DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Report Bk. No. 90/45
PALAEOZOIC SEDIMENTARY BASINS OF SOUTH AUSTRALIA

GEOLOGICAL SURVEY

by

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OCTOBER 1990 DME 120/87

A proposed publication for inclusion in `Phanerozoic of the World, Palaeozoic B' to be published by Elsevier.

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ELSEVIER CHAPTER   PHANEROZOIC OF THE WORLD, PALAEOZOIC B

INTRODUCTION

Widespread marine to paralic Cambrian-Ordovician strata form the major Early Palaeozoic succession in South Australia. The Late Palaeozoic succession consists chiefly of non-marine Late Carboniferous to Permian sediments although restricted marine facies are locally evident. Eight separate sedimentary basins have been defined for the thickest sequences (Fig. 1) but in the Early Cambrian, and again in the Early Permian, there was probably a degree of lateral continuity of deposition. Present basin outlines are thus partly the result of uplift and erosion in subsequent tectonic regimes. Only two in situ Devonian occurrences have been confirmed on fossil evidence although wider lithostratigraphic correlations have been suggested. Late Ordovician to Silurian and Late Devonian to Middle Carboniferous strata are unknown.

Early Palaeozoic Basins

The vertical stratigraphic record in the Early Palaeozoic is incomplete due not only to the effects of later erosion but also to non-deposition and syn-sedimentary tectonic activity in the Early Cambrian of the Arrowie and Stansbury Basins (Figs 2 to 5). Lack of diagnostic fossils in thick strata in the upper part of the Cambrian also hinders precise age determination. Examples are siliciclastic sediments in the eastern Officer Basin (Figs 8, 9) and Arrowie Basin where it is impossible to demonstrate continuity of deposition into the Ordovician. Ironically, Middle Cambrian to Early Ordovician marine fossils have been recorded from the eastern Warburton Basin (Figs 6, 7), but because of its deeply buried position beneath the Late Palaeozoic Cooper Basin (Figs 13 to 16) any downward extension of the stratigraphic record into the Early Cambrian is beyond depths currently drilled in petroleum wells.

Away from the relatively well-known exposures in the Delamerian fold belt, Cambrian-Ordovician outcrops are extremely sparse, being restricted to thin Early Cambrian on the Stuart Shelf and Early Cambrian to Ordovician in the eastern Officer Basin. A great deal of reliance is thus placed on information from petroleum, mineral, and stratigraphic drilling, and from seismic surveys. Recent subsurface exploration in the eastern Officer Basin has greatly improved the understanding of that region while Warburton and Arrowie Basin geology has advanced gradually with the progression of petroleum and mineral exploration. Major gaps still exist in our knowledge of the western Warburton Basin; and the southeastern limits of the Stansbury Basin remain obscured by Tertiary sediments.

Notwithstanding these obstacles, the Early Palaeozoic succession in South Australia has one major advantage over rocks of comparable age elsewhere, that is its remarkable state of preservation. Except for Kanmantoo Trough metasediments in the southern Mount Lofty Ranges, the Early Palaeozoic has escaped severe orogenic deformation, even within the Delamerian fold belt; exposures in the Flinders Ranges in particular have become classic areas for the study of Cambrian fossils, sedimentary facies, and environments of deposition.

<u>Arrowie Basin</u>

Early Cambrian sedimentation commenced unconformably over Adelaidean (Wilpena Group) strata in the Arrowie Basin. As defined by Wopfner (1969,1972), thicker basinal sediments are bounded to the west by the Torrens Hinge Zone and extend eastward across the central and northern Flinders Ranges, over the substable Curnamona Cratonic Nucleus and Benagerie Ridge, to the Barrier Ranges in northwestern New South Wales (Fig. 2). Thinner equivalents occur in the Stuart Shelf, also included in the Arrowie Basin by Youngs and Moorcroft (1982). A southwestern connection with the Stansbury Basin is established from fossil evidence, but to the southeast the Arrowie Basin onlapped Adelaidean cover on the Willyama Block. The northern limit of the Arrowie Basin is placed arbitrarily at the Lake Blanche Lineament (Youngs and Moorcroft, 1982), an extension of the Lake Eyre Lineament, but continuous marine sedimentation is likely via the Warburton Basin from as far north as the Georgina Basin in Queensland. Sediments older than Middle Cambrian have not yet been confirmed in the Warburton Basin because drillholes have not penetrated sufficiently deeply. Deposition is likely to have ceased in the Arrowie Basin by the Middle to Late Cambrian with the onset of the Delamerian Orogeny.

Arrowie Basin sediments were deposited on the eastern seaboard of the Gawler Craton (Jenkins and Gravestock, 1988) in two contrasting but conformable thick sedimentary packages. The lower package (Hawker Group to Wirrealpa Limestone) is wholly Early Cambrian in age and is carbonate-dominated, while the upper package (Lake Frome Group) of early Middle to Late Cambrian age consists primarily of siliciclastics (Fig. 3).

The basal unit, the Uratanna Formation (Daily, 1973), filled depressions and channels, incised into the late Precambrian (Ediacaran) Rawnsley Quartzite, with sandstone and shale. Uratanna Formation and Adelaidean strata were overlain by extensive trace-fossil bearing strandline sandstone of the Parachilna Formation (Dalgarno, 1964) which grades up into peritidal carbonate of the Woodendinna Dolomite and Wirrapowie Limestone (Haslett, 1975). The stromatolitic and subtidal oolitic muddy tidal flats represented by Woodendinna Dolomite have also been mapped as basal units of the Ajax and Wilkawillina Limestones. Similar but younger facies characterise the Andamooka Limestone on the Stuart Shelf west of the Torrens Hinge Zone (Fig. 2). The richly fossiliferous bulk of Ajax and Wilkawillina Limestones accumulated in a wide shallow-marine platform setting with a variety of bioherms and bioherm complexes constructed by calcified cyanobacteria, archaeocyaths and sponges in varying proportions (James and Gravestock, in press). During the Early Cambrian, differentiation between shallow platform and deeper slope and basinal carbonate became more pronounced. At this time a platform margin developed about a broad east-west hinge zone in the northern Flinders Ranges, and locally, spectacular megabreccias accumulated downslope from the platform edge (e.g. Moorowie Formation, Mount, 1970). Elsewhere, slope carbonate of the underlying Parara Limestone prevailed (Clarke, 1986a,b). Oraparinna Shale was deposited in more basinal regions but also intertongued with platform sequences, and shows evidence of upward shallowing towards the top.

The upper platform units of the Hawker Group were deposited as a generally regressive sequence with shelf-margin reef limestone giving way to stromatolitic and evaporitic limestone and dolostone. At several widespread localities this sequence is underlain by calcareous sandstone and carbonate-breccia channel fill which may represent proximal facies of the prograding Narina Greywacke. Erosional channels cut the Moorowie Formation and comprise the basal Coads Hill Member of the Oraparinna Shale (Mount, 1970; Moore, 1980). These sandy units were deposited in response to a tectonic phase known as the Kangarooian Movements (Daily & Forbes, 1969) which is widespread in the Arrowie Basin as well as in the Stansbury Basin in the vicinity of Yorke Peninsula and as far south as Kangaroo Island. Tuffaceous horizons in the upper Parara Limestone, Narina Greywacke and Coads Hill Member attest to contemporaneous volcanism. The overlying Billy Creek Formation (Daily, 1956) is a coarsening-upwards but nevertheless chiefly fine-grained, shallow, marginal-marine to paralic deposit which accumulated in response to the same tectonic uplift (Moore, 1979). Overlying the widespread Billy Creek Formation is the Wirrealpa Limestone and Aroona Creek Limestone, in the east and west respectively, of the Arrowie Basin. Predominantly shallow-water marine carbonate, these units represent a thin (75 to 140 m) transgressive complex (Youngs, 1977).

The Lake Frome Group represents a return to clastic deposition with only a minor carbonate component. Feldspathic sandstone (Moodlatana Formation) is overlain by a cyclic succession of shale and thin carbonate (Balcoracana Formation), followed by sandstone which becomes coarser in upper units (Pantapinna Sandstone). The uppermost unit, the Grindstone Range Sandstone, may represent uplift associated with initial stages of the forthcoming Delamerian Orogeny. Pebbly quartzite beds characterise this formation, which is fluvial in part.

Stansbury Basin

The Stansbury Basin of Early to Middle Cambrian age developed as the southeastern margin of the Gawler Craton subsided (Fig. 4). Preserved sediments (Fig. 5) cover approximately 10 000 km^2 from a western margin on Yorke Peninsula, beneath Gulf St Vincent to Fleurieu Peninsula. At the western margin, Early Cambrian sediments onlap Adelaidean rocks and onto the basement of the Gawler Craton. Shallow shelf sediments initially were probably contiguous with platform carbonate of the Arrowie Basin to the north. The southeastern part of the basin opened into the Kanmantoo Trough late in the Early Cambrian epoch and were characterised by rapid influx of siliciclastics.

Deposition commenced with the Winulta and Mount Terrible Formations (Daily, 1963b; 1976) unconformably on Precambrian sediments of the Adelaide Geosyncline and crystalline basement. These clastic units consist of marine arkosic sandstone, siltstone, and conglomerate representing regional transgression on to the craton margin. Clastic sediments were quickly replaced by shallow-marine carbonate, reflecting moderate energy conditions on a shelf several tens of kilometres wide. Variations in sediment supply and subsidence rate, with continued transgression, led to differentiation of facies belts parallel to the palaeoshoreline. Adjacent to the craton, moderate to high energy shallow shelf facies of the upper Kulpara Formation were overlain by low energy lagoonal to marine nodular wackestone and archaeocyath-algal bioherm complexes of the Parara Limestone. Seaward of the shelf, the vertical facies sequence on Fleurieu Peninsula indicates development of a deepening carbonate ramp characterised by ribbon limestone with storm and slide breccias, and isolated archaeocyathan- sponge mud mounds (Sellick Hill Formation), coalescing mound complexes and sparsely fossiliferous mottled limestone (Fork Tree Limestone) passing into the open marine Heatherdale Shale (Abele and McGowran, 1959; Daily, 1963b; Jago et al., 1984; Debrenne and Gravestock, in press; Alexander and Gravestock, in press).

On northern Yorke Peninsula, disconformity is represented by red haematite-rich microstromatolites several centimetres thick, capping solution-sculptured Kulpara Formation and underlying the Parara Limestone at its type locality near Ardrossan. This horizon is absent in cored drillholes 40 km to the south where a conformable boundary between the formations is indicated on fossil evidence (Zhuravlev and Gravestock, in prep.), suggesting that the base of the Parara Limestone is diachronous. An almost identical reddened horizon occurs at a slightly higher stratigraphic level over a wide area in the Arrowie Basin where it is associated with limited, though locally spectacular, karst development.

While Parara Limestone was being deposited on northern Yorke Peninsula, the Heatherdale Shale accumulated on Fleurieu Peninsula. Further north in the Kanmantoo Trough, 75 km northeast of Adelaide, the Truro Volcanics are interbedded with and intrude Heatherdale Shale. Several tuff beds, no more than 30 cm thick, have been found in Parara Limestone drillcore on Yorke Peninsula, suggesting limited intermittent extrusive volcanism late in the Early Cambrian. The calcareous, phosphatic and pyritic Heatherdale Shale has locally abundant trace-fossils and a sparse shelly fauna (Jago et al., 1984). Rare trilobites suggest an open marine setting and, presumably, relatively deep water (base of ramp) in the type area near Sellick Hill. Further north however, shallower conditions may have prevailed near volcanic centres not yet located. It is on this unit that the Kanmantoo Group began to accumulate (Daily and Milnes, 1971, 1973) towards the end of the Early Cambrian.

Kanmantoo Group sediments metamorphosed during the Delamerian Orogeny have not yet yielded age-diagnostic fossils. Suggested environments of deposition range from deep-sea fans on Kangaroo Island (Flint, 1978) to the Inner or Middle-fan Association of Mutti and Ricci Lucchi (1972) at Carrickalinga Head.

On the south coast of Fleurieu Peninsula, the Madigan Inlet Member is possibly a Middle-fan Association (Gatehouse et al., in press). On Kangaroo Island, Daily et al. (1979) indicated that water depths were `relatively shallow', while below wave-base flaser and linsen-bedded fine-grained sandstones have been recognised in the Mount Lofty Ranges in the Carrickalinga Head Formation (Gatehouse et al., in press).

On Yorke Peninsula the Parara Limestone was overlain conformably by the Minlaton Formation in persistently subsiding areas, but localised uplift along structurally high corridors of the Pine Point Fault Zone led to erosion of previously deposited Parara Limestone, Kulpara Formation, and even of basement gneiss, resulting in syn-tectonic alluvial fan and fan-delta conglomerates interbedded with sandstones and shales. This episode of tectonic activity was named the Kangarooian Movements by Daily and Forbes (1969). The Minlaton Formation is a heterogeneous unit composed of these conglomerates, redbeds, bioturbated calcareous siltstone, limestone, stromatolitic dolostone, and interbedded anhydrite deposited on restricted evaporitic mudflats.

A return to marine conditions resulted in deposition of the richly fossiliferous late Early Cambrian (Toyonian=Ordian) Ramsay Limestone which is correlated on fossil evidence with the widespread Wirrealpa and Aroona Creek Limestones of the Arrowie Basin (Daily, 1956; Horwitz and Daily, 1958). At least 700 m of redbeds and minor limestone were deposited above the Ramsay Limestone under shallow marine to subaerial conditions as evidenced by desiccation cracks and sparse trilobite trails. The uppermost redbed unit (Yuruga Formation, Jago and Daily, 1982) contains interbedded poorly sorted breccia, principally of basement gneiss, suggesting recurrence of the Kangarooian Movements beyond the Early Cambrian, but there is no biostratigraphic evidence as to how young this unit is. As far as is known, the Yuruga Formation was the last unit deposited in the Stansbury Basin on Yorke Peninsula prior to the onset of the Delamerian Orogeny in Late Cambrian time.

Warburton Basin

The wholly subsurface Warburton Basin occupies about 175 000 km^2 in northeastern South Australia and extends into the Northern Territory, Queensland and perhaps into northwest New South Wales (Figs 1, 6). The basin limits are poorly understood. It contains sediments, igneous intrusive and extrusive rocks ranging in age from Early Cambrian through to Middle Carboniferous and has been subjected to mild metamorphism in the hottest, most deeply buried troughs. At shallow depths (~2000 m) the sediments have undergone burial diagenesis but are not metamorphosed.

Few drillholes have penetrated deeply into the basin and seismic exploration has only recently been able to produce records of sufficient quality to elucidate structure beneath the Cooper Basin. Wopfner (1969, 1972) first defined the basin; Gatehouse (1983, 1986) reviewed the geology based on drilling and seismic exploration to 1982.

The Warburton Basin is an early Palaeozoic pericratonic region known to contain Cambrian carbonate, clastic and volcanic sediments, Ordovician and possibly Devonian clastic units (Fig. 7). Sedimentation older than early Middle Cambrian has not yet been recognised, but older Cambrian strata peripheral to the Warburton Basin occur to the west near Marla (Jago and Youngs, 1980; Brewer et al., 1987) as well as in the Arrowie Basin to the south and southeast. Whether these areas connected with the Warburton Basin is not yet established but palaeogeographic reconstructions suggest this should have been the case (Jenkins and Gravestock, 1988).

Initial development of the Warburton Basin may have begun in latest Proterozoic or Early Cambrian time, by analogy with late Proterozoic (Adelaidean) events in the Flinders Ranges (Preiss, 1987; Gravestock in Jenkins and Gravestock, 1988). The Bancannia Trough (Scheibner, 1972) opened up at about this time (though Webby (1982) suggests otherwise).

The Early? Cambrian Mooracoochie Volcanics occur along the Gidgealpa Volcanic Arc and may correlate with the Mount Wright Volcanics in northwest New South Wales (Gatehouse, 1986). Throughout Middle and Late Cambrian time the Gidgealpa Volcanic Arc was the site of shallow marine deposition. The Kalladeina Formation accumulated on this broad arcuate ridge predominantly as ooid/oncolite shoals and ripple-laminated fine sand and mud. Adjacent slope facies consist of dark organic-rich lime mudstone with large blocks of lithified limestone derived from the shelf. Both shelf and slope facies are interbedded with tuff and ignimbrite (Gatehouse, 1986).

Thick carbonate, mostly dolomitised and grainstone, of Late Cambrian age was intersected in Coongie 1, Cuttapirrie 1 and others in the vicinity (Fig. 6). Palaeogeographic reconstructions are shown by Gatehouse (1986).

The Ordovician Dullingari Group accumulated on the eastern and western flanks of the Gidgealpa Volcanic Arc. Minimal information is available from areas to the west. To the east, shallow-water facies of clean sandstone and green siltstone apparently pass into basinal black pyritic shale and then into another shallow-water facies belt near and on the Gnalta Shelf (Fig. 6; Gatehouse, 1986, fig. 1) further to the east.

The age determination of the Dullingari Group is based on poorly preserved graptolites. In Pandieburra 1, Daily (1963) gave a 'Lower to Middle Ordovician age', while in Dullingari 1, Öpik and Jones (1962) suggested a Middle to early Late Ordovician age. More recently Cooper (1986) determined, on a small conodont fauna, an early Arenig age for core in Packsaddle 1.

The `Innamincka Red-Beds' occupy an uncertain position in the stratigraphic column. Although initially determined by Ludbrook (1961) as possibly Devonian, no further evidence is forthcoming to prove or disprove this. The distribution of the `Innamincka Red-Beds' is restricted to a present-day subsurface feature, the Gidgealpa-Merrimelia-Innamincka (GMI) Trend (Fig. 13) which passes through Gidgealpa 1 and Packsaddle 1. The unit seems to have been deposited in a predominantly shallow open marine environment.

Granite has been encountered at the base of several drill-holes and geochronology has been attempted. Martin (1967) gave a biotite K-Ar age of 305 Ma for the granite at Moomba 1. More recently a whole-rock Rb-Sr dating gave values of 333 to 362 Ma depending on the initial ratio assumed (Webb, 1974). Granite at MacLeod 1, using U-Pb isotopic analysis of zircons, gave an age of 310$\pm$17 Ma (Fanning, 1986), i.e. Middle Carboniferous. The timing of granite emplacement compares well with the Alice Springs Orogeny of central Australia and the Kanimblan Orogeny of southeast Australia.

Eastern Officer Basin

Early Palaeozoic rocks of the 200 000 km^2 Officer Basin in South Australia disconformably overlie Late Proterozoic sediments and both are thought to onlap Early? Proterozoic crystalline basement of the Ammaroodinna Inlier (Krieg, 1972) and Gawler Craton. However, the northern margin adjacent to the Musgrave Block has been overthrust and the eastern margin is now largely faulted against the Gawler Craton, so that depositional relationships are obscure. The western margin in Western Australia abuts the Archaean Yilgarn Block and outcropping Early to Middle Proterozoic sediments. The Coompana Block forms the southwestern limited of the basin close to the Western Australia border. Possible connections with the Canning Basin to the northwest region have yet to be clarified. Structural elements of the South Australian portion of the Officer Basin are shown on figure 8.

Uncertainty exists as to the continuity between Officer Basin and Warburton Basin sediments east of the Marla area (Figs 8, 9, 18) because of limited outcrop and drilling.

The Munyarai Trough contains the thickest accumulation of sediment (Fig. 8), much of which is of Adelaidean (Late Proterozoic) age. Thinner Cambrian units extend southwest and south onto the Murnaroo Platform although there are indications of thickening south of and onto the Yalata Platform. Seismic evidence indicates that a relatively thick sequence is also preserved in the Tallaringa Trough.

Early Cambrian Relief Sandstone, the oldest unit of the Marla Group, is clean in its lower parts (Brewer et al., 1987), while the upper levels of the unit in Giles 1 (Stainton et al., 1988) are interbedded siltstone and sandstone. The overlying Ouldburra Formation represents shallow marine conditions in the northeast, while its partial equivalent, the lower part of the Observatory Hill Formation, formed a widespread low-energy and terrestrial environment over much of the eastern Officer Basin (Brewer et al., 1987). Archaeocyaths and trilobites in the Ouldburra Formation indicate an Early Cambrian age (Dunster, 1986; Brewer et al., 1987; Jago and Youngs, 1980).

While the Ouldburra Formation and its equivalent were accumulating, episodic ingressions crossed the Yalata Platform over the Watson High into the Tallaringa Trough. In this area, limited egress of seawater and high evaporation rates produced thick halite deposits interbedded with dolomitic mudstone (e.g. Wilkinson 1).

In contrast, the upper part of the Observatory Hill Formation was deposited under regressive conditions indicated by the Oolarinna Member (Benbow, 1982), playa lake sediments in the Parakeelya Alkali Member with chert nodules, dolomite, trona and shortite (White and Youngs, 1980), and the Moyles Chert Marker Bed (Brewer et al., 1987). Alluvial fan conglomerates of the Wallatinna Formation accumulated locally on the northern margin of the playa lake system (Benbow, 1982).

The widespread Arcoeillinna Sandstone was deposited probably in a fluvio-lacustrine environment with evidence of aeolian influence (Benbow, 1982). Trainor Hill Sandstone is the uppermost unit of the Marla Group. The environment of deposition is suggested as fluvial or possibly deltaic (Benbow, 1982). Regression and erosion produced a significant break in the succession at this level (Fig. 9). The Munda Group commenced locally with the fluvial Byilkaoora Formation in the northeast. Marine transgression led to tidal or deltaic/tidal-flat conditions for the Mount Chandler Sandstone, which is quartzose and contains Skolithos and Diplocraterion burrows (Benbow, 1982). With increasing water depth, deposition of the Indulkana Shale followed. Several depositional sequences continued through Ordovician time during which Blue Hills Sandstone and the Cartu beds accumulated. No Silurian sediments have been recognised in the Munyarai Trough but fish-scales and other fragments of early Middle Devonian age occur in unnamed sediments in Conoco Munyarai 1 (Long et al., 1988).

In the northeastern Officer Basin the Mintabie beds of possible Devonian age were deposited (Krieg, 1973). Festoon cross-bedded sandstone with shaly and clay-rich sandstone interbeds are thought to have accumulated in a deltaic environment. This was followed by the Waitoona beds, a sandstone/conglomerate sequence which appears to have been locally derived (Krieg, 1973).

Correlation of the eastern Officer Basin succession with the western part of the basin and adjacent areas relies on lithology and sequential superposition, as palaeontological evidence is generally lacking. The Kulyong Volcanics (Table Hill Volcanics in Western Australia), possibly of Ordovician or Cambrian age, outcrop west of Birksgate 1 and are not found further east (Major and Teluk, 1967). In Cootanoorina 1 in the Boorthanna Trough (Figs 10 and 11), the Cootanoorina Formation of Cambrian or Devonian age was intersected. Correlation of this occurrence with other rocks in adjacent basins is uncertain.

Radiometric age-dating on Phanerozoic rocks from this basin is limited to a few samples only. A Middle Ordovician age of 460$\pm$15 Ma (I.R. Sr87/Sr86 0.7128$\pm$0.0022) has been calculated from a well-fitted whole-rock isochron on Indulkana Shale (Webb, 1978).

Tectonism has only mildly affected the western and southern areas but to the north and east, faulting, overthrusting, and folding are evident. The Karari Fault Zone appears to have bounded a half-graben and the Tallaringa Trough may have extended further east. Rankin et al. (1989) interpret the Karari Fault Zone as a Proterozoic high-angle thrust with post Cambrian normal movement. Under north-south compression during the Alice Springs Orogeny, the Musgrave Block was thrust over the northern Officer Basin margin (Milton and Parker, 1973), causing localised faulting and folding in the Mount Johns area.

Late Palaeozoic Basins

Late Palaeozoic strata crop out in localised areas in southern and northwestern South Australia. The best known are Late Carboniferous to Early Permian, almost unconsolidated, sediments on Fleurieu and Yorke Peninsulas and on Kangaroo Island. Those on Fleurieu Peninsula are historically significant as the first glacigene deposits discovered in the State (David and Howchin, 1897). These outcrops, together with an occurrence near the Peake and Denison Inliers (P. Macdonald, unpublished data), are the few places in South Australia where glacial geomorphology (striated pavements, exhumed valleys) can be studied. Permian sediments on Fleurieu Peninsula have been assigned to the Troubridge Basin (Sprigg and Stackler, 1965) but are outlying remnants of a sequence whose depositional geometry is as yet too poorly known to discuss here in the context of a basin. Other outcrops have been documented from the margins of the Arckaringa Basin (Figs 10 to 12) (Ambrose et al., 1981; Barnes et al., 1977) and from the flanks of a steeply dipping piercement structure in the Boorthanna Trough (Freytag, 1965). Isolated occurrences of possible Late Palaeozoic rocks (Alpana Formation) have been described from the Flinders Ranges (Coats, 1962; Morton et al., 1984) and in the Mulgathing Trough (Daly, 1981, 1985; Nelson, 1976).

The thickest and stratigraphically most complete Permian sequences occur at depth in the Cooper, Pedirka, and Arckaringa Basins, where they are unconformably overlain by Jurassic - Cretaceous sediments of the Eromanga Basin. Late Triassic sediments overlie part of the Cooper Basin which is completely concealed by Mesozoic and Tertiary strata. The basin is an important producer of natural gas (discovered in 1963) and oil (discovered in 1970). Over 600 petroleum exploration and development wells have been drilled in the area, and numerous seismic surveys conducted.

Geophysical surveys, petroleum, coal, and stratigraphic drillholes have greatly enhanced knowledge of the Pedirka and Arckaringa Basins, however they are poorly known compared with the Cooper Basin.

Permo-Carboniferous deposits have also been intersected in drillholes beneath Mesozoic strata in the Officer (Benbow, 1986), Eucla (Harris and Ludbrook, 1966) and Murray Basin regions (Thornton, 1974), and in the narrow fault-bounded Polda Basin which cuts across the southern Gawler Craton to extend westward offshore beneath the Great Australian Bight (Cooper et al., 1982; McClure, 1982a,b).

Arckaringa Basin

The Arckaringa Basin is a Late Palaeozoic, predominantly non-marine to marginal marine intracratonic basin of about 75 000 km^2 in central northern South Australia (Fig. 10). The basin consists of the Boorthanna Trough, Phillipson Trough, and the northern extension of the Tallaringa Trough, surrounding the Mabel Creek High (Townsend, 1976; Moore, 1982). Benbow (1983) showed a complex basement structure north of the Gawler Craton with trends subparallel to its margin.

Sediments have been assigned to the Boorthanna, Stuart Range, and Mount Toondina Formations (Fig. 11). The Late Carboniferous to Early Permian Boorthanna Formation is disconformable on older Palaeozoic sediments, and nonconformable on crystalline rocks of the Gawler Craton. The Boorthanna Formation is divisible into three lithologically distinct members. The shaly basal member in Boorthanna 1 drillhole (Homes and Rayment, 1970) contains pebbles of Precambrian crystalline basement rocks near the top. Seismic evidence suggests that this unit is confined to the Boorthanna Trough (Moore, 1982). The middle member, a diamictite of pebbles and cobbles in a clay matrix, is restricted to the Boorthanna and Phillipson Troughs (Allchurch et al., 1973; Ludbrook, 1961). The fining- upwards, upper sandy member commences with a basal conglomerate. Several fining-upwards cycles are apparent (Moore, 1982). Wopfner (1970) interpreted the unit as a proximal turbidite sequence with clasts of metamorphic and igneous origin presumably from the Gawler Craton.

A possible marine flooding event led to accumulation of the Stuart Range Formation for which Moore (1982) suggests a quiet-water marine origin (Fig. 11). Ludbrook (1961) assigned the Stuart Range Formation to Early Permian (Sakmarian to Artinskian) based on foraminifera. Stage 2 age and Stage 3 palynological ages are indicated (Evans, 1969; Harris and McGowran, 1973; Gilby and Foster, 1988).

The conformably overlying Mount Toondina Formation is divided into two units - the lower member is sandy and contains no coal seams while the upper member is highly carbonaceous shale with numerous coal seams. The environment of deposition changes progressively from lacustrine at the base to paludal towards the erosional top. The Arckaringa Basin is unconformably overlain by sediments of the Jurassic-Cretaceous Eromanga Basin (Fig. 12).

Pedirka Basin

The Pedirka Basin (Canaple and Smith, 1965; Wopfner, 1972) is a Late Carboniferous to Early Permian sequence beneath the western Eromanga Basin (Fig. 10). The total area is approximately 150 000 km^2 of which about one third lies in South Australia. The northwestern basin limits were defined by outcrops in the Northern Territory (Wells et al., 1970), and are now known from seismic and drilling data to be much less extensive to the south and east than once thought (Giuliano, 1988). Principal structures within the basin include the Eringa Trough to the west and the McDills Trend in the Northern Territory (Fig. 10) which is probably a northerly extension of the Peake and Denison Inliers.

Subsurface data are sparse and rock relationships are poorly understood. The sediments, from occurring at shallow depths of only several hundred metres in the west, occur at depths of more than 2500 m in the east (Youngs, 1976a). Stratigraphic thickness is known to be about 700 m and there is a strong possibility of a former connection to the Arckaringa Basin west of the Peake and Denison Inliers. Whether or not this connection has survived subsequent erosion is unknown.

The Pedirka Basin overlies older Palaeozoic sediments which were deformed by the Early Carboniferous Alice Springs Orogeny (Youngs, 1976b). Permo-Carboniferous sedimentation occurred during a compressive phase with basin limits and structural style largely controlled by pre-existing tectonic trends (Youngs, 1976a; Wopfner, 1981, 1985).

Only two stratigraphic units have been assigned to the Pedirka Basin. They are the Crown Point and Purni Formations (Figs 11, 12) (Townsend, 1976; Youngs, 1975).

The Crown Point Formation comprises glacially associated or glacially derived diamictite, sandstone, and siltstone with varve-like bedding (Giuliano, 1988). It terminated with a clean sandstone upon cessation of glacial activity and this sandstone may be equivalent to the Tirrawarra Sandstone of the Cooper Basin (Giuliano, 1988). In Mount Hammersley 1 in the Eringa Trough the Crown Point Formation is 701 m thick which is the thickest known intersection.

The Purni Formation (Youngs, 1975) consists of three unnamed units (Fig. 11). Youngs inferred a northerly sediment source from conglomeratic bands and sandstone percentages. The lower marine unit comprises shale and kaolinitic sandstone with minor coal seams deposited in a fluvial environment.

The middle member is commonly cross-bedded and contains fining-upwards packages of sandstone, shale, and coal consistent with a moderate-energy meandering fluvial system with channel-fill, point-bars and associated lag deposits (Giuliano, 1988).

The upper member with its coal seams, low-angle and planar cross-beds and slump structures has been attributed to a paludal to flood plain environment.

<u>Cooper Basin</u>

The Cooper Basin occupies a northeast trending depression straddling the S.A.-Qld border and covers about 130 000 km^2 with only one third in South Australia (Fig. 13). Sedimentation was initiated on an erosional surface on the Warburton Basin in the Late Carboniferous and continued, with minor breaks, into the Triassic.

The basin contains three troughs - the Patchawarra, Nappamerri, and Tennappera Troughs (Fig. 13). Structurally high trends are associated with reactivated northwest-directed thrust-faults of the underlying Warburton Basin (Kuang, 1986) (Fig. 13).

Sedimentation commenced in the Late Carboniferous (Fig. 14) with terrestrial and subaqueous proglacial clastics which resulted from widespread Gondwanan glaciation. Sediments of the Cooper Basin (Fig. 15) are predominantly fluvial, lacustrine and deltaic clastics, which are thickest in the Nappamerri

Trough. The older units of the Gidgealpa Group vary considerably in thickness and are thin to absent on fault-bounded ridges (Fig. 16).

The Merrimelia Formation and Tirrawarra Sandstone formed part of a glaciofluvial system (Williams and Wild, 1984) deposited on a surface of strong relief resulting from deformation during the Alice Springs/Kanimblan Orogenies. This cold environment gave way quite rapidly to cool, more moist conditions in the Early Permian. The Patchawarra Formation consists of sandstone, coal and shale, in a predominantly fluvial setting, becoming deltaic and lacustrine towards the top (Stuart, 1976; Stanmore and Johnstone, 1988).

Syndepositional faulting in the Early Permian produced local relief in the vicinity of depositional sites, and rapid thickness changes are evident (Gatehouse, 1972; Battersby, 1976; Thornton, 1979). Uniform subsidence produced two phases of lacustrine conditions (Murteree Shale, Roseneath Shale) and intervening fluvio-deltaic to shoreface sandstone (Epsilon, Daralingie Formations).

Renewed tectonic activity at the end of the Early Permian eroded previously deposited sediments on structural highs, locally removing Early Palaeozoic (Warburton Basin) sediments. The western margin of the Cooper Basin was delineated by regional uplift but further east and off-structure, effects were minor. In the Late Permian the Toolachee Formation was deposited under renewed fluvial and deltaic conditions with thin laterally extensive lacustrine sediments in its upper part. Such conditions persisted into the Early Triassic when a lower energy environment developed under more strongly oxidising conditions (Araburg Formation, Powis, 1989).

Troubridge Basin

The present extent of the Troubridge Basin (Wopfner, 1972a and b; Alley, 1990) is only a remnant of a much larger area of sedimentation. The Cape Jervis Formation (Ludbrook, 1967; Alley and Bourman, 1984) consists of a wide variety of rock types including lodgement till, proglacial sand with dropstones, diamicton, and subaquatic fan deposits and suraerial flow till. The maximum recorded thickness is 300 m on Fleurieu Peninsula. Glacial erosional features such as striae, distribution of erratics, and till fabrics indicate a west northwesterly ice flow.

Glaciomarine sediments representing deglaciation in the basin has been dated by foraminifera and palynology as Early Permian (Sakmanon) age by Ludbrook (1957, 1965a, 1967, 1969). These occur in Stansbury 1, Minlaton 1, and Troubridge Island 1 and at Cape Jervis. The age of glaciation must be older than this and may extend into the carboninferous (Alley, 1990).

Denman Basin

The Denman Basin (Fig. 1) is restricted to Permian sediments in western South Australia (Wopfner, 1969; Young, 1974: Harris, 1980; Veevers, 1984). It is an intracratonic feature 200 km long by up to 70 km wide with a maximum thickness of 400 m of sediment. Although initiated by normal faulting glacial activity has modified the basin (Cockshell, 1990) which is a remnant of a much more extensive area.

The sediments in this basin are unnamed and subhorizontal. Sedimentation commenced with a glacial phase followed by deglaciation and a glacio-eustatic transgression from the west (McGowran, 1973; Wopfner, 1980). Ice movement may have been to the north or northwest. The age of the sediments ranges from Asselian to Salemarian.

Synthesis

Early Palaeozoic Basins

Cambrian and Ordovician sediments were deposited within 20 degrees latitude of the palaeoequator (Cook, 1982; Embleton, 1984), in predominantly marine environments east and northeast of the Gawler Craton, and in paralic to non-marine environments north and west of the Gawler Craton. Early Cambrian deposition commenced with an episode of down-cutting and channel-fill locally in the northern Flinders Ranges followed by widespread deposition of arkosic siltstone, sandstone, and conglomerate extending disconformably over Adelaidean sediments and locally onlapping crystalline basement of the Gawler Craton. Siliciclastics bordered the Gawler Craton to the east and west, but to the north on the Stuart Shelf, shallow-marine carbonates formed the somewhat younger initial sediments. Ooid, fenestral and stromatolitic limestones rapidly became widespread in peritidal settings on the eastern seaboard of the Gawler Craton while thick interbedded evaporite (halite) and lime mudstone accumulated in the episodically inundated Tallaringa Trough on the eastern margin of the Officer Basin. Towards the interior of the Officer Basin redbeds were deposited while to the east, in the Arrowie Basin and on the Stuart Shelf, broad platform carbonates developed between the Gawler Craton and the Willyama Inliers (Fig. 17).

Further south, in the Stansbury Basin, shallow shelf carbonates fringing the Gawler Craton deepened gradually seawards (to the southeast), changing through siliciclastic facies to fine-grained ribbon limestone. Shelf and platform-margin carbonate beds were characterised by high-energy bioclastic beds with, as yet relatively minor, shallow-water buildups composed of archaeocyaths and calcified cyanobacteria. Deeper water archaeocyath-sponge-mud mounds occurred in intrashelf depressions and on the carbonate ramp.

Marine faunal links were established with the Amadeus Basin and the Georgina Basin (Daily, 1972; Walter et al., 1979; Kruse and West, 1980; Laurie and Shergold, 1985) indicating widespread shallow marine conditions.

Localised tectonic instability in platform carbonate of the Arrowie Basin at this time is evident from large fissures filled with successive submarine calcite cements and bioclastic debris, and locally from trains of clastic debris shed from exposed diapirs. This depositional sequence was terminated by partial withdrawal of the sea from areas of the carbonate platform, leading to subaerial exposure and widespread though only locally intense karst development. Deposition was continuous in more basinal regions while a significant hiatus developed above the subaerially exposed platform in the central Flinders Ranges and northwestern Stansbury Basin. Lack of fossil evidence hinders extending correlation of this event to the Officer Basin.

The transgressive phase of a second depositional sequence in the Early Cambrian was characterised by more marked differentiation between platform carbonate and basinal shale in the Arrowie Basin. Bioherm complexes flourished on the platform and spread onto the Stuart Shelf (James and Gravestock, in press). Archaeocyaths reached peak diversity at this stage (Botomian) (Zhuravlev, 1986) and species-level correlation is demonstrated between the Arrowie Basin and Gnalta Shelf (Kruse, 1978, 1982) and Antarctica (Debrenne and Kruse, 1986). Archaeocyaths of presumed Botomian age also occur in the eastern Officer Basin (Dunster, 1986; Brewer et al., 1987). Carbonate slope turbidites, often slumped (Mount, 1970; Clarke, 1986b), were shed into re-entrants on the periphery of a major shelf margin in the northern Flinders Ranges (Haslett, 1975). This margin may have continued northward as a deeply buried (as yet undrilled) precursor of the Middle and Late Cambrian shelf/slope sequence in the Warburton Basin.

Quiet-water lagoonal limestones were overlain by shallow marine bioherm complexes in the western Stansbury Basin while deep-water black shales were deposited to the southeast. Shallow-water equivalents in the northeastern Stansbury Basin, however, are interbedded with intrusive and extrusive Truro Volcanics.

Tectonic activity along the Torrens Hinge Zone at the onset of regression led to the elevation and erosion of fault blocks from which conglomerates accumulated into shoreline settings on Yorke Peninsula and Kangaroo Island (Daily et al., 1979, 1980), and in the northwest Arrowie Basin (Mount Scott Range). These uplifts (Kangarooian Movements of Daily and Forbes, 1969) foreshadowed a major change from carbonate to clastic- dominated deposition on the eastern seaboard of the Gawler Craton and may have triggered rapid deposition of basal Kanmantoo Group sandstones and turbidites (Jago and Daily, 1982). With widespread regression in the late Early Cambrian, carbonate dominance waned. Evaporitic and stromatolitic dolostone and redbed formed extensive units in the Arrowie Basin, Stuart Shelf, eastern Officer Basin and western Stansbury Basin. One brief but very widespread transgression covered much of the Australian craton with an epicontinental sea linking the palaeo-Pacific and Tethyan Oceans (Cook, 1982; Veevers and Powell, 1984). At this time in South Australia, shallow subtidal and peritidal limestone (Wirrealpa, Aroona Creek, Ramsay Limestones) were deposited in the Arrowie and western Stansbury Basins (Youngs, 1977), and marginal sabkha conditions may have prevailed in the eastern Officer Basin (Brewer et al., 1988). In the eastern Warburton Basin deep drilling has confirmed a marine carbonate/volcaniclastic sequence (Gatehouse, 1986) possibly contiguous with earlier Cambrian platform deposits.

During the Middle Cambrian, arkosic siliciclastics were stripped from the exposed Gawler Craton and redeposited as prograding wedges over the southwest-central Arrowie Basin, across the Stansbury Basin and into the Kanmantoo Trough, the eastern limits of which are obscured by Tertiary sediments of the Murray Basin.

Lake Frome Group siliciclastic sediments shed into the Arrowie Basin are paralic to deltaic with evidence of alternating intermittent subaerial exposure and shallow submergence, but contain no diagnostic fossils to determine a minimum age.

In the Officer Basin, fluvial and alkaline playa lake sediments spread as the sea withdrew to the east (White and Youngs, 1980; Brewer et al., 1988). Moore (1982) has suggested correlation with the Cootanoorina Formation in the Boorthanna Trough on the basis of lithological similarity.

In contrast, carbonate-dominated sedimentation prevailed in the eastern Warburton Basin throughout the Middle and Late Cambrian (Gatehouse, 1986). Trilobites provide evidence of deposition up to latest Cambrian time and are useful for correlation with the Georgina Basin in western Queensland.
Borehole data are too sparse to confirm continuity of sedimentation into the Ordovician which is known from graptolites and conodonts in only three boreholes.

There is no evidence from the eastern Warburton Basin to suggest cessation of sedimentation due to the Delamerian Orogeny nor is there any evidence of Delamerian deformation. In the eastern Officer Basin however, gently folded Ordovician sediments in the Mount Chandler Ranges overlying strongly folded Adelaidean rocks may suggest an early phase of Delamerian folding (Thomson, 1969). Williams (1975) discussed evidence of Delamerian influences in the western part of the Warburton Basin which may extend into the Northern Territory; he suggested that low-grade metasediments dated as Ordovician by K-Ar were deposited during the Adelaidean. These regions were presumably sufficiently protected by the Gawler Craton and Willyama Inliers to have escaped the effects of compression during plate convergence except at their points of closest approach.

Quartzose fluvio-deltaic to marginal marine sandstone and siltstone outcrops in the northeastern extremity of the Officer Basin also have failed to yield proof of an Ordovician age, though this is highly likely on the grounds of lithological similarity with the Amadeus Basin, the presence of *Diplocraterion* in both basins (Krieg, 1973; Benbow, 1982), and geochronology on the Indulkana Shale. Similar lithologies in Mount Crispe 1 suggest a connection with the Amadeus Basin to the northwest via the western Warburton Basin.

Gatehouse (1986) has suggested that the Benambran Orogeny may have been responsible for terminating deposition in the eastern Warburton Basin. Effects of the Devonian-Carboniferous Alice Springs Orogeny have complicated interpretation of events in the eastern Officer Basin and speculation in this region is best avoided until the Ordovician-Mid Devonian history of the region is clarified.

Lake Frome Group sediments are presumed to be the last deposited in the Arrowie Basin prior to Mid-Late Cambrian uplift associated with the Delamerian Orogeny. There is no record on the Stuart Shelf of Lake Frome Group or its equivalent. Redbeds and minor carbonate beds 750 m or more in thickness overlie the transgressive Ramsay Limestone in the Stansbury Basin; these form the landward edge of the prograding wedge of Kanmantoo Group strata which reach an apparent thickness of 10 km or more. Milnes et al. (1977) and Daily et al. (1979) have argued for an even greater thickness based on observations that granite intrusives of Encounter Bay were crystallised beneath 5 to 10 km of cover. Webby (1978) has noted that latest Cambrian-Early Ordovician conglomerates on the Gnalta Shelf contain granite pebbles possibly from unroofed Delamerian age granites. If this is so, then it is extremely unlikely that uppermost exposures of Kanmantoo Group are younger than Late Cambrian in age.

Effects of the Delamerian Orogeny have been reviewed elsewhere (Preiss, 1987; Offler and Fleming, 1968; Thomson, 1969) but its causes are at present unconstrained by factual data. That orogeny was brought about by plate convergence is accepted by many workers but critical evidence as to the nature of the plate advancing towards the Gawler Craton is buried beneath the western Murray Basin. It is quite possible that Adelaidean and Early Cambrian extension did not result in complete plate separation. Thus the Delamerian Orogeny may be of an intraplate character.

Late Palaeozoic Basins

Glacigene influence on lower parts of the Late Palaeozoic basin succession reflects the sub-polar latitudes (66^0S to 77^0S) experienced by the South Australian sector of Gondwana during Late Carboniferous to Early Permian time. The Cooper and Pedirka Basins are non-marine but foraminifera from parts of the succession in the Arckaringa, Troubridge, and Denman Basins, and in the NADDA Trough beneath the Murray Basin indicate some marine influence (Ludbrook, 1967). The direction of marine transgression may have been from the south or west.

Basement beneath Late Palaeozoic sediments around northern and eastern margins of the Gawler Craton consists of Early Palaeozoic and older rocks deformed during the Delamerian Orogeny. However, Harris and McGowran (1971) have suggested that Devonian spores reworked into Early Permian sediments on southern Yorke Peninsula may have come from a nearby Devonian (post orogenic) source, perhaps in the Mount Lofty area. The only known Devonian spore-bearing sediments are beneath the Murray Basin east of the Mount Lofty Ranges (N.F. Alley, 1989, pers. comm.). The Cooper and Pedirka Basins are floored by sediments deformed during the Alice Springs Orogeny, and the Cooper Basin by associated granite intrusives.

The oldest deposits are of Late Carboniferous age. Veevers (1984) has suggested that older Carboniferous strata were not deposited due to their entombment in continental ice despite the generation of mid-Carboniferous structural depressions. Alternatively, Wopfner (1970, 1981, 1985) maintains that subsidence immediately preceded deposition in the Late Carboniferous and continued with varying degrees of intensity through the Early Permian as evidenced from seismic and drilling data in the Cooper and Pedirka Basins.

Basal sediments are generally matrix or framework- supported conglomerates. These have a variety of till fabrics indicating deposition in terrestrial and subaqueous environments. Clasts are commonly derived from local bedrock although several tens of kilometres of transport can sometimes be demonstrated (e.g. Encounter Bay Granites on Yorke Peninsula 60 km to the northwest). Glacial striae and till fabrics on Fleurieu Peninsula generally indicate west to northwest (rarely southeast) ice flow (Wopfner, 1980; Alley and Bourman, 1984). Dropstones have been recorded disrupting bedding in gravity-flow sediments in the Cooper Basin (Williams and Wild, 1984) and lacustrine turbidite units indicate large tracts of deep water in all of the northern basins, principally in structural troughs.

Widespread glacial retreat in the Early Permian released large volumes of sandy sediment which were rapidly redeposited by glacio-fluvial systems (Youngs, 1976; Williams and Wild, 1984). Marine incursion, presumably, from the south, took place at this time in southern regions and extended as far as the Arckaringa Basin (McGowran, 1973; Veevers, 1984).

Fluvial sediments merged with vegetated peat swamp facies in low-lying areas in the Cooper, Pedirka and Arckaringa Basins, accumulating as seam coal with a small but significant algal, fungal, and bacterial content (Smyth *et al*., 1988). Two major lacustrine mudrock sequences are interbedded with heterolithic fluvio-deltaic and shoreline units in the Cooper Basin, but not in the Pedirka and Arckaringa Basins where there is no preserved record of late Early Permian sedimentation.

Reactivation of Early Palaeozoic faults led to an episode of diastrophism in the Cooper Basin at the end of the Early Permian known as the Daralingie Movements. This tectonism also contributed to shaping the western margin of the Cooper Basin and isolating it from the Pedirka and Arckaringa Basins. Erosion of uplifted fault blocks was locally severe enough to remove earlier Permian sediments and expose Early Palaeozoic or older rocks along arcuate northeasterly structural trends. Late Permian deposits occur only in the Cooper Basin where they are thin but widespread. These consist of mixed-load fluvial sandstones often fining up to well preserved overbank mudrocks, and overlain by fine-grained lacustrine sediments which pass conformably into Triassic sandstone and redbeds.

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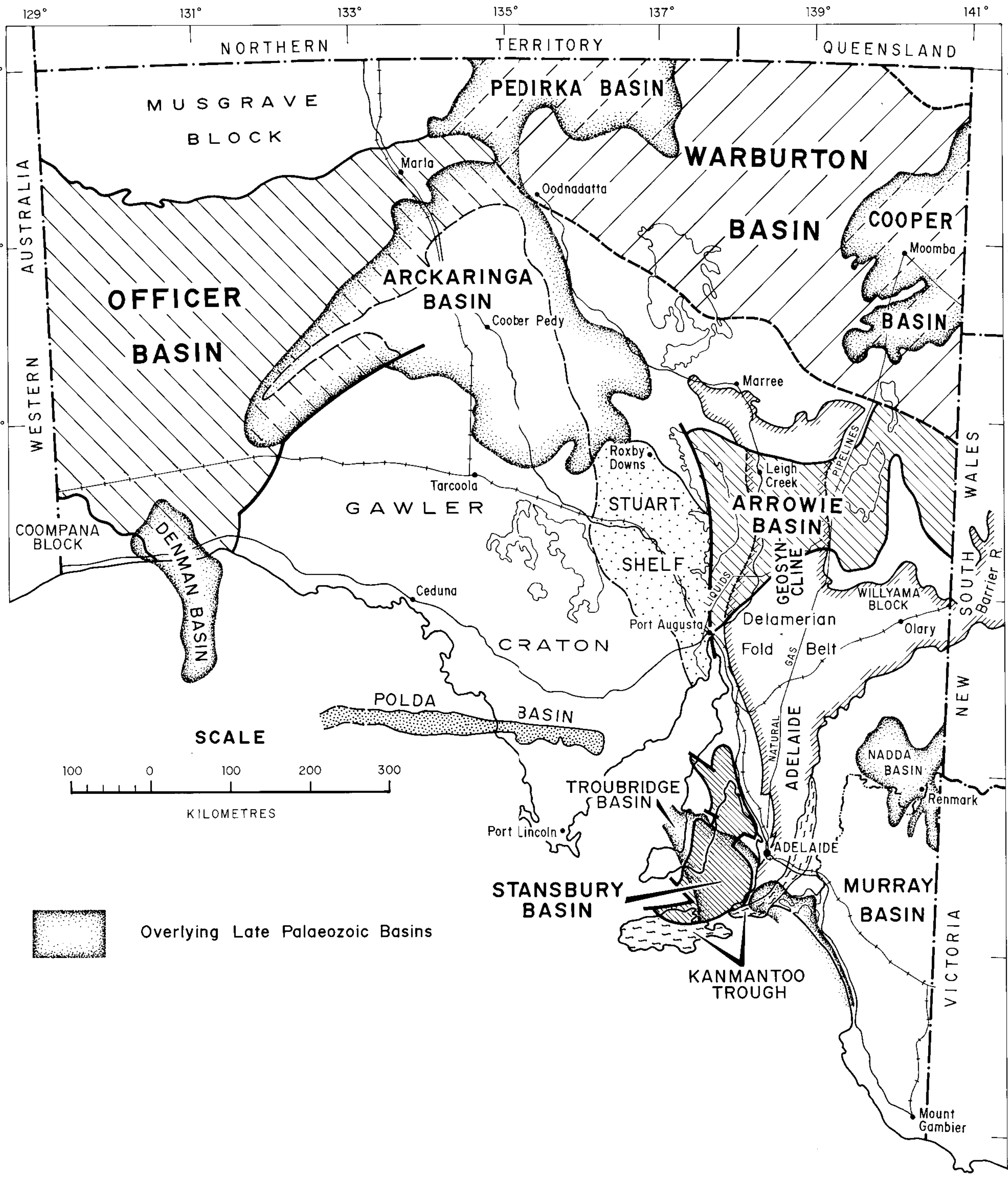

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Figure.....1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS IN SOUTH AUSTRALIA

COMPILED C.G.G.	C.D.O.	DATE 2·11·90
DRAWN M.R.	SCALE	
DATE July '90	PLAN NUMBER	
CHECKED	S 21134	

4721

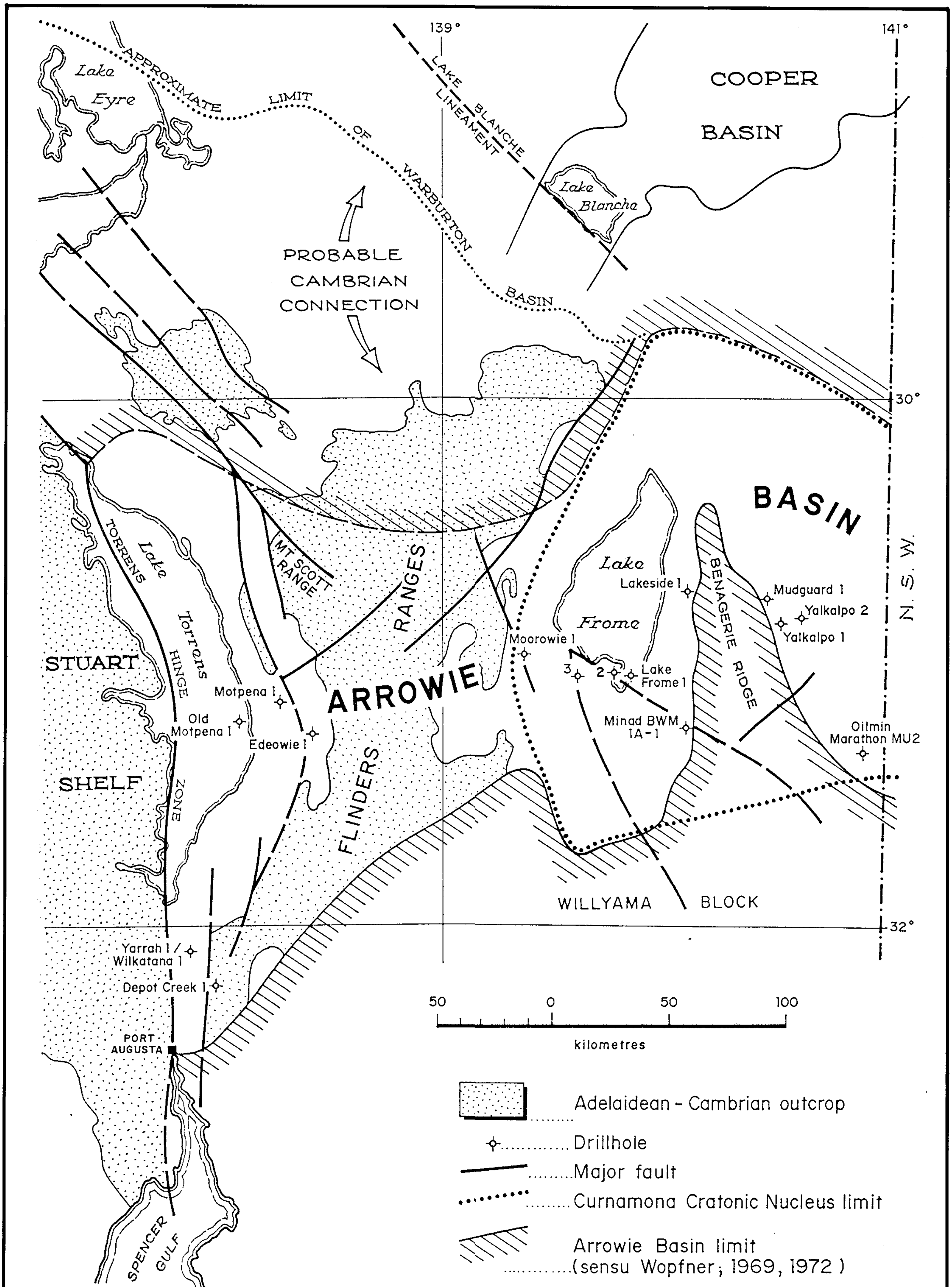

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Figure 2

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED C.G.G.	C.D.O.	2·11·90 DATE
PALAEOZOIC SEDIMENTARY BASINS SOUTH AUSTRALIA	DRAWN M.R.	SCALE	
ARROWIE BASIN	DATE Nov. '89	PLAN NUMBER S 21135	
	CHECKED		

4721

AGE	ROCK UNIT		COMPOSITE LITHOSTRATIGRAPHY
MIDDLE - LATE CAMBRIAN	LAKE FROME GP	GRINDSTONE RANGE SANDSTONE	SANDSTONE: Silicified at base, feldspathic above, rippled, cross-bedded; well rounded quartz grains. Top not exposed. Possibly deltaic, supratidal to continental. Max. thickness 430m
		PANTAPINNA SANDSTONE	SANDSTONE & SHALE: Red, purple, red-brown, micaceous, with subordinate shale. Large scale cross-bedding, slump structures. Marginal marine to deltaic. Max. thickness 1370 m.
		BALCORACANA FORMATION	SHALE & SANDSTONE: Shale interbedded red and red-brown. Sandstone cross-bedded, micaceous. Trilobite tracks. Marginal marine. Maximum thickness 460 m.
		MOODLATANA FORMATION	SHALE, SANDSTONE & DOLOMITE: Shale, red-brown, micaceous. Sandstone argillaceous, cross-bedded. Dolomite thin-bedded with chert nodules near base. Marginal marine. Trilobites. Maximum thickness 400 m.
EARLY CAMBRIAN		WIRREALPA LIMESTONE / AROONA CREEK LMST.	Mudstone, ooid oncolite, grainstone, packstone and siltstone. Fossils include *Redlichia*, *Helcionella*, archaeocyaths and *Girvanella*. Shallow marine, ooid bank megafacies with transgressive and regressive phases. Max. thickness 140 m.
		BILLY CREEK FORMATION	SHALE, SANDSTONE & SILTSTONE: Shale, red-brown, micaceous; with sandstone and siltstone. Rippled with halite pseudomorphs near top, tuff beds; buff coloured dolomite and calcareous shales in lower third. Trilobite bearing. Mudflats are evaporitic in part. Predominantly regressive. Maximum thickness 1000 m.
	HAWKER GROUP	MOOROWIE FM.; ORAPARINNA SH.; NARINA G'WACKE; UPPER WILKAWILLINA LMST.; PARARA LMST; BUNKERS SST; NEPABUNNA SLT; MIDWERTA SHALE; AJAX LIMESTONE; WIRRAPOWIE LMST.; LOWER WILKA-WILLINA LIMESTONE; WOODENDINNA DOLOMITE	**Moorowie Formation**: Limestone, siltstone and shale with lenticular mega breccias. Limestone with archaeocyaths and trilobites. Maximum thickness 200 m. **Oraparinna Shale**: Green, micaceous with dark blue-grey rubbly limestone. Hyolithid and trilobite fossils. Maximum thickness 210 m. **Upper Wilkawillina Limestone**: Calcareous mudstone, wackestone, packstone, grainstone, intraclast rudstone, floatstone. Fossils include trilobites, echinoderms, archaeocyaths, sponge spicules, brachiopods, *Renalcis*, *Epiphyton*. Glauconitic, with ferruginous and phosphatic peloids. Initially shallow marine platform with rapidly increasing water depth. Maximum thickness 350 m. **Ajax Limestone**: Grey, siliceous; pink, purple, archaeocyath; oolite, calcareous shale; with trilobites and brachiopods. Maximum thickness 370 m. **Narina Greywacke**: Sandstone, green, fine-coarse-grained, feldspathic and tuffaceous. Maximum thickness 700 m. **Parara Limestone**: Grey, dark blue-grey, mottled, sandy in part with chalcedony nodules. Fossils include trilobites (*Yorkella*, *Pararaia*), archaeocyaths, molluscs (*Helcionella*, *Pelagiella*) hyoliths and sponge spicules. Maximum thickness 1000 m. **Nepabunna Siltstone**: Dark, blue-grey. Minor limestone. Correlative of Midwerta Shale. Maximum thickness 490 m. **Bunkers Sandstone**: Sandstone, shale and limestone. Limestone 15 m thick, siliceous. Shale calcareous. Quartzite white to buff, feldspathic, rippled, cross-bedded. Maximum thickness 210 m. **Midwerta Shale**: Grey-green, calcareous in part; Limestone nodular. Maximum thickness 130 m. **Lower Wilkawillina Limestone**: Fossil packstone, skeletal intraclast and quartz arenite. Calcmudstone and wackestone. Fossils include archaeocyaths, brachiopods, trilobites and sponge spicules. Shallow marine. Maximum thickness 350 m. **Wirrapowie Limestone**: Limestone and siltstone. Limestone dark grey, siltstone green-grey, calcareous. Stromatolitic, intra-formational conglomerates, ooid grainstone. Maximum thickness 300 m. **Woodendinna Dolomite**: Carbonate; oolitic, pisolitic with green shale interbeds. Dolomite and stromatolites. Ooid grainstone, flat pebble conglomerate, quartz sandstone. Chevron cross-bedding. Warm marine, moderate to low energy, intertidal to supratidal. Maximum thickness 300 m.
		PARACHILNA FORMATION	**Parachilna Formation**: Sandstone, increasing clay content up-section, green-grey shales at the top. Flaser bedding. *Diplocraterion* plus other trace fossils. Max. thickness 610 m.
		URATANNA FM.	**Uratanna Formation**: Quartzite; basal, grey, fine to medium grained, clay galls, poor to well bedded, micromicaceous shale and siltstone. Fossils include *Diplocraterion*, *Rusophycus*, and *Curvolithus*. Shallow marine. Maximum thickness 460 m.

from Daily, 1956; Dalgarno, 1964; Coats *et al.*, 1973 (Copley 1: 250,000); Haslett, 1975; Clarke, 1986 a,b

Original 90-829

Figure 3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS SOUTH AUSTRALIA

ARROWIE BASIN GEOLOGICAL SUMMARY

COMPILED	C.G.G.	C.D.O.	DATE 2.11.90
DRAWN	M.R.	SCALE	
DATE	Nov. '89	PLAN NUMBER	S 21136
CHECKED			

4721

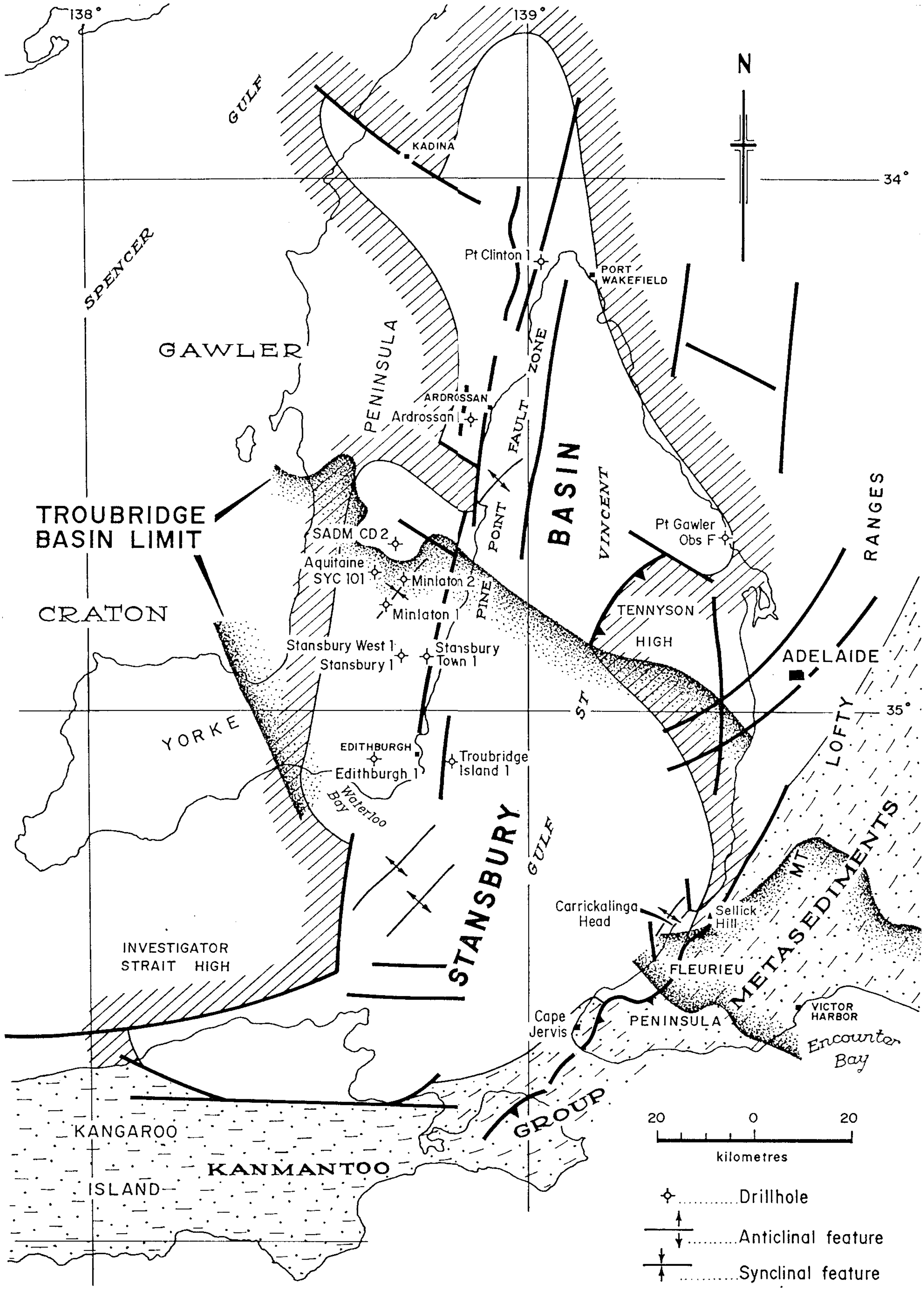

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Figure 4

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED C.G.G.	C.D.O. DATE 2.11.90
PALAEOZOIC SEDIMENTARY BASINS SOUTH AUSTRALIA	DRAWN M.R.	SCALE
STANSBURY BASIN	DATE Nov. '89 CHECKED	PLAN NUMBER **S 21137**

4721

AGE	ROCK UNIT	Thickness	LITHOLOGY	DEPOSITIONAL ENVIRONMENT
MIDDLE CAMBRIAN	YURUGA FM	550 m		**SANDSTONE & ARKOSE**: Red, pink, calcareous in part. Shale interbeds, trilobite tracks, mudcracks, local conglomerate. Paralic.
	COOBOWIE FM	25 m		**LIMESTONE**: Pale grey, oolitic. Shallow marine shelf.
	MOONAN FM	25 m		**SHALE**: Dark grey, non-calcareous with sandstone interbeds. Possible strandline.
	STANSBURY LST	80 m		**LIMESTONE**: Oolitic, sandy, with grey shale interbeds. Fossils: *Redlichia* sp. Open marine shelf.
	CORRODGERY FM	75 m		**SANDSTONE**: Interbedded red, green-grey, micaceous, calcareous cement. Occasional siltstone. Regressive shoreface.
EARLY CAMBRIAN	RAMSAY LST	85 m		**CARBONATE MUDSTONE**: Richly fossiliferous, oolitic near base. Fossils: *Redlichia, Obolella,* hyoliths. Widespread marine shelf.
	MINLATON FM	120 m		Clastics, evaporites, stromatolitic dolostones overlying vuggy limestone, arkosic muddy sandstone. Conglomerate wedges. Restricted embayment.
	KOOLYWURTIE LIMESTONE MBR	76 m		Archaeocyath/cyanobacteria bioherms capped by peritidal limestone.
	PARARA LST	300 m		Lime mud, wackestone nodules. Fossiliferous: trilobites, molluscs, echinoderms, sponge spicules. Rare tuffs. Oxic/anoxic lagoon.
	KULPARA FM	500 m		Ooid shoals, local bioclastic packstone, stromatolites. Part subaerially exposed, part conformable with Parara Limestone. Pervasively dolomitised. Supratidal to shallow subtidal.
	WINULTA FM	100 m		**SANDSTONE**: Arkosic, conglomerate, glauconitic, calcareous. Shallow marine. Fossils: hyoliths, *Chancelloria*.
PRE-Є	CRYSTALLINE BASEMENT and ADELAIDEAN SEDIMENTS			

from Daily, 1972, 1976 a,b

Original 90-831

Figure 5

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS
SOUTH AUSTRALIA

WESTERN STANSBURY BASIN GEOLOGICAL SUMMARY

COMPILED C.G.G.	C.D.O. 2·11·90 DATE
DRAWN M.R.	SCALE
DATE Nov. '89	PLAN NUMBER
CHECKED	S 21138

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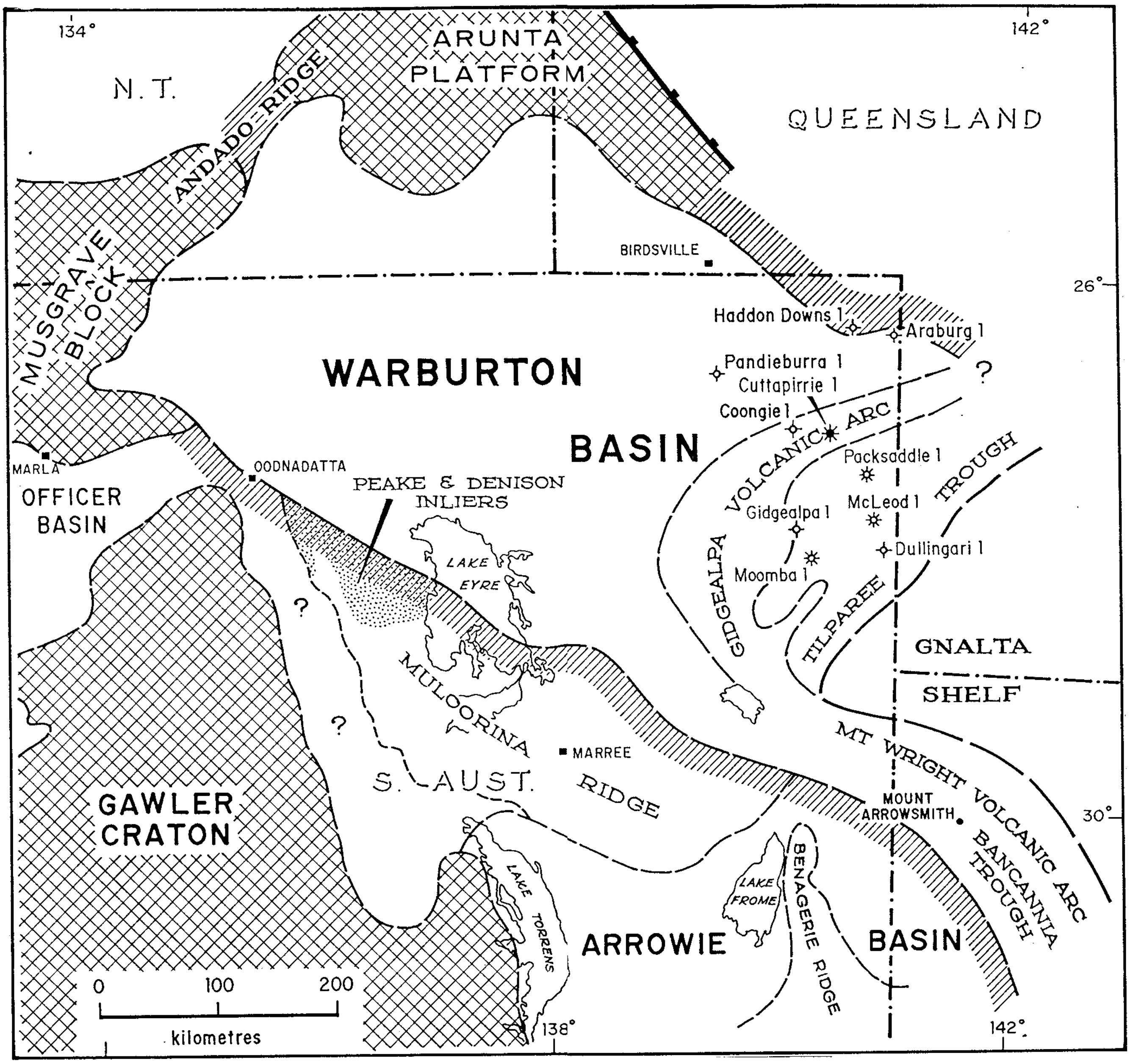

after Gatehouse, 1986

Original 90-832

Figure..... 6

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS
SOUTH AUSTRALIA

WARBURTON BASIN

COMPILED C.G.G.	2·11·90 C D O DATE	
DRAWN M.R.	SCALE	
DATE Nov. '89	PLAN NUMBER	
CHECKED	S 21139	

4721

AGE	ROCK UNIT	COMPOSITE LITHOSTRATIGRAPHY
CARBON-IFEROUS	Unnamed Granite	ALICE SPRINGS OROGENY (intrusion of unnamed Carboniferous granite) 310 ± 17 Ma
DEVONIAN	'INNAMINCKA RED-BEDS'	SANDSTONE: Thin bedded, grey brown, white, fine to medium grained, carbonaceous, pyritic, glauconitic in part; with dolomitic shale. Depositional environment: Marine in part. SHALE and MUDSTONE: Calcareous, red, sandy shale and purple micaceous mudstone. Depositional environment: Probably marine.
SILURIAN		BENAMBRAN OROGENY
ORDOVICIAN	DULLINGARI GROUP	SHALE: Grey, grey-green, laminated, with quartz, biotite, muscovite and chlorite. SILTSTONE: Grey to brown, laminated in part, with pyrite inclusions. Fossils include graptolites. PYRITIC SHALE: Black, dark brown, pyrite as interbedded laminae, and veins. Sandstone: with conodonts.
CAMBRIAN	KALLADEINA FORMATION	LIMESTONE: Oolitic, micritic, sparry, with silicified fossils. SHALE: Dark grey-brown, micaceous, carbonaceous, pyritic and dolomitic. VOLCANICS: Tuffs, welded, lithic, crystal; agglomerates, trachyte, andesite. SANDSTONE: Tuffaceous, with dolomite. Depositional environment: Shallow marine, platform margin, slope, with volcanic activity in the vicinity.
CAMBRIAN	MOORACOOCHIE VOLCANICS	Trachyte, rhyolite, rhyodacite, dacite, amygdaloidal andesite., Tuff: pink, red-brown and green volcanic and volcaniclastic with admixed angular claystone clasts.
? PROTERO-ZOIC	WILLYAMA SUPERGROUP	Quartz-muscovite phyllite, of sedimentary origin.

From Gatehouse, 1986

Original 90-833

Figure 7

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS
SOUTH AUSTRALIA

WARBURTON BASIN
GEOLOGICAL SUMMARY

COMPILED C.G.G.	C.D.O. DATE 2-11-90
DRAWN M.R.	SCALE
DATE Nov. '89	PLAN NUMBER S 21140
CHECKED	

4721

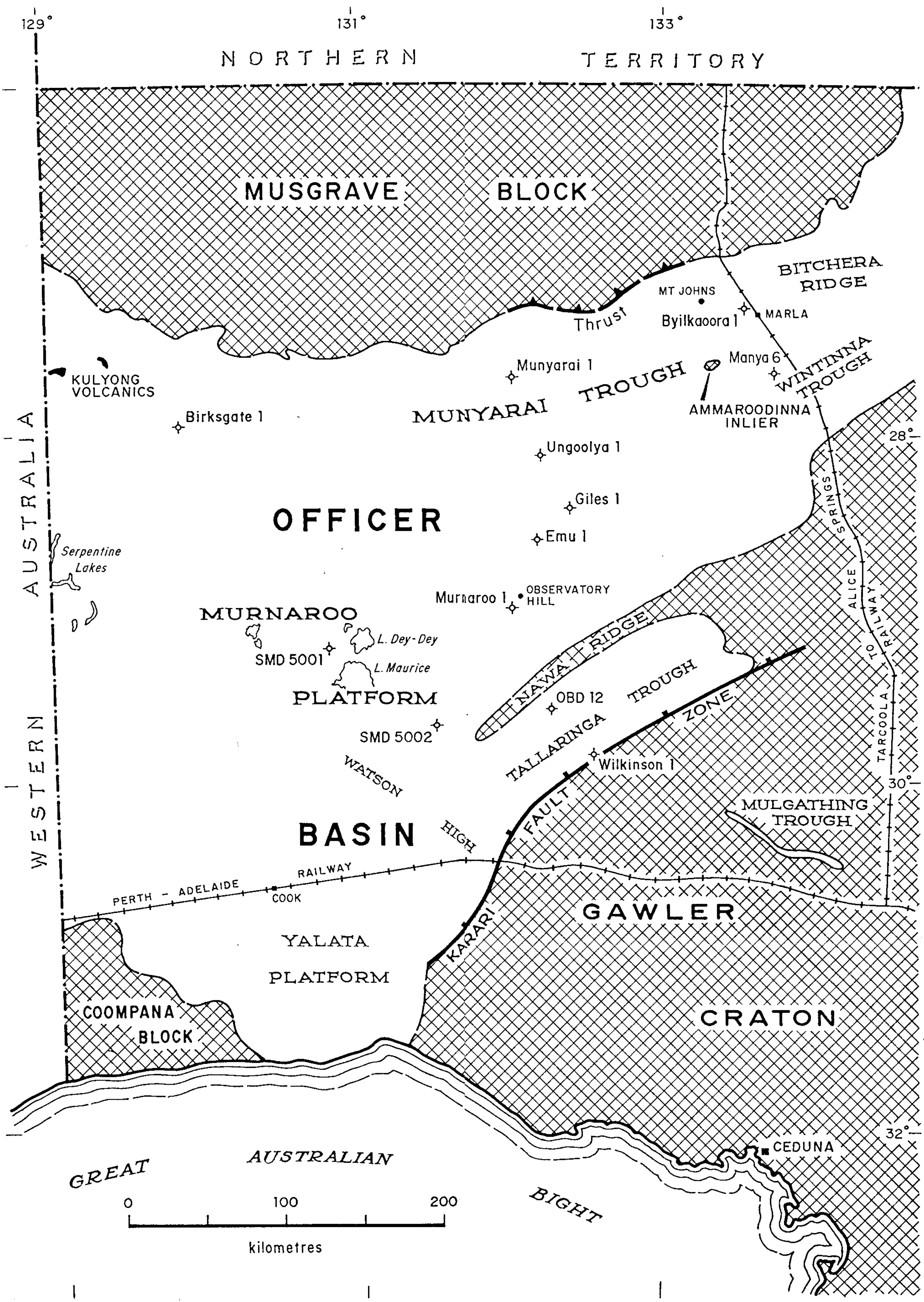

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Figure 8

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED C.G.G.	C.D.O	2-11-90 DATE
PALAEOZOIC SEDIMENTARY BASINS SOUTH AUSTRALIA	DRAWN M.R.	SCALE	
OFFICER BASIN	DATE Nov. '89	PLAN NUMBER S 21141	
	CHECKED		

4721

AGE	ROCK UNIT	COMPOSITE LITHOSTRATIGRAPHY
		ALICE SPRINGS OROGENY
CARBON-IFEROUS	WAITOONA BEDS	SANDSTONE, CONGLOMERATE: Sandstone white, medium to very coarse-grained, feldspathic, pebbly in part, kaolinised. Conglomerate polymict with well-rounded clasts.
DEVON-IAN	MINTABIE BEDS	SANDSTONE, SILTSTONE: Sandstone grey-brown, arkosic, lithic and micaceous. Interbedded with siltstone. Siltstone yellow, purple-weathering, micaceous, feldspathic. Opal-bearing sandstone at top. Large-scale arcuate and planar cross-beds near base.
SIL.		BENAMBRAN OROGENY
ORDOVICIAN	MUNDA GROUP: CARTU BEDS	SANDSTONE, SILTSTONE and SHALE: Sandstone white, medium to fine grained, kaolinitic. Sandstone and siltstone green biotitic. Shale white, red, thinly laminated.
ORDOVICIAN	MUNDA GROUP: BLUE HILLS SANDSTONE	SANDSTONE: Red-brown, fine to medium-grained, kaolinised, quartzose; grit and pebble bands; well-rounded. Large festoon cross-beds near top. Rare organic trails.
ORDOVICIAN	MUNDA GROUP: INDULKANA SHALE	SHALE: Red, green, with rare limestone lenses. Laterally grading to pale green, slightly calcareous siltstone and very fine-grained sandstone. Depositional environment: Very shallow, marginal marine.
ORDOVICIAN	MUNDA GROUP: MT CHANDLER SANDSTONE; BYILKAOORA FORMATION	QUARTZITE to SANDSTONE: Clean, well sorted, fine to very fine-grained, grains well-rounded. Pebbly near base. *Diplocraterion* and *Skolithos* present. Maximum thickness 2060 m. Byilkaoora Fm: Pebble to boulder conglomerate. Sandstone cross-bedded. Depositional environment: Non-marine, transgressive, fluvial.
		DISCONFORMITY RELATED TO DELAMERIAN OROGENY
CAMBRIAN	MARLA GROUP: TRAINOR HILL SANDSTONE	SANDSTONE: Medium to very fine-grained, well-sorted, cross-bedded; with minor interbeds of red-brown siltstone and claystone. Pebbly near base. Dolomitic and calcareous in part. Depositional environment: Fluvial to possibly delta-plain. Maximum thickness 420 m.
CAMBRIAN	MARLA GROUP: MT JOHNS CONGL.; APAMURRA MEMBER	CONGLOMERATE: Reddish, poorly sorted, pebbles and boulders with red-brown sandstone. Piedmont fan intertongues with fluvial and food-plain sediments. Includes Apamurra Member. Depositional environment: Fan conglomerate. Maximum thickness 160 m.
CAMBRIAN	MARLA GROUP: ARCOEILLINNA SANDSTONE	SANDSTONE: Red and brown, feldspathic and lithic. Depositional environment: Fluvio-lacustrine with aeolian influence. Maximum thickness 100 m.
CAMBRIAN	MARLA GROUP: OBSERVATORY HILL FM (OOLARINNA MBR; MOYLES CHERT MARKER BED; PARAKEELYA ALKALI MEMBER); OULDBURRA FM (SE); WALLATINNA FORMATION (NE)	SILTSTONE and CLAYSTONE: Red-brown and brown, with interbedded carbonate-rich evaporative members. Includes Oolarinna Member, Moyles Chert Marker Bed and Parakeelya Alkali Member. Depositional environment: Playa lake. Wallatinna Fm: ARKOSE: Coarse sand to cobbles, angular to subangular quartz and feldspar. Siltstone and claystone. Depositional environment: Braided, fluvial, fanglomerate and marginal playa-lake. Maximum thickness 260 m. Ouldturra Fm: Mixed carbonates and siliciclastics, marine carbonates and evaporites. Halite, sandstone and stacked sand/silt/mud sets. Wackestone, packstone, grainstone and thrombolitic and stromatolitic algal boundstone; archaeocyath bafflestone. Depositional environment: In part salinas on peri-emergent sand flat, in part shallow marine and sabkha with ooid shoals. Max. thickness 1100 m.
CAMBRIAN	MARLA GROUP: RELIEF SANDSTONE	SANDSTONE: Mottled medium to pale brown, moderately well-sorted, silica and dolomite-cemented. Siltstone and claystone interbeds near the top. Depositional environment: Ranges from marine to fluvial, with reworking at Observatory Hill suggesting marginal marine. Shallow marine near Mount Johns. Maximum thickness 300 m.

Original 90-835

from Krieg, 1973; Benbow, 1982; Dunster, 1986; Brewer et al., 1987

Figure 9

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS SOUTH AUSTRALIA

OFFICER BASIN GEOLOGICAL SUMMARY

COMPILED	C.D.O.	DATE
C.G.G.		2.11.90
DRAWN M.R.	SCALE	
DATE Nov. '89	PLAN NUMBER S 21142	
CHECKED		

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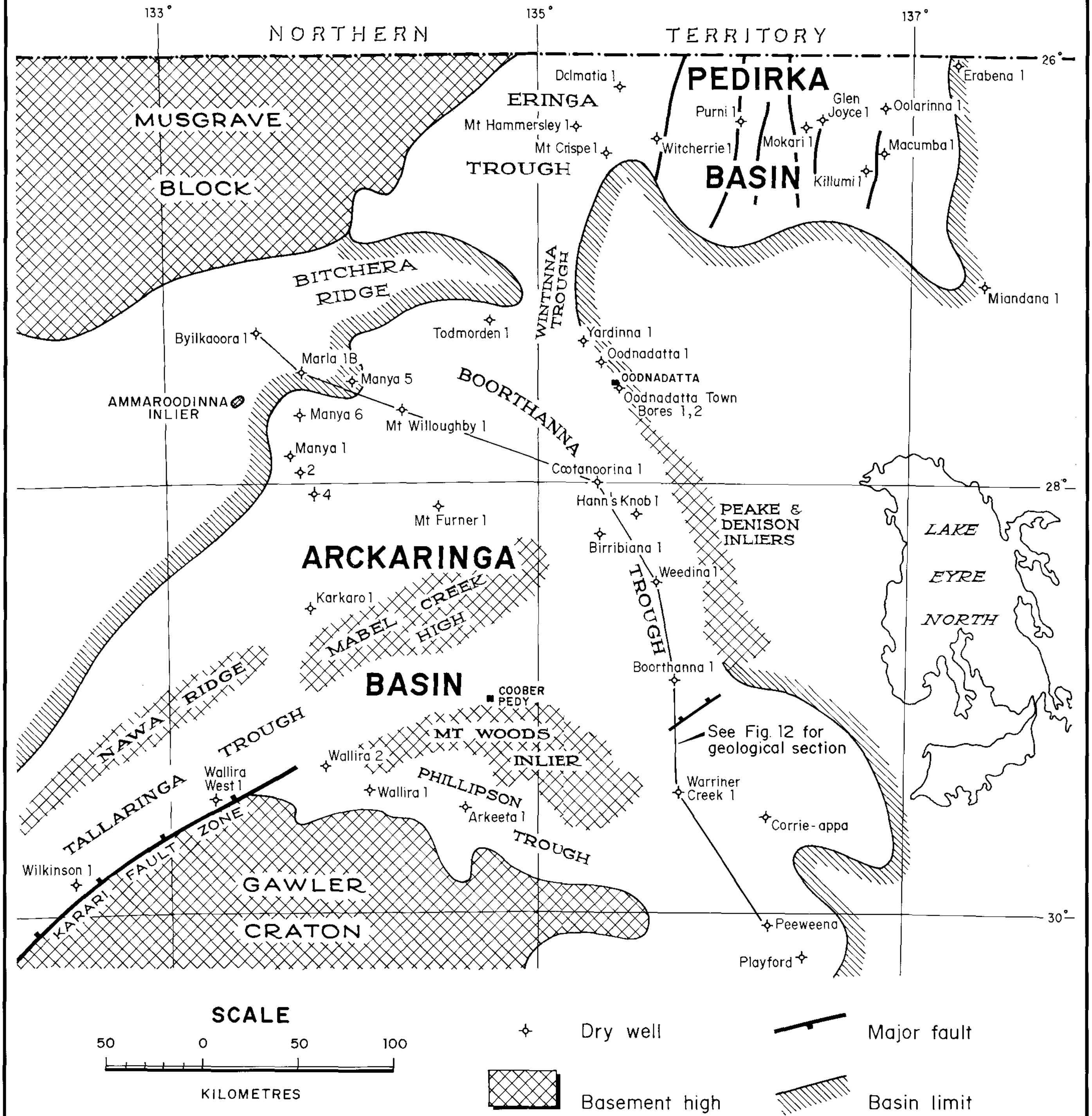

Original 90-836

Figure..... 10

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS
SOUTH AUSTRALIA

PEDIRKA and ARCKARINGA BASINS

COMPILED C.G.G.	*WR* 2 · 11 · 90 C.D.O. DATE	
DRAWN M.R.	SCALE	
DATE July '90	PLAN NUMBER	
CHECKED *[initials]*	S 21143	

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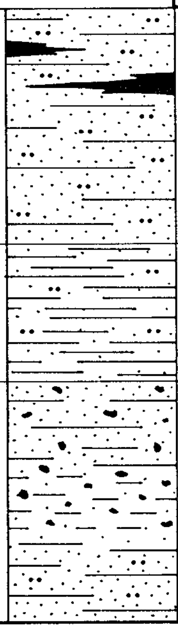
AGE	ROCK UNIT	COMPOSITE LITHOSTRATIGRAPHY

ARCKARINGA BASIN



AGE	ROCK UNIT	DESCRIPTION
EARLY PERMIAN	MOUNT TOONDINA FORMATION	UPPER MEMBER: Interbedded sandstone, siltstone, coal and carbonaceous shale. Sandstone grain-size very variable. Pyritic and micaceous. Depositional environment: Paludal, marine influence apparent in Boorthanna 1. LOWER MEMBER: Slightly more sandy than the upper member. No coal beds. Depositional environment: Lacustrine. Maximum thickness 600 m.
EARLY PERMIAN	STUART RANGE FORMATION	SHALE: Grey, greenish-grey, with minor siltstone interbeds, minor sandstone with scattered detrital grains of quartz, feldspar, and basement lithologies. Fossils: foraminifera, rare macrofossils. Depositional environment: Marine to brackish water, low energy. Maximum thickness 490 m.
EARLY PERMIAN – CARB.	BOORTHANNA FORMATION	UPPER UNIT: Shale, sandstone and conglomerate. Basal conglomerate fining upwards in several beds. Sandstone coarse grained (of igneous and metamorphic origin), slumped. MIDDLE UNIT: Diamictite of pebbles and cobbles in a pale grey clay matrix with scattered quartz and feldspar grains. Depositional environment: Cold, proglacial. LOWER UNIT: Shale, grey, sandy and siltstone. Fossils: foraminifera, spores. Maximum thickness 420 m.

PEDIRKA BASIN

AGE	ROCK UNIT	DESCRIPTION
EARLY PERMIAN	PURNI FORMATION	UPPER MEMBER: Sandstone; very fine-grained, silty, carbonaceous, with upward-increasing proportion of carbonaceous shale and coal. Depositional environment: Swamps. MIDDLE MEMBER: Sandstone, with minor interbedded carbonaceous shale and coal. Depositional environment: Fluvial and deltaic. LOWER MEMBER: Shale with minor interbedded kaolinitic sandstone and occasional coal seams, conglomerate. Depositional environment: Fluvial and deltaic. Maximum thickness 350 m.
EARLY PERMIAN – CARB.	CROWN POINT FORMATION	Diamictite, sandstone, siltstone and claystone. Depositional environment: Non-marine, proglacial. Maximum thickness 700 m +.

from Townsend & Ludbrook, 1975; Barnes et al., 1977; Giuliano, 1988

Original 90-837

Figure 11

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED C.G.G.	C.D.O.	DATE 2.11.90
PALAEOZOIC SEDIMENTARY BASINS SOUTH AUSTRALIA	DRAWN M.R.	SCALE	
PEDIRKA and ARCKARINGA BASINS GEOLOGICAL SUMMARY	DATE Nov. '89	PLAN NUMBER S 21144	
	CHECKED		

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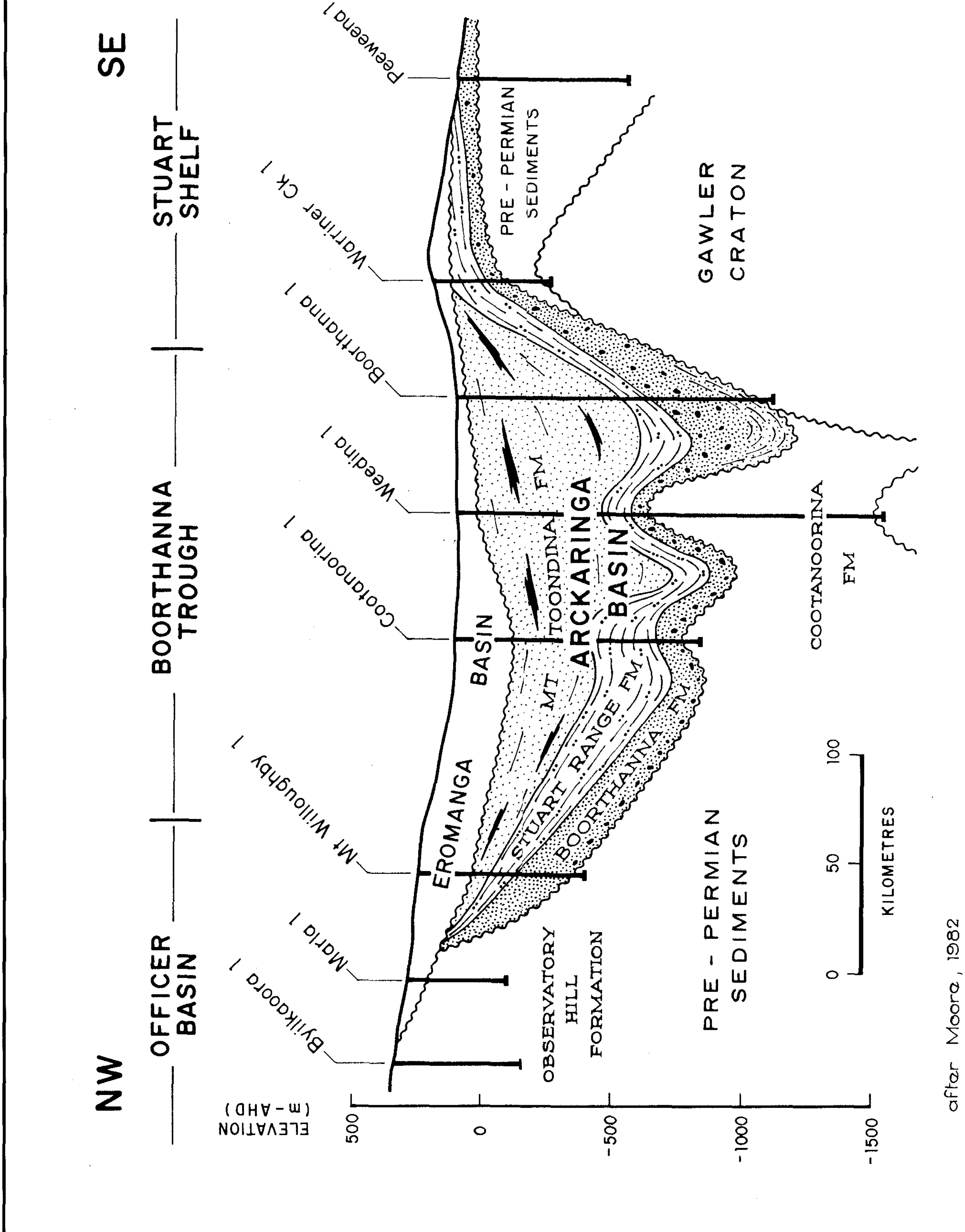

Original 90-838

Figure 12

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA		COMPILED C.G.G.	2. 11. 90 C.D.O. DATE
PALAEOZOIC SEDIMENTARY BASINS SOUTH AUSTRALIA		DRAWN M.R.	SCALE
ARCKARINGA BASIN GEOLOGICAL SECTION		DATE Nov. '89	PLAN NUMBER S 21145
		CHECKED	

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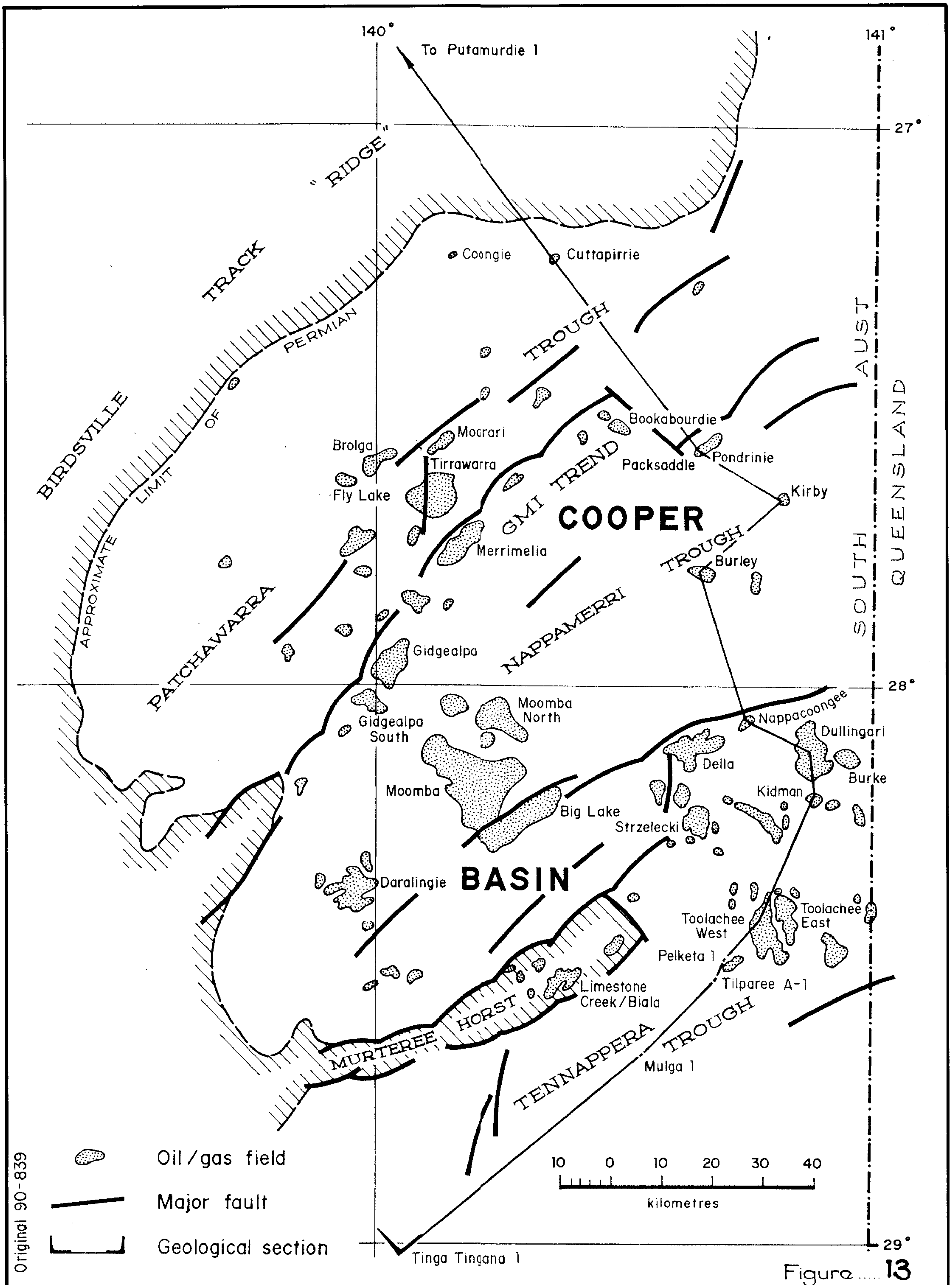

Figure 13

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS
SOUTH AUSTRALIA

COOPER BASIN

COMPILED	C.G.G.	C.D.O.	DATE 2·11·90
DRAWN	M.R.	SCALE	
DATE	Nov. '89	PLAN NUMBER	
CHECKED		S 21146	

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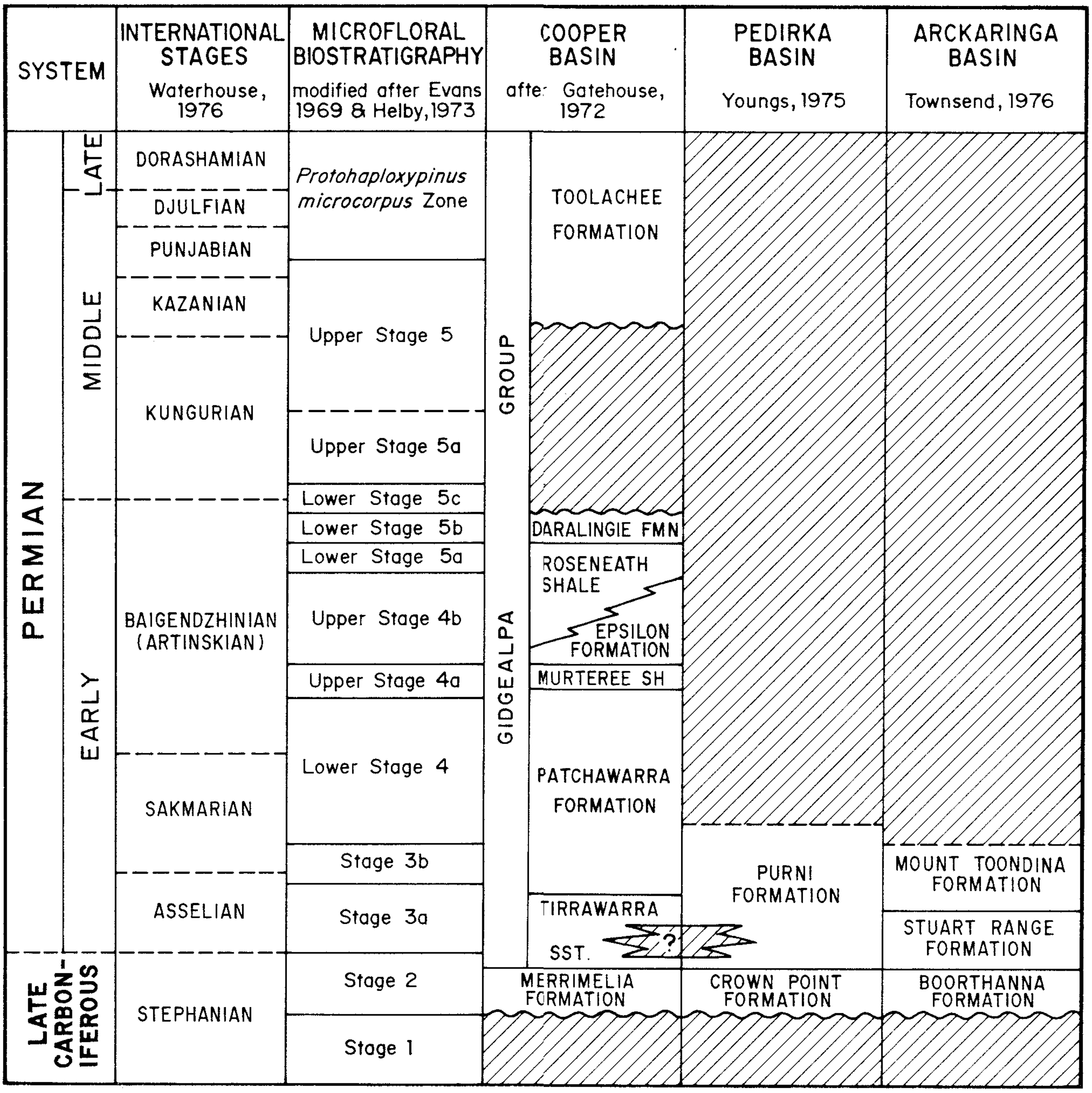

after Cooper, 1981

Original 90-840

Figure 14

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS SOUTH AUSTRALIA

STRATIGRAPHIC CORRELATION OF LATE PALAEOZOIC BASINS

COMPILED C.G.G.	C.D.O. 2.11.90	DATE
DRAWN M.R.	SCALE	
DATE Nov. '89	PLAN NUMBER S 21147	
CHECKED		

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AGE		ROCK UNIT	COMPOSITE LITHOSTRATIGRAPHY
LATE PERMIAN	GIDGEALPA GROUP	TOOLACHEE FM	SANDSTONE, SILTSTONE, SHALE and COAL Sandstone with lithic grains, mica and carbonaceous wisps; medium to coarse grained, conglomeratic in part, fining upwards sequences common. Shale grades up to siltstone, carbonaceous, micromicaceous, with abundant plant fragments. Depositional environment : fluvial, floodplain tract, lacustrine. Progradation eastwards. Maximum thickness 160 m.
EARLY PERMIAN	GIDGEALPA GROUP	DARALINGIE FM	SANDSTONE, SHALE and COAL : Similar to Toolachee Formation but more shaley, sandstone and coal units thinner. Base abrupt, top erosional and difficult to recognise. Depositional environment : deltaic with distributary mouth bars. Maximum thickness 95m.
EARLY PERMIAN	GIDGEALPA GROUP	ROSENEATH SHALE	SHALE : Minor siltstone. Shale dark grey, black, micaceous and carbonaceous. Depositional environment : lacustrine Maximum thickness 80 m.
EARLY PERMIAN	GIDGEALPA GROUP	EPSILON FM	SANDSTONE, SHALE and COAL : Sandstone pale brown, very fine to fine grained, grading to siltstone, quartzose subangular to subrounded, well-sorted. Shale dark grey, grey-brown, carbonaceous. Depositional environment : deltaic with fining upward and coarsening upward sequences. Maximum thickness 90 m.
EARLY PERMIAN	GIDGEALPA GROUP	MURTEREE SHALE	SHALE : Medium to dark grey, grey-brown, micromicaceous. Minor interbedded siltstone and fine grained sandstone. Depositional environment : lacustrine. Maximum thickness 80 m.
EARLY PERMIAN	GIDGEALPA GROUP	PATCHAWARRA FORMATION	SANDSTONE, SHALE, SILTSTONE and COAL : Sandstone quartzose, some lithics, fine to medium grained, occasionally conglomeratic; kaolinitic matrix. Shale dark grey, black, micaceous, carbonaceous, grading to coal. Coal in thick seams, black, sub-bituminous Depositional environment : warm, humid, fluvial, fluvio-lacustrine and flood-plain to deltaic. Maximum thickness 680 m.
EARLY PERMIAN / LATE CARBONIF.	GIDGEALPA GROUP	TIRRAWARRA SANDSTONE	SANDSTONE, MINOR SILTSTONE and COAL : Sandstone brown to white, well sorted subrounded quartz, medium to fine grained with clay matrix; occasionally conglomeratic. Depositional environment : fluvial, braided stream, proglacial. Maximum thickness 75m.
LATE CARBONIF.	GIDGEALPA GROUP	MERRIMELIA FORMATION	SANDSTONE, CONGLOMERATE, SHALE and SILTSTONE : Sandstone white, pale grey, quartzose, conglomeratic, very poorly sorted, fine grained, angular, in clay matrix with pebbles and cobbles to 130 mm, (diamictite). Pebble lithotypes : quartzite, chert, siltstone, shale, metamorphics, igneous rock fragments. Shale and siltstone : grey, hard, micaceous, rhythmites. Thickness very variable, maximum 450 m. Depositional environment : Glacigene, glaciolacustrine, glacio-fluvial, proglacial outwash fans.

from Gatehouse, 1972; Williams & Wild, 1984; Morton & Gatehouse, 1985.

Original 90-841

Figure..... 15

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS
SOUTH AUSTRALIA

COOPER BASIN GEOLOGICAL SUMMARY

COMPILED C.G.G.	C.D.O. 2·11·90	DATE	
DRAWN M.R.	SCALE		
DATE Nov. '89	PLAN NUMBER	S 21148	
CHECKED			

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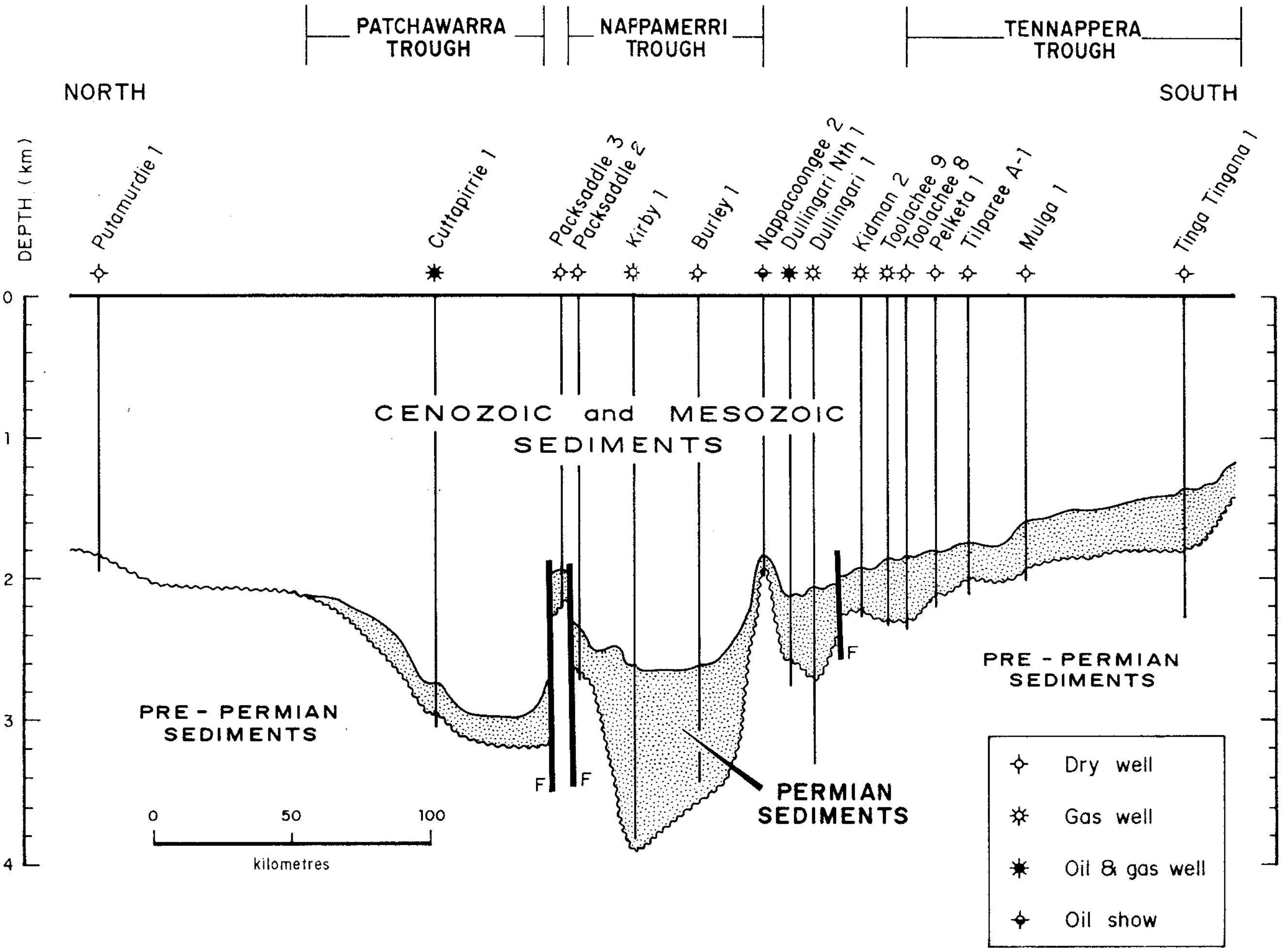

FORMATION	Putamurdie 1	Cuttapirrie 1	Packsaddle 2	Packsaddle 3	Kirby 1	Burley 1	Nappacoongee 2	Dullingari Nth 1	Kidman 2	Toolachee 9	Toolachee 8	Pelketa 1	Tilparee A-1	Mulga 1	Tinga Tingana 1
TOOLACHEE	-	-	2257	-	2551	2610	1764	2060	1880	1793	1813	1781	1726	1576	-
DARALINGIE	-	-		-	2630	2765	-	2169	1988	1946	1943	1882	1804	1634	-
ROSENEATH	-	-		-	2711	2861	-	2176	1991	1953	1957	1903	1828	1656	1367
EPSILON	-	-		-	2767	2921	-	2238	2018	2017	2023	1962	1858	1683	1380
MURTEREE	-	-	-	-	2917	3058	-	2292	2054	2079	2099	2024	1917	1746	1449
PATCHAWARRA	-	2704	2268	-	2987	3139	1840	2292	2067	2133	2167	2079	1969	1804	1462
TIRRAWARRA	-	2919	2515	-	3667	-	-	-	-	-	-	-	-	-	1652
MERRIMELIA	-	-	2537	2035	-	-	-	-	-	-	-	-	2044	-	1724
PRE - PERMIAN		2947	2589	2065	3751		1852	2648	2176	2273	2274	-	2084	1892	1835

Figures are depths to top of formations (metres MSL)

Original 90-842

Figure 16

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS
SOUTH AUSTRALIA

COOPER BASIN GEOLOGICAL SECTION

COMPILED C.G.G.	C.D.O.	DATE 2·11·90	
DRAWN M.R.	SCALE		
DATE Nov. '89	PLAN NUMBER S 21149		
CHECKED			

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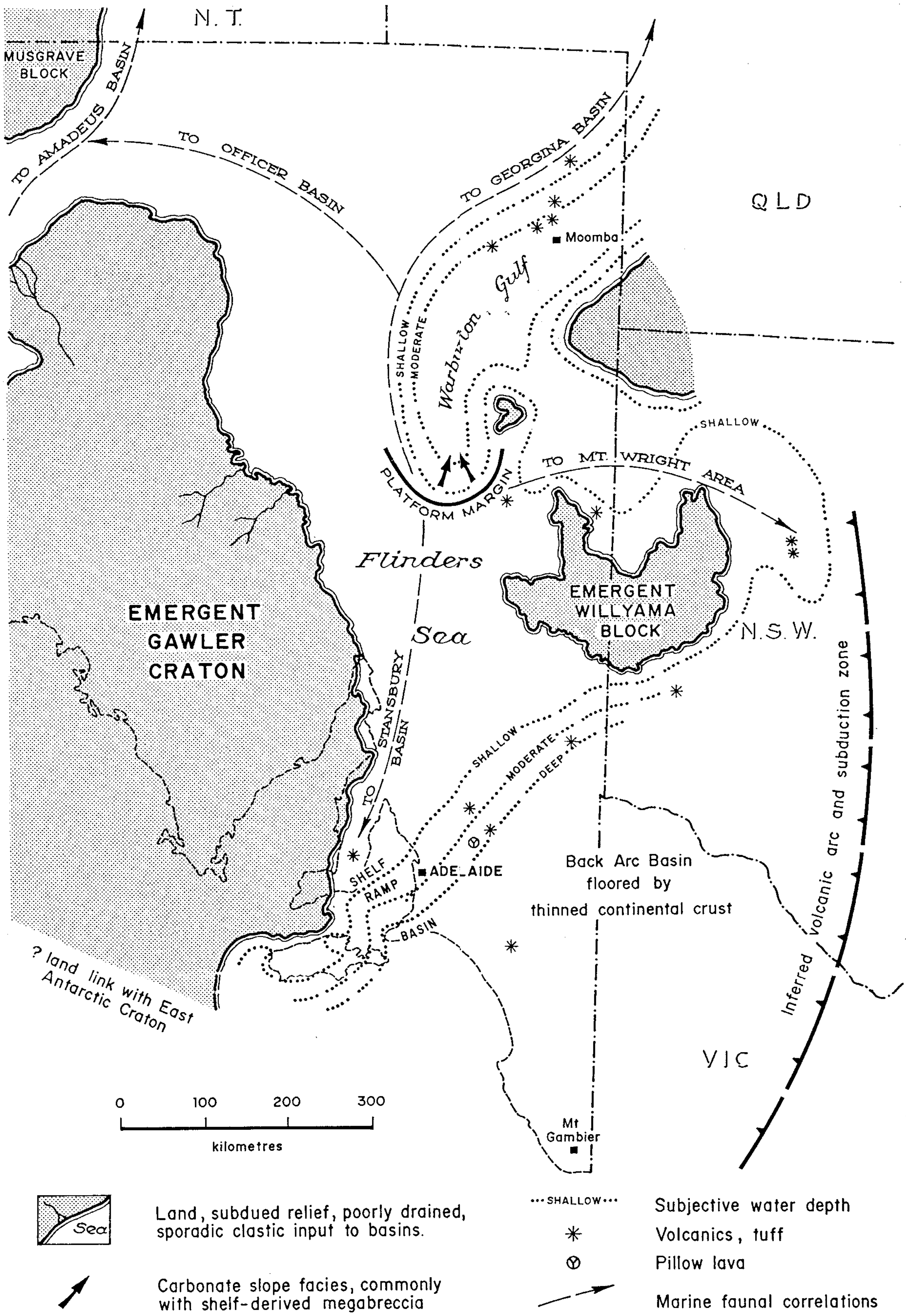

after Jenkins and Gravestock, 1988

Original 90-843

Figure 17

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED C.G.G.	C.D.O.	DATE 2-11-90
PALAEOZOIC SEDIMENTARY BASINS SOUTH AUSTRALIA	DRAWN M.R.	SCALE	
PALAEOGRAPHIC SKETCH OF EASTERN S. AUST. DURING EARLY CAMBRIAN	DATE Nov. '89	PLAN NUMBER S 21150	
	CHECKED		

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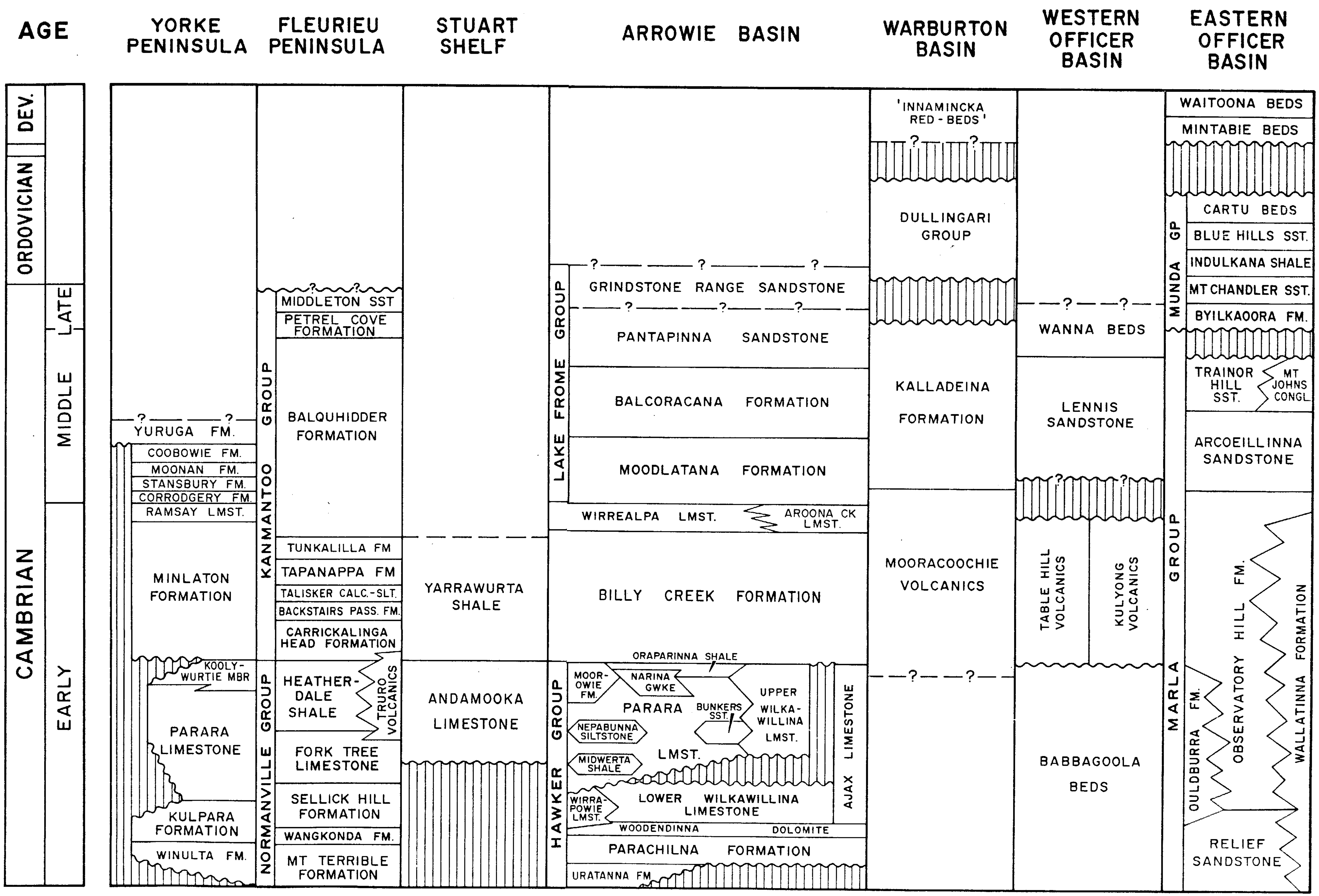

Original 90-844

Figure 18

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

PALAEOZOIC SEDIMENTARY BASINS
SOUTH AUSTRALIA

EARLY PALAEOZOIC REGIONAL CORRELATION CHART

COMPILED C.G.G.	C.D.O.	DATE 2.11.90
DRAWN M.R.	SCALE	
DATE Nov. '89	PLAN NUMBER 89-484	
CHECKED		

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