only the southernmost margin of these sediments is represented on CURNAMONA.
Wopfner (1969) regarded the Parabarana Sandstone (on CALLABONNA, see Ludbrook 1965) as representing the beginning of the Lower Cretaceous marine transgression following non-marine Jurassic conditions. The Cadna-Owie Formation is thought to represent a nearshore facies of this unit and it intertongues with the lower part of the Marree Formation at the basin margins.
5. During the Late Cretaceous there was a major regression which left little or no sedimentary evidence.
6. In the Early Paleocene, renewed uplift initiated erosion of the regressive sediments of the Late Cretaceous. A new phase of non-marine sedimentation took place during the Paleocene. A widespread sand blanket, the Eyre Formation, was laid down by braided, and subsequently meandering, streams, over much of the Great Australian Basin. The basin may have had an outlet to the sea to the north, (Veevers & Rundle, 1979) and constant reworking and high rainfall caused the abundant fines eroded from the Cretaceous sediments to be flushed out. High rainfall and humid conditions are indicated by the floral content, and forests grew in the vicinity. Polished pebbles of fossil wood, chert and porphyry originated from the Mesozoic strata.

Coarse sandy and kaolinitic sediments were deposited by meandering streams in structurally controlled valleys flanking the Benagerie Ridge. Sediments were derived from deeply weathered kaolinized basement rocks of the interfluves and drainage was to the north.

Palynology shows the Early Eocene is unrepresented by sediments over a wide area of Australia and the surrounding seas (McGowran, 1979).

7. The fine, brown, carbonaceous silts of the Eocene portion of the Eyre Formation represent swampy or lacustrine conditions with meandering streams, indicating decrease in stream gradient as adjacent upland was eroded and as drainage transferred from dominantly northerly, to southerly (Veevers & Rundle 1979). Further deposition took place in the channels.

8. Widespread stable conditions then prevailed during the Oligocene, which was essentially a period of nondeposition. Silcrete developed sporadically along the marings of the Flinders and Barrier Ranges as a result of peculiarities in groundwater composition and climate, but has not been identified on CURNAMONA.

9. In Medial Miocene times the Poontana trough began forming west of Lake Frome, and was the site of deposition of very finely laminated fissile carbonaceous clays of the lowermost Namba Formation, in a probable fluctuating saline/fresh lake environment. The vertebrates and microflora indicate permanent water and high rainfall. Warm conditions are suggested from foraminiferal evidence in equivalent marine strata of the Murray Basin. Higher in the Miocene sequence, vertebrates are present, and their taxonomic content implies

a large body of permanent water with forested shores, in agreement with the high rainfall suggested from the somewhat older floral evidence.

Abundant smectite in the lower Namba Formation was formed during Medial Miocene times under conditions of restricted leaching, though much was probably inherited from the Marree Subgroup. A fluviatile environment, perhaps with shallow swamps and lakes was present. Fossils suggest gallery rainforest along rivers, with grassy interfluves. A subtropical savanna probably existed. The palygorskite/dolomite sequence later developed to the west of the Benagerie Ridge during times of seasonal aridity. Intermittent exposure of the lake sediments to weathering is recorded by incipient soil formation.

During deposition of the upper Namba Formation (unit Tmb_2), with its illite-rich clay mineral suite, a marked change in conditions occurred. This probably resulted from both uplift of the Flinders Ranges in Late Tertiary times, and imposition of a more seasonal, possibly cooler climate. It is difficult to assess the relative roles of climate and tectonics. The lakes were swamped with detritus, and extensive alluvial fans of the Willawortina Formation began to form.

10. In Late Tertiary times, after deposition of the Namba - Formation, there was a period of extensive ferruginisation and silicification (CzSi), producing variable and well-developed silcretes.

11. The silicification was followed by vigorous uplift of the Flinders Ranges, and to lesser degree, the Barrier Ranges and Olary Ranges. The main phase of deposition of the

Willawortina Formation took place. Meandering streams dominated the lower part of the fan environment whilst mud flow and streamflood deposits built up near the ranges.

12. Deposition of the Millyera Formation lacustrine, fluviatile and beach deposits followed or coincided with this event. Subsequently the lake dried up as the climate became more arid.

13. In the Pasmore River region, extensive coarse clastics of the Pasmore Conglomerate palaeo-river system fed the former lake Frome, the lake being represented by the Coombes Springs Formation lacustrine and shoreline deposits. Present day rivers flow intermittently in relic valleys of these low sinuosity prior streams. Rainfall must have been higher than at present as the lake was much larger, extending at least as far as the latitude of Lake Bumbarlow to the east (on FROME). Cliffing of the southern shore took place. Large marusupials lived in the vicinity. The lake eventually dried, thus ending this second pluvial phase of considerable antiquity.

    Calcrete and other palaeosols developed.

14. The Eurinilla Formation records an essentially fluviatile environment, with some aeolian activity (clay pellet lunettes), dominated by meandering streams closely coincident with present drainage. The large delta of the Pasmore River built out into Lake Frome, which now approached its present or reduced size. Large marsupials were still living in the area.

15. A calcareous palaeosol then formed over a wide area.

    In Late Pleistocene to Early Holocene times (Callen 1980) a new phase of deposition set in, represented by the

Coonarbine Formation, which is essentially aeolian. An extensive system of seif dunes and gypsum/quartz sand lunettes developed, in at least four phases beginning well beyond the range of radiocarbon dating and lasting to about 16 000 yrs B.P. During the major Quaternary aridity (c. 25 000 to 16 000 yrs B.P.), lunettes formed in and adjacent to the eastern side of Lake Frome, and smaller lakes to the east. Dry westerly winds prevailed. Carbonate palaeosol horizons are intercolated between the aeolian phases.

16. Fan deposition occurred west of Lake Frome, but it is not known whether this coincided with the last phases of dune development; it is most likely to have alternated with or postdated the major aeolian phases, perhaps coinciding with the major pluvial interval of c. 7 000 - 4 000 yrs BP recorded elsewhere in Southern Australia. Very Late Pleistocene beach deposits are known from the western shore of Lake Frome.

During Late Pleistocene times the Flinders Ranges and flanking High Plains continued to be uplifted, whilst the Olary and Barrier Ranges were comparatively stable. Lacustrine and fan sediments continue to be deposited in Lake Frome. Dunes are being eroded by strong southerly winds and rainstorms.

ECONOMIC GEOLOGY

Metallic Minerals

Exploration for uranium began with the work of E.A. Rudd & Co. Ltd. in 1969.

Reserves of 3 000 tonnes of uranium oxide have been proved at the Honeymoon and E. Kalkaroo prospects by Mines Administration Pty Ltd in joint venture with Sedimentary Uranium

N.L., The uranium occurs in medium fluviatile sands in the lower part of the Eyre Formation. Other prospects occur in channels of the Eyre Formation at Gould's Dam and Yarramba. The Benagerie Ridge partly controlled sedimentation, and direction of flow of the uraniferous groundwaters, so as to cause deposition of the uranium. Economic aspects of this geology are discussed by Callen (1974a, 1976a), Brunt (1978), Ellis (1980) and extractive leaching by Lackey (1974). The distribution of channels is shown in Fig. 7.

The sands of the Eyre Formation, particularly on CURNAMONA, locally contain up to 5% rutile, plus zircon and other heavy minerals.

Non Metallic Minerals & Fossil Fuels

Swelling clays of the palygorskite group (a variety of Fuller's Earth) and degraded ?montmorillonite type occur in association with dolomite, in outcrops around many of the small lakes. Demand for palygorskite for use as industrial absorbants and catalysts is such that exploration has begun, southeast of Lake Frome (Barnes & Olliver 1978).

Thick white kaolinite deposits are associated with sands of the Eyre Formation, particularly adjacent to granitic source areas, and have been investigated along the northeastern margin of the Olary Hills.

The potential of the Cretaceous strat for oil and gas in the Great Artesian Basin has been discussed in reports by Ward (1944), Osborne (1945) and others. Evans (1946) was the first to suggest that Cambrian rocks of the Frome Embayment might have an oil potential, while Wopfner (1970), Freeman (1966) and Youngs (1978a, b) assessed the potential of Cambrian and Ordovician strata. Recently Truelove (1980) reassessed Mesozoic stratigraphy. The Cambrian limestones contain some hydrocarbon source rocks, and the Middle Cambrian redbeds and Jurassic sands are good reservoir rocks.

The exploratory oil wells Black Oak 1 (Zinc Corporation Ltd, Enterprise Exploration Ltd and Frome Broken Hill Co. Ltd 1945) and Lake Frome 1, 2 and 3 south of Lake Frome (Delhi Australia Petroleum Ltd, 1968), did not intersect any significant hydrocarbons.

Hydrogeology

Several workers have studied the hydrogeology, the most recent being Ker (1966), Waterhouse & Beale (1978). Underground water supplies are availalbe over most of the area; artesian supplies are provided from the basal Great Australian Basin sediments where these are present.

South of Lake Frome, water of variable quality is obtained from several sources including stream gravels of the Eurinilla Formation, unconsolidated sands of the Willawortina Formation channels, and blanket Tertiary sands, the latter providing moderate stock quality sub-artesian water.

East of then Benagerie Ridge the major aquifers, the Cadna-Owie Formation and Algebuckina Sandstone (Interstate Conference on Artesian Water 1929), have been used.

Over the Benagerie Ridge, the only water available is from surface runoff.

RAC:AF

R.A. CALLEN

GEOLOGIST

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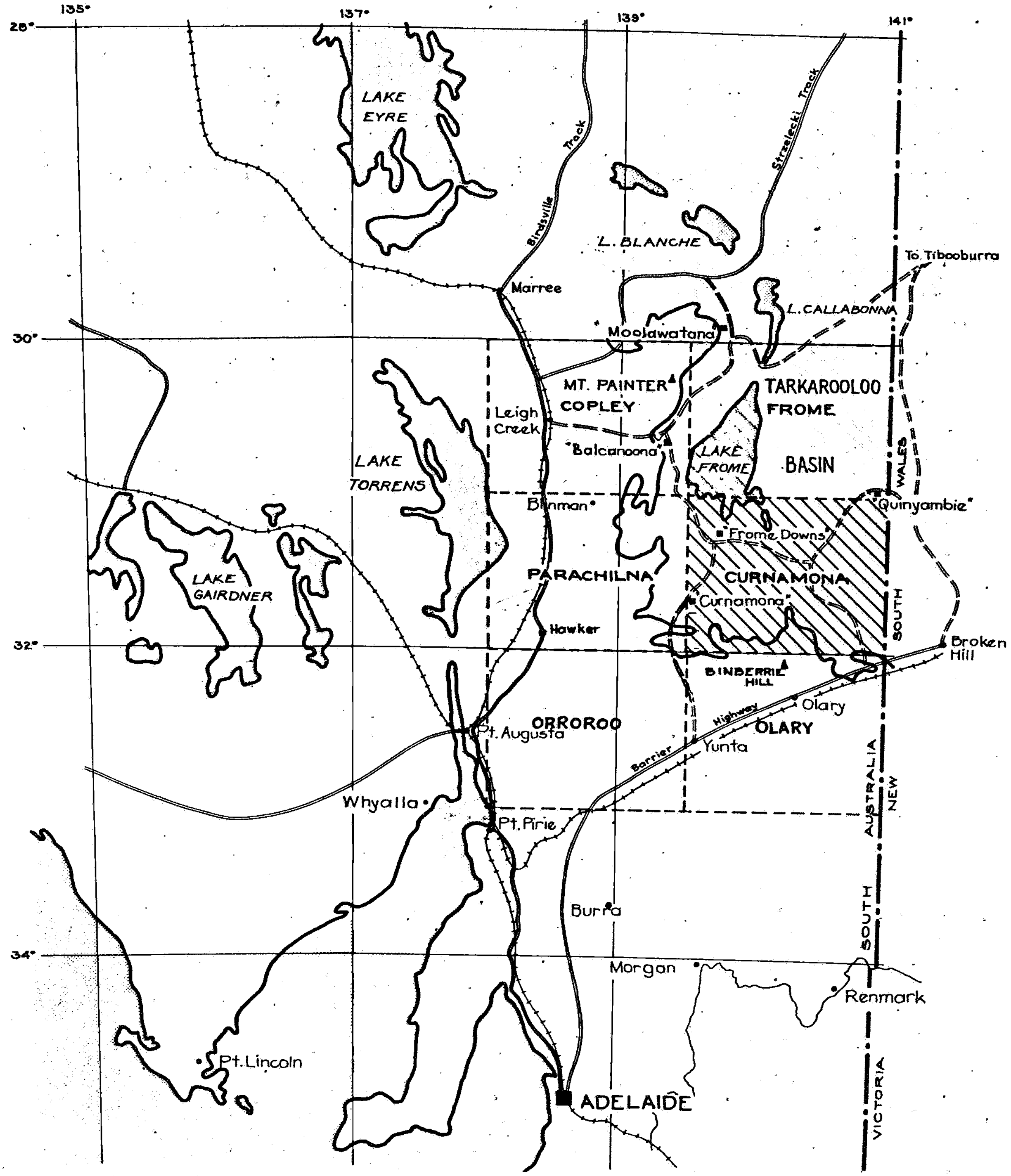


1:100,000 ENLARGEMENTS

SICCUS **PASMORE** *SANDYOOTA*	*EURINILLA* **BENAGERIE** *BENAGERIE*	*BERBER* **LAKE CHARLES** *MULYUNGARIE*
CURNAMONA **CURNAMONA** *GLENORCHY*	*TELECHIE* **KALABITY** *KALABITY*	*ST. ANDREWS* **MULYUNGARIE** *BOOLCOOMATA*

CURNAMONA

1:63,360 ENLARGEMENTS

SCALE IN KILOMETRES

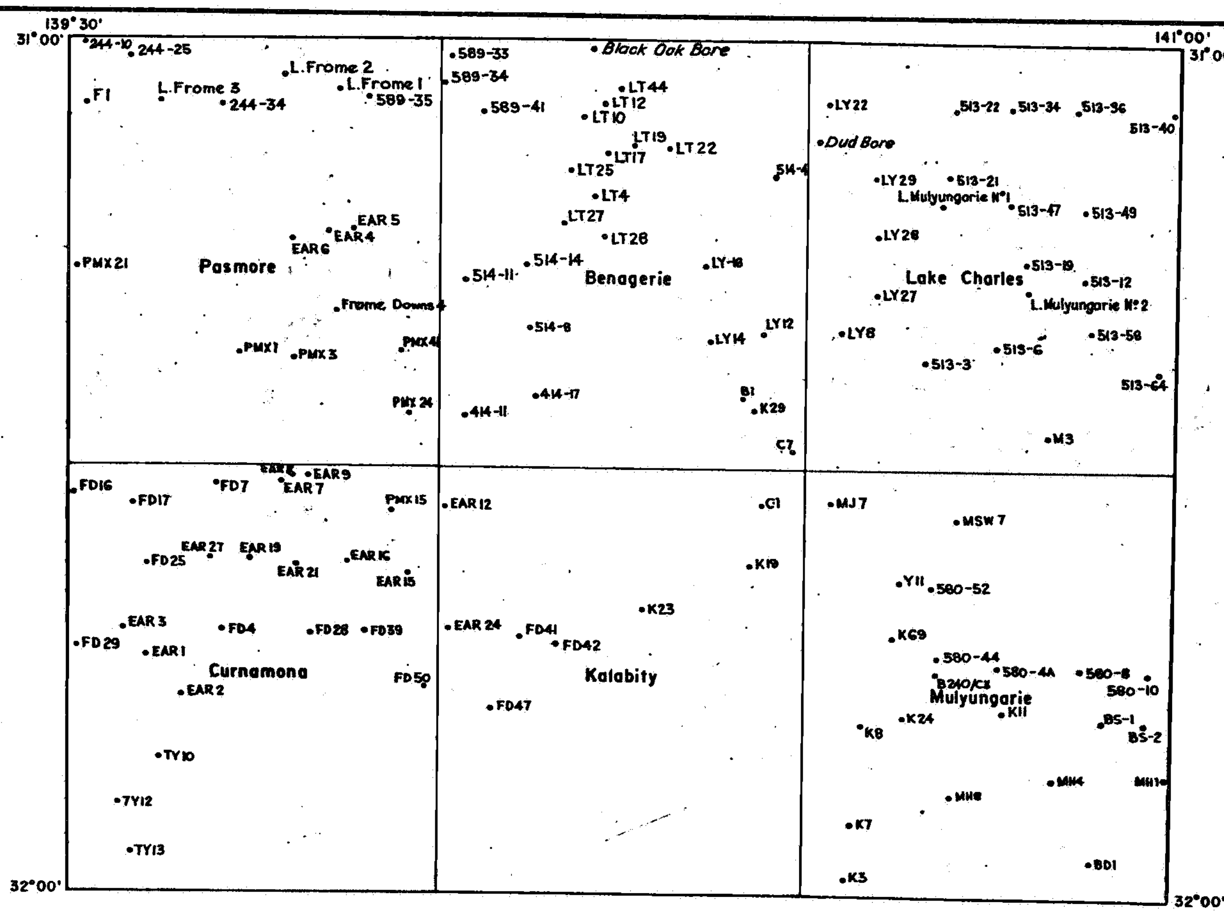
0 100 200

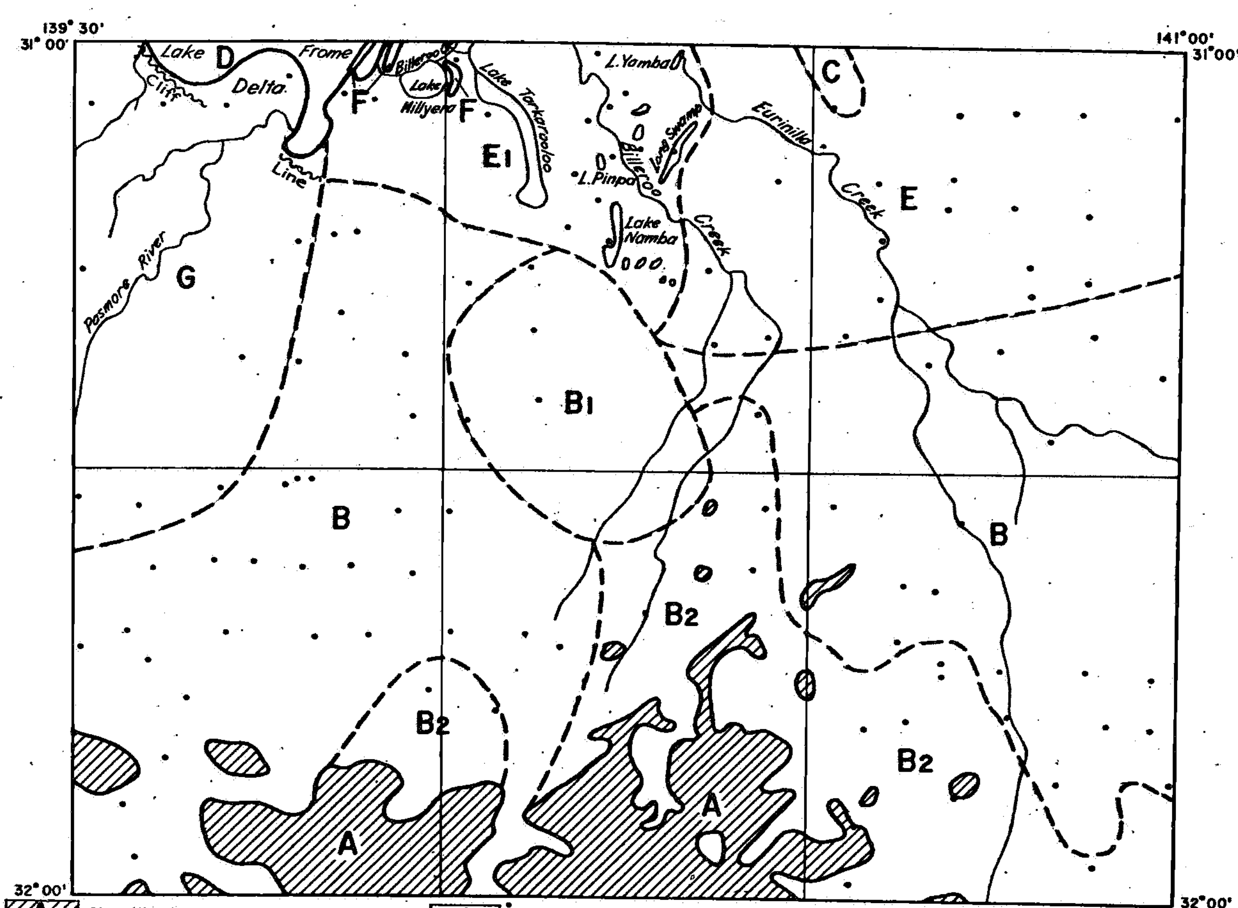
Boundary of Cainozoic Sediments (TARKAROOLOO BASIN)

FIG.1

	DEPARTMENT OF MINES—SOUTH AUSTRALIA	SCALE 1:4,000,000
COMPILED: R.Callen	**CURNAMONA 1:250,000**	DATE August 1980
DRN A.R. / CKD	LOCALITY PLAN	PLAN NUMBER
9.7.81		S14971

2034





A	Olary Hills (Basement rocks).
B / B1 / B2	Curnamona Plains B1 degraded dunes and claypans B2 gilgai with shallow calcrete and basement.
C	'Karoonda' paleosol – silcrete.
D	Lake Frome playa
E / E1	Strzelecki Desert dunefield E1 areas of small playas
F	Gypsum lunettes
G	Area of prior stream valleys and Pasmore River valley.

Fig. 2

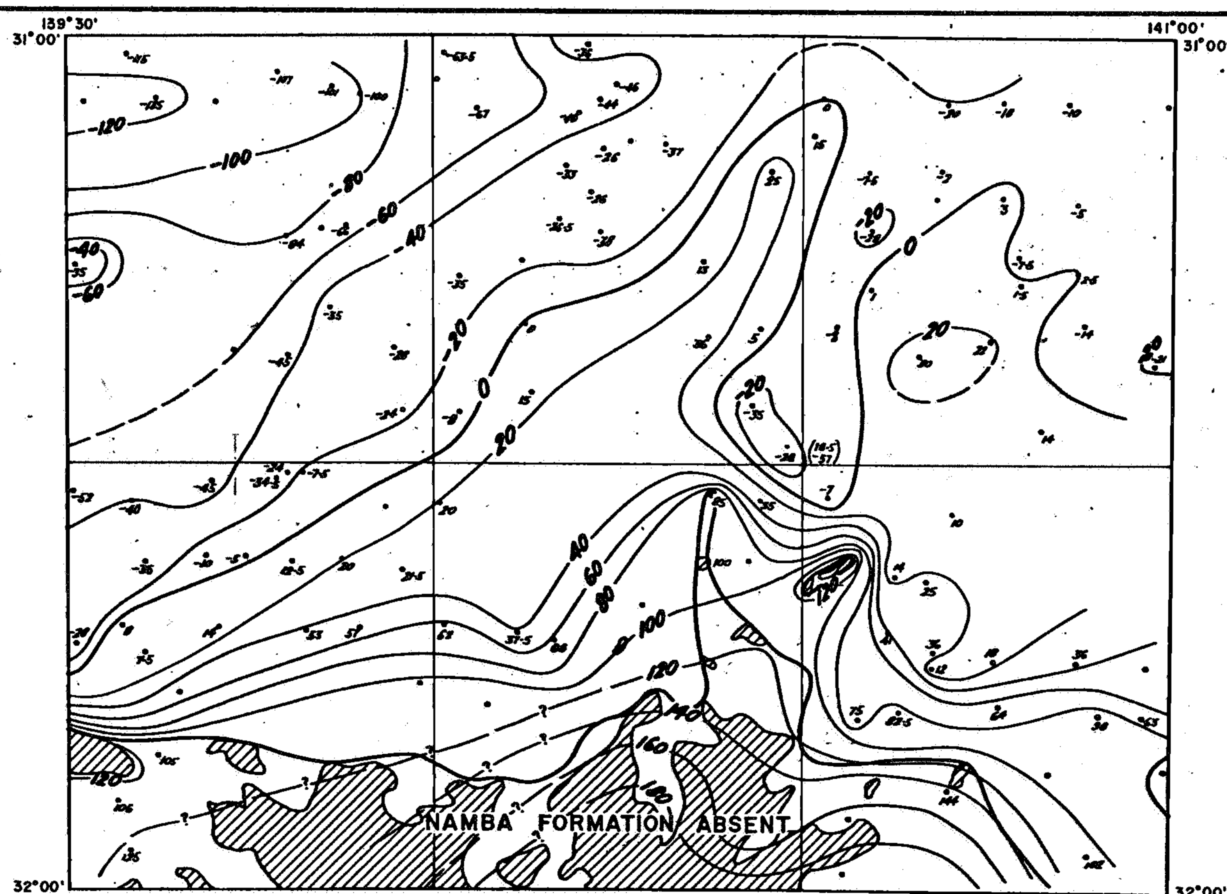
DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

CURNAMONA 1:250000 PROGRESS REPORT

DRILLHOLE LOCATIONS and PHYSIOGRAPHIC REGIONS

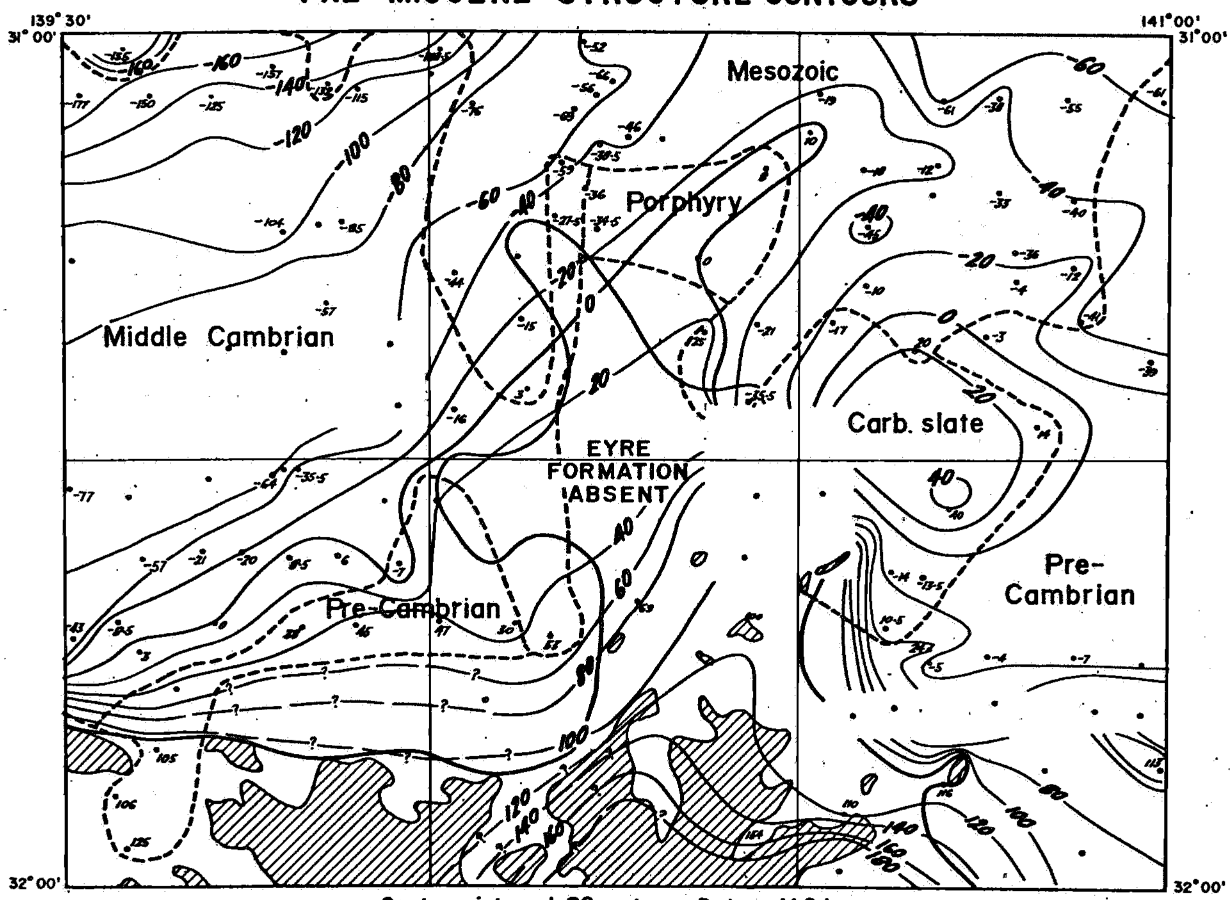
COMPILED R.A.Callen A.Robertson	C D O	DATE 9.7.81
DRAWN A.F.	SCALE 1:1000000	
DATE July 1980	PLAN NUMBER	S14987
CHECKED		

2034



Contour interval 20 metres ; Datum MSL
Surface subject to erosion where Namba Formation absent

PRE-MIOCENE STRUCTURE CONTOURS



Contour interval 20 metres ; Datum MSL
Surface subject to erosion where Eyre Formation absent

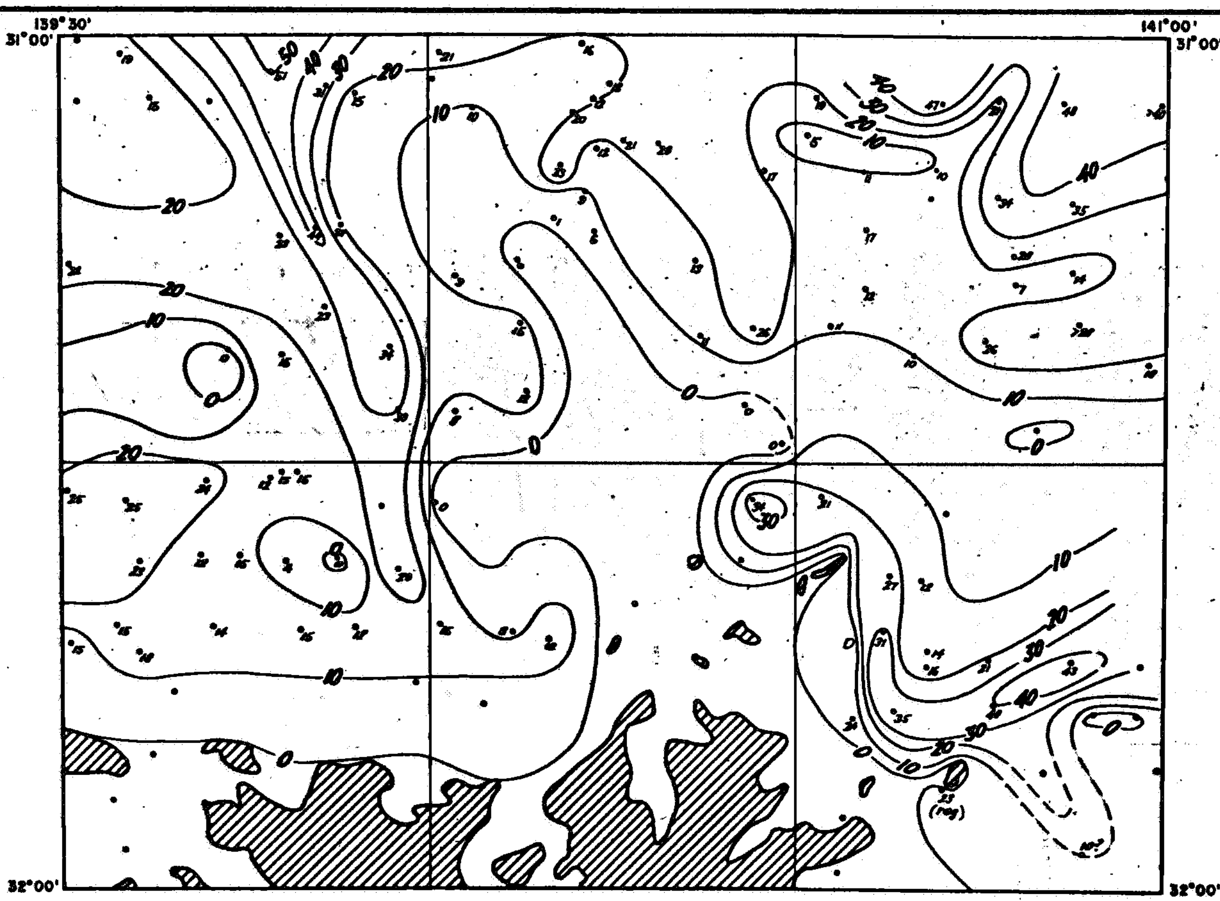
PRE-PALEOCENE STRUCTURE CONTOURS

Fig. 3

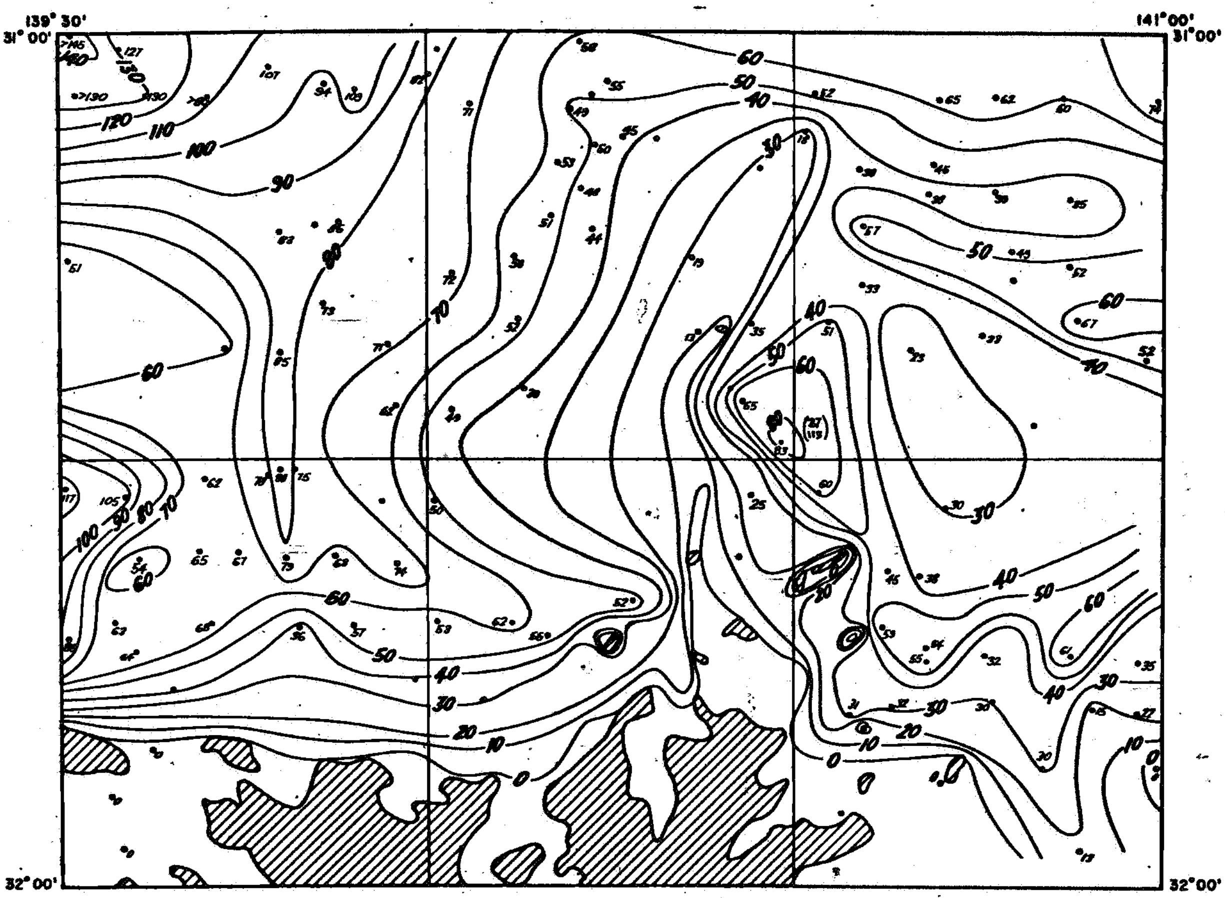
DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

CURNAMONA 1:250000 PROGRESS REPORT STRUCTURE CONTOURS OF THE PRE-MIOCENE and PRE-PALEOCENE SURFACE	COMPILED R.A.Callen A.Robertson	CDO 9-7-81 DATE
	DRAWN A.F.	SCALE 1:1000000
	DATE July 1980	PLAN NUMBER
	CHECKED	S14991

2034



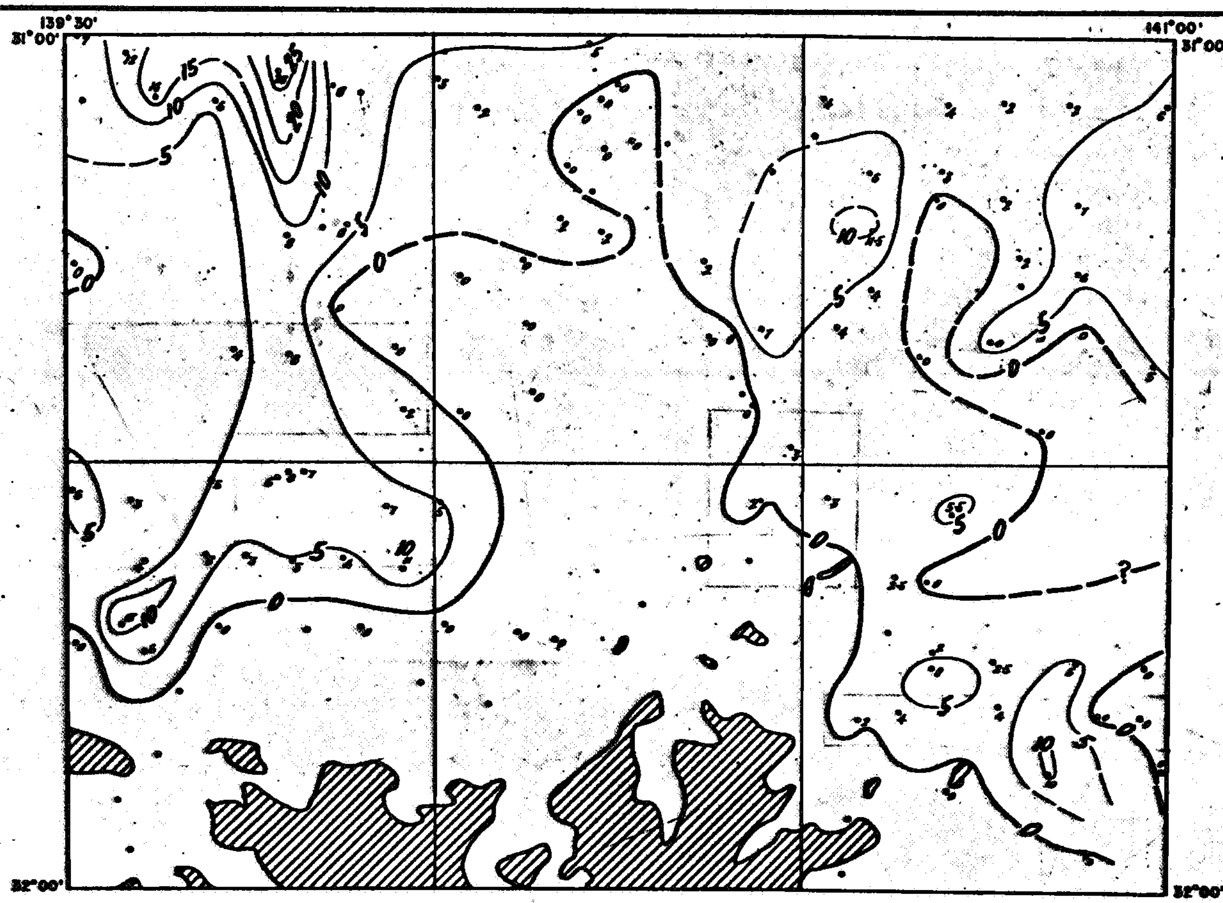
EYRE FORMATION ISOPACH MAP
Contour interval 10 metres



NAMBA FORMATION ISOPACH MAP
Contour interval 10 metres

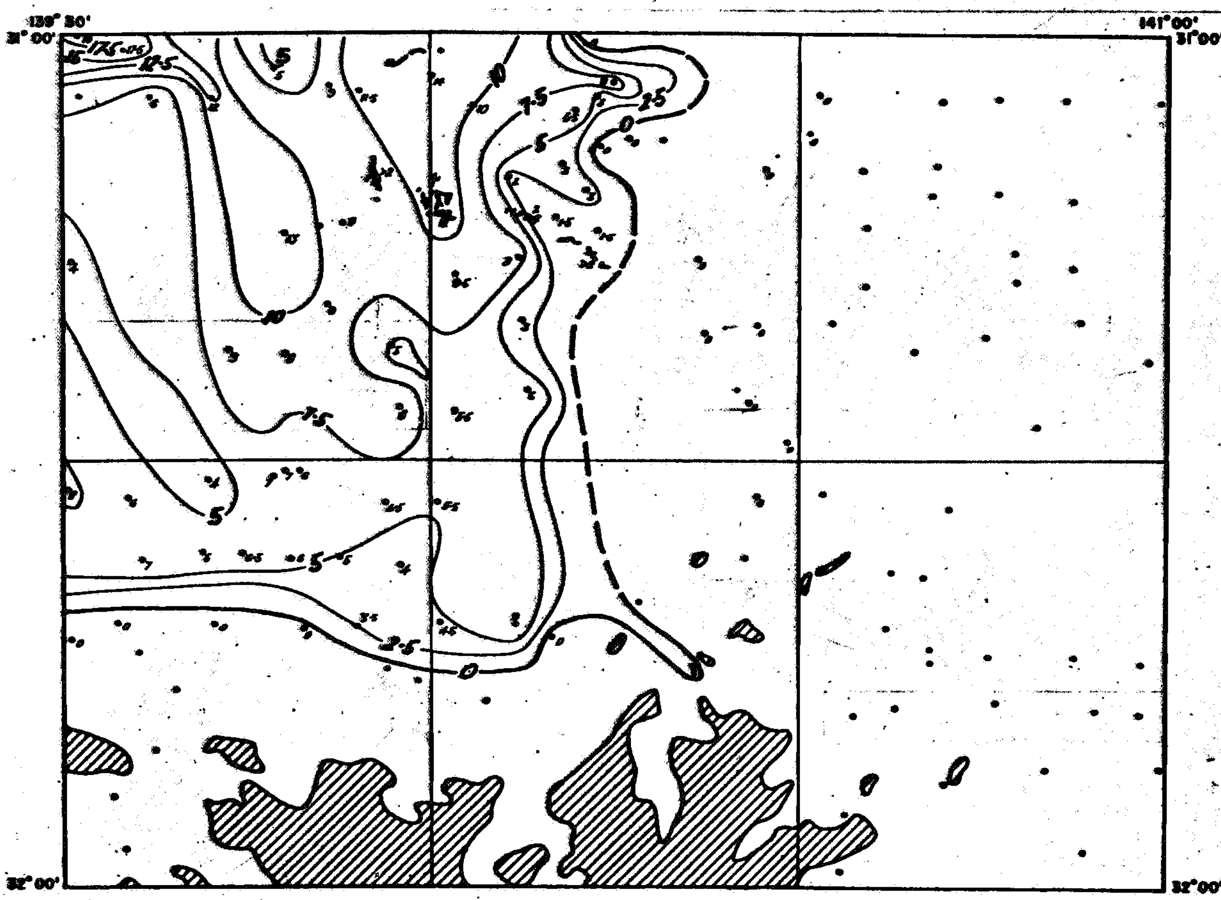
Fig. 4

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R.A.Callen A.Robertson	CDO 9·7·81 DATE
CURNAMONA 1:250000 PROGRESS REPORT	DRAWN A.F.	SCALE 1:1000000
EYRE FORMATION and NAMBA FORMATION ISOPACH MAPS	DATE July 1980	PLAN NUMBER
	CHECKED	S14988



ISOPACH MAP OF SAND (>2m thick sand beds, >50% sand) IN NAMBA FORMATION

Contour interval 5 metres



ISOPACH MAP OF DOLOMITE IN NAMBA FORMATION

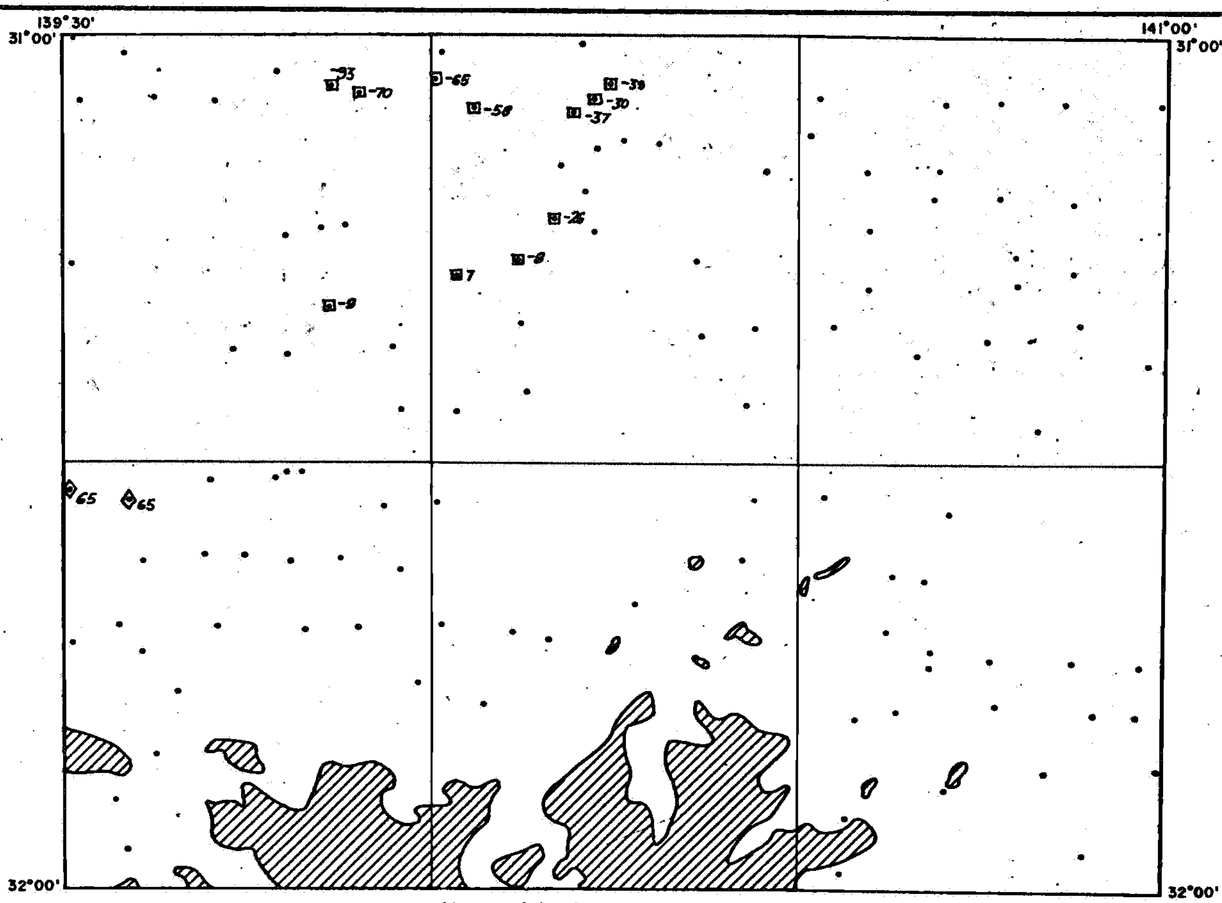
Contour interval 2·5 metres

Fig. 5

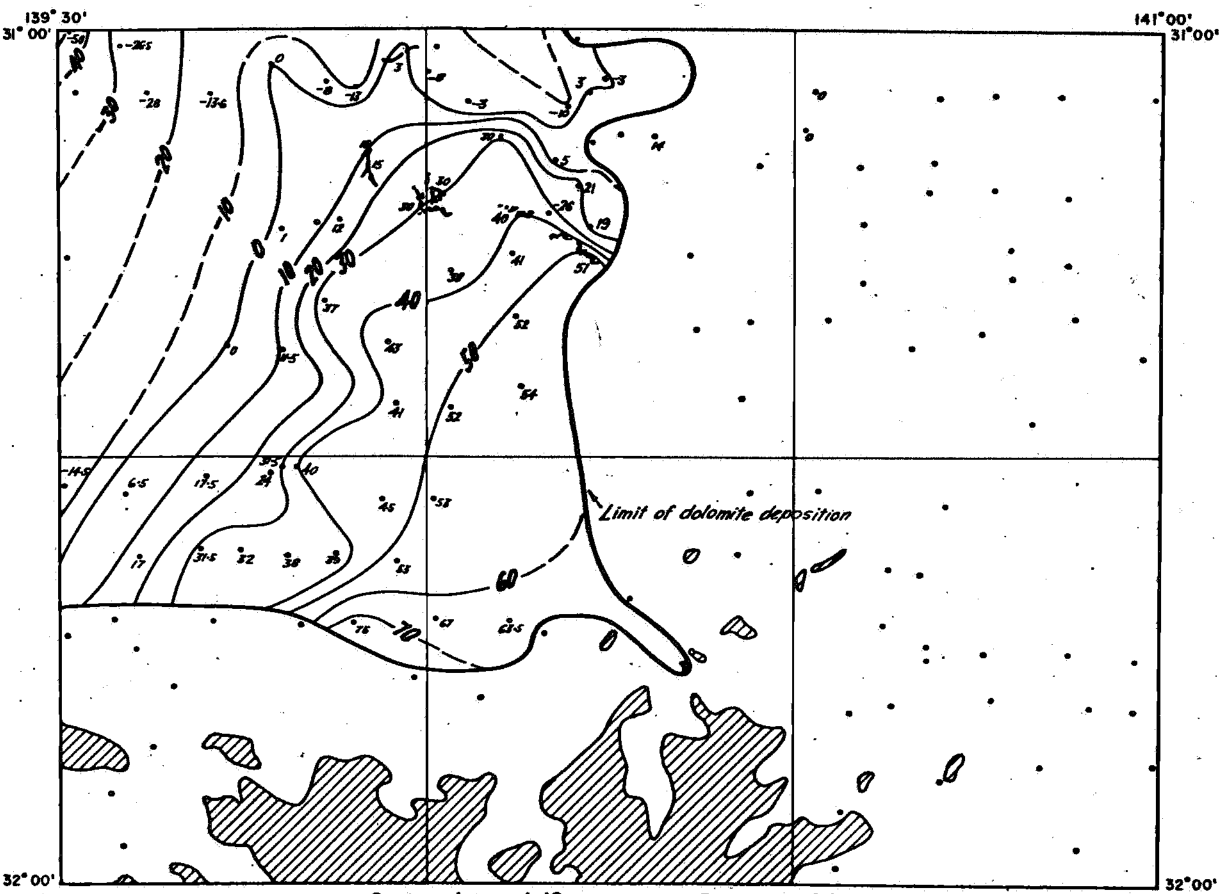
DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

CURNAMONA 1:250000 PROGRESS REPORT
ISOPACH MAPS OF DOLOMITE and SAND
IN THE NAMBA FORMATION

COMPILED R.A. Callen A. Robertson	C.D.O.	DATE 9·7·81
DRAWN A.F.	SCALE 1:1000000	
DATE July 1980	PLAN NUMBER	
CHECKED	S14992	



Upper dolomite .... ◇
Lower dolomite .... □



Contour interval 10 metres ; Datum M S L

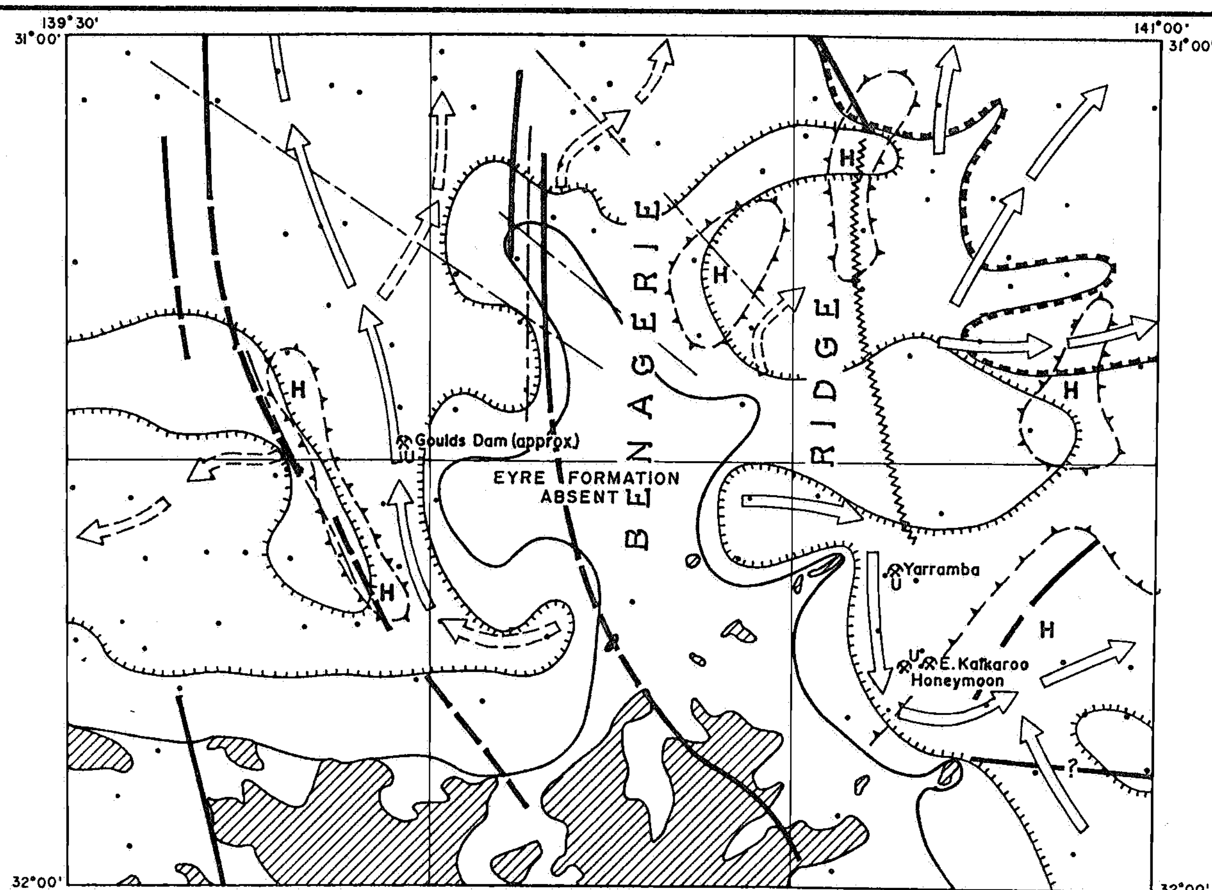
Middle dolomite

Fig. 6

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

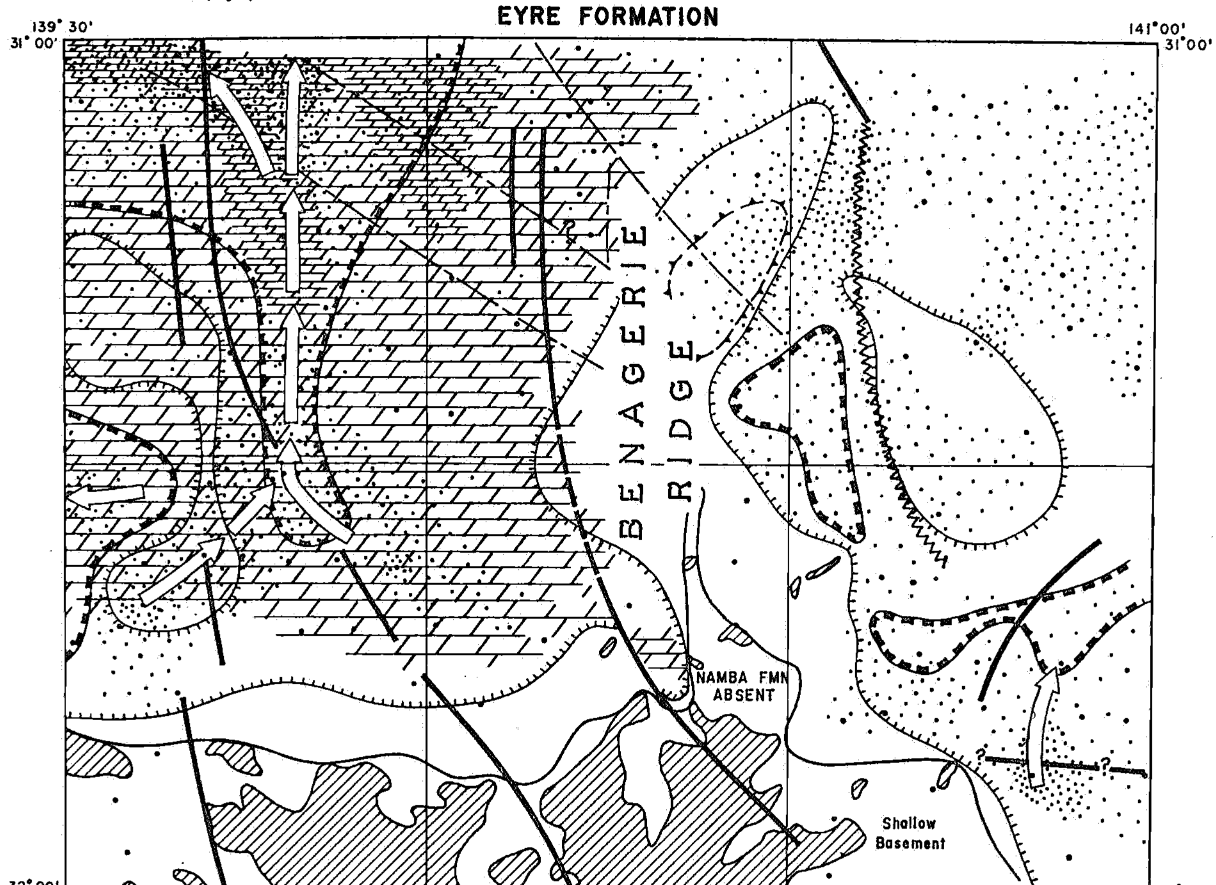
CURNAMONA 1:250 000 PROGRESS REPORT
STRUCTURE CONTOURS ON DOLOMITES IN THE NAMBA FORMATION

COMPILED R.A.Callen A.Robertson	C D O	9·7·81 DATE
DRAWN A.F.	SCALE 1:1000000	
DATE July 1980	PLAN NUMBER	
CHECKED	S14990	



River channel
Alternate channel route
Fault
Trend from topographic data
Aeromagnetic trend
Possible basement high (aeromag data)
Thin sequence on rises
Thick sequence in depressions

EYRE FORMATION



Possible channel trends
Fault
Trend from topographic data
Aeromagnetic trend
Possible basement high (aeromag data)
Thin sequence on rises
Thick sequence in depressions
Dolomite, sand distribution

NAMBA FORMATION

Fig. 7

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R.A. Callen A. Robertson	CDO	9.7.81 DATE
CURNAMONA 1:250000 PROGRESS REPORT	DRAWN A.F.	SCALE 1:1000000	
PALAEOGEOGRAPHIC, LITHOFACIES and STRUCTURAL INTERPRETATION OF THE EYRE and NAMBA FORMATIONS	DATE July 1980	PLAN NUMBER S14989	
	CHECKED		

2034

Qhs — Modern dune sands; bright red-brown fine sand, pale near playas and watercourses; sand spreads. Often includes upper units of Qc, then synonymous with SIMPSON SAND.

Qha — Stream bedload and younger terraces within present watercourses, with weak soil.

Qht — Scree, conglomerate, coarse sand of high angle slope deposits around Olary ranges.

Qh3 — Strandline deposits close to present shore of L. Frome. Red-brown to white sand. Locally abundant calcareous, tubular ?algal casts.

Qh2 — Patterned ground (gilgai) of Olary ranges; stone mounds parallel to contours in coarse red-brown sand. Dots show trend and are extended onto Qpe where Qh2 thin. Developed on proximal fan deposits.

Qh1 — Patterned ground: Thin sand sheets influenced by flooding from Barrier Ranges, N S W. Developed on distal fan deposits. Probably includes some Qc.

Ql — Undifferentiated playa lake deposits of Pliocene to Holocene age; laminated green to blue-black (pyritic) fine clastics and sedimentary gypsum. Red-brown to brownish-green, laminated, mud-cracked silt and clay with gravel deposits of fans marginal to L. Frome. Contains wedge-shaped gypsum crystal nodule horizons and carbonate nodules. Part equivalent to CZ2, Qpe, Qh. Spores and pollen, fish, ostracods, charophytes.

Qh — Undifferentiated brown sands. Probably includes upper portion of Qc. Rainsplash and sheetwash deposits, and marginal fan deposits. Characteristic columnar structure, locally abundant land snails and aboriginal artifacts. Mainly in depressions of western part of map. (Included in Qp1 of FROME).

CAINOZOIC — QUATERNARY — HOLOCENE / PLEISTOCENE

Q1 — As below with thin overlay of Qhs. Younger fan deposits around Olary ranges, south of southern limit of Qc.

Calcareous paleosols. At least four horizons from c.28000 yrs B.P. to 7000 yrs B.P. Upper horizons locally associated with emu eggshell, aboriginal artifacts and rounded pebbles. Nodular calcrete in western part of map and around margins of Olary ranges. Patchy and elongate centimetric white carbonate. (Sections and rock relation diagram only).

Qc — COONARBINE FORMATION (Qp1 of FROME). Aeolian sands, fine to medium grained, moderately well sorted, brown to reddish-brown. Forms cores of seif dunes. Chara oogonia abundant. Windblown gastropod shells in lower part. Locally abundant clay pellets. Land snails locally common.

Qps — Lunette sands and leeside mounds (Qp2 of FROME), of coarse gypsum, quartz, shell and clay pellets. Sandier away from lake. Cross-bedded on small and large scale.

Qpg — Wedge-shaped gypsum crystal rosettes of nodular or massive crust in basal Qpe.

Characteristic calcareous paleosol of Qpe ~45000 yrs B.P. Develops into massive calcrete in coarse facies. Characteristic white patchy segregations of lime of calcareous paleosol in upper part, weathering out as nodules. Section and rock relation diagram only.

Qpe — EURINILLA FORMATION (Qp4 of FROME). Clayey sand and silt, bright red-brown to dark brown, very poorly sorted, cross-bedded or laminated. Coarse channel deposits near base, finer floodplain facies at top. Grades into coarse fan deposits around margins of Olary ranges. Coarser facies massively cemented by gypsum or carbonate. Abundant chara oogonia, locally common vertebrates.

TERTIARY — PLIO-PLEISTOCENE

CZ2 — Undifferentiated lacustrine and fluviatile deposits of CZm and CZcs; outlines of channel facies.

CZcs — COOMBES SPRINGS FORMATION (Qp3, Qp5 of FROME). Shelly, well to moderately sorted, cross-bedded, thin bedded strand-line deposits. Brown to white or greenish. Locally coquina or chara oogonia limestone. Ostracods, bivalves, gastropods, charophytes, fish, emu egg shell. Limited to margins of L. Frome and L. Millyera.

Interbedded fine white sand and green laminated clay with sub-conchoidal fracture of lacustrine deposits. Fossils as above.

Basal, bright red-brown, poorly sorted silty sand as for Qpe, cemented by massive wedge-shaped gypsum crystal rosettes.

CZm — MILLYERA FORMATION (in part Qp6 of FROME). Finely laminated green clay, with sub-conchoidal fracture, lacustrine. Interbedded with charophyte stem mould limestone and rippled gypsum at top. Abundant ostracods and chara oogonia.

PASMORE RIVER AREA

CZ1 — Undifferentiated fluviatile deposits of CZw, CZp and Qpe of Pasmore River system, showing outline of channels mainly associated with Czp.

CZp — PASMORE CONGLOMERATE (partly Qp7 of FROME). Coarse sand to cobbles, well rounded, brown, with poorly sorted, tough, bright red-brown to greenish clayey sand and silt (as for Qpe lithology). Cemented by CZca and calcretes. Mainly of ancestral Pasmore River system in western part of sheet. Intertongues with CZcs.

CZw — WILLAWORTINA FORMATION: Red-brown pebbly, sandy clay, very poorly sorted, but moderately sorted coarse sands and pebble beds in channels. Massive, tough, with numerous hiatuses, carbonate nodules, greenish red, orange black mottles of paleosols and weathering horizons. Crudely bedded in outcrop, cross-bedded with fining upward sequences in cores. Bioturbated.

FIG. 8

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R.A.C.	9·7·81 — C D O — DATE
CURNAMONA 1:250 000 SHEET CAINOZOIC REFERENCE	DRAWN J.B.	SCALE
	DATE JULY 1980	PLAN NUMBER S14986
	CHECKED	

2034

2034

LAKE FROME AREA - MESOZOIC ROCK UNITS

	ROCK UNIT	SYMBOL	LITHOLOGY	FOSSILS	THICKNESS (METRES)	COMMENTS
CRETACEOUS	MARREE SUB-GROUP (MARREE FORMATION) (OODNADATTA FORMATION AND BULLDOG SHALE equivalent)	K1m	Monotonous sequence of dull greenish grey micaceous shale and siltstone, intraformational breccia, minor pebble beds.	Burrows, leaf impressions & carbonaceous material. Spores. Foraminafera	150-275	Often pyritic or ferruginous. Present in most deep bores, Sand beds may be Attraction Hill Sandstone in part.
CRETACEOUS / JURASSIC	?CADNA-OWIE FORMATION, formerly Pelican Well Formation ↓	K1c	Sandstone, micaceous, medium grained and subangular: interbedded with dull greenish-grey micaceous shale and silty shale; pebble and boulder beds common, some limestones.	Leaf and stem detritus, spores.	52 max.	

Table 1

MESOZOIC ROCK UNITS

CURNAMONA 1:250 000 PROGRESS REPORT

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

COMPILED R.A.C.	C.D.O. DATE 9.7.81
DRAWN S.R.	SCALE
DATE 7/8/80	PLAN NUMBER S14972
CHECKED	