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STRATIGRAPHY, CORRELATION AND SEDIMENTARY HISTORY OF ADELAIDEAN (LATE PROTEROZOIC) BASINS IN AUSTRALIA

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and

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ABSTRACT

Preiss, W.V. and Forbes, B.G., Stratigraphy correlation and sedimentary history of Adelaidean (late Proterozoic) basins in Australia.

Adelaidean (late Proterozoic) time is represented by the Precambrian portion of the very thick and well exposed sequence in the Adelaide Geosyncline (its stratotype basin) in South Australia. Comparable Adelaidean sedimentation, including the deposition of glaciogenic sediments, is recorded in other intracratonic and epicratonic basins extending northwards across Australia. The inception of this system of basins and of similar and approximately coeval basins and geosynclinal systems elsewhere in the world may be related to a break-up of a large continental landmass during the late Proterozoic.

In the Adelaide Geosyncline, which lies to the east of the Gawler Craton and its cratonic platform cover (the Stuart Shelf), up to 15 km of mainly shallow water sediment accumulated, partly in intracratonic troughs and perhaps partly on a miogeoclinal continental shelf. The earliest sedimentation is associated with rifting and basic volcanism. An age estimate of about 1100 Ma for the base of the Adelaidean is based on correlation of these volcanics of the Adelaide Geosyncline with dated volcanics on the Stuart Shelf. The early Adelaidean sequence commences with basal blanket sands, shelf carbonates and basaltic volcanics, followed by mixed carbonate, clastic and evaporitic beds (Callanna Beds). The overlying Burra Group consists of a number of west-

derived, possibly deltaic cycles and magnesite-bearing platform carbonates. The unconformably overlying late Adelaidean Umberatana Group contains the lower glacial beds (including the Sturt Tillite), interglacial siltstone (dated at about 750 Ma) and carbonate, and the upper glacial beds. The succeeding Wilpena Group is entirely postglacial. It commences with a distinctive "cap" dolomite above the upper glacials, and contains mainly fine to medium clastics; its uppermost unit, the Pound Subgroup, contains the Ediacara metazoan assemblage.

Late Adelaidean sedimentation patterns are sufficiently similar in the Officer, Amadeus, Ngalia and Georgina Basins of central Australia, and in the Kimberley Region, Western Australia to suggest interconnection with the Adelaide Geosyncline to the south. In the Amadeus Basin, the early Adelaidean sequence is younger than about 1050 Ma. It is only broadly similar to the early Adelaidean sequence of the Adelaide Geosyncline and formations cannot be directly correlated between the two basins. However, the late Adelaidean glacial and younger sequences are readily correlated; they include the lower glacial Areyonga Formation and the Arumbera Sandstone I, containing elements of the Ediacara assemblage. The total thickness of Adelaidean in the Amadeus Basin is up to 6 km. In the Georgina Basin, mainly late Adelaidean sequences, including thick glacials, occur in grabens; most of the formations can be correlated with the Amadeus Basin. The Ngalia Basin sequence is similar to but less complete than that of the Amadeus Basin.

In the Kimberley Region, earliest Adelaidean clastics may be represented, but only the late Adelaidean glaciogenic and associated sediments can be correlated with confidence. The tillites frequently overlie glaciated pavements. The lower glacials are represented only in a graben, while the upper glacial and succeeding sequence are more widespread. Shales not far above the upper glacials have been dated at about 670 Ma, and younger shales at about 640 Ma.

The dominantly carbonate and clastic sequences of the Bangemall Basin, Western Australia, cannot be directly correlated with any type Adelaidean, but geochronology suggests an earliest Adelaidean age (about 1050 Ma).

In western Tasmania, thick, partly metamorphosed sequences of probably Adelaidean age include the Rocky Cape Group (siltstones, quartzites), Burnie Formation (turbidites) and Smithton Dolomite (youngest unit). Unconformably above the Smithton Dolomite, and also on King Island, there are diamictites that may be glacial, and may correlate with the upper glacials of the other basins.

Because of the endemic nature of Australian Adelaidean stromatolites, only limited biostratigraphic correlations are possible with stromatolitic sequences of the USSR. The best comparisons are of the Bitter Springs Formation (early Adelaidean of the Amadeus Basin) assemblage with the Late Riphean assemblages of the USSR, and of the interglacial Umberatana Group assemblage with Late Riphean to Vendian assemblages of the USSR. In the future, microfossil studies and magnetostratigraphy are likely to assist in further correlations.

INTRODUCTION

Global stratigraphic subdivision and correlation in the Precambrian are as yet unattainable goals, because of the special problems that arise from the lack of a refined biostratigraphic zonation in the Precambrian. Currently, a number of different methods are being used in an attempt to solve these problems, but there has not been a worldwide consensus on the principles of Precambrian chronostratigraphy (e.g. Stockwell, 1973; Trendall, 1966; Dunn *et al.*, 1966; Crook, 1966; Semikhatov, 1974; James, 1972, 1978).

Lithostratigraphy and regional mapping are the basic methods whereby vertical and lateral relationships of mappable rock units are established within, and under special circumstances between, depositional basins. However, unless there are widespread, unique, isochronous marker beds, precise time correlation between different regions is not possible.

Biostratigraphic methods are starting to be employed for chronostratigraphy in the Precambrian, but the subdivisions and correlations based on them are, even by the most optimistic estimates, very broad by Phanerozoic standards. Schopf (1977) and Vidal (1976a) have discussed the biostratigraphic application of late Precambrian microfossils, while Preiss (1977) outlined the potential of stromatolites for Precambrian biostratigraphy. Glaessner (1971) described the stratigraphic distribution of the latest Precambrian soft-bodied metazoa.

Palaeoclimatology may be applicable in certain cases; e.g. Harland (1964) suggested the use of Precambrian glaciations for stratigraphic subdivision, though Crawford & Daily (1971) have claimed that they are unlikely to be isochronous. Palaeomagnetism is likely to become increasingly important as global data on apparent polar wander and magnetic reversals are compiled. The polar wander curves are sometimes useful for broad correlations, but are subject to very large uncertainties. The unique magnetic reversal "signatures" of known related sedimentary sequences have been used to establish specific local correlations (e.g. Burek el al., 1979). Geochronology has so far been most useful in defining age limits for sedimentary sequences. The large margins of error in most Precambrian age determinations and the difficulty of dating sedimentary rocks directly mean that detailed correlation of formations can rarely be based on geochronology.

Chronostratigraphic subdivision

James (1978) has reviewed the most important of the many schemes of Precambrian chronostratigraphic subdivision that have been proposed. In Australia, most Precambrian stratigraphers have taken the view that Precambrian time-subdivisions, like those of the Phanerozoic, should be keyed in to rock sequences and that each should be represented by a stratotype. Such subdivisions, are then independent of analytical uncertainties and future refinements. Dunn et al. (1966) proposed a three-fold subdivision of the Proterozoic of Australia, based on stratotypes in the following basins: Early Proterozoic (Hamersley Basin, Western Australia), Carpentarian (McArthur Basin, Northern Territory) and Adelaidean (Adelaide Geosyncline, South Australia). Although these subdivisions were widely used for over a decade, and rock sequences far removed from the stratotypes were assigned to them, it is now recognised that the geochronological boundaries originally allotted to these divisions do not necessarily correspond to the times of inception of sedimentation in the stratotype basins. Only in exceptional cases is direct correlation with the stratotypes possible (e.g. all late Precambrian glacials in Australia are known to be Adelaidean). Sequences near the boundaries of the major time subdivisions cannot be definitely assigned to one or the other. In addition the assumption by Dunn et al (1966) that the three stratotypes taken together represent continuously the whole of Proterozoic time is not justified, and major hiatuses are now recognised.

The youngest subdivision, the Adelaidean, is the subject of this paper. The Adelaide Geosyncline is accepted as its stratotype basin; this is appropriate since the sequences in the Adelaide Geosyncline are the thickest, and in general provide the most complete record of late Proterozoic sedimentation in Australia. Recent work has shown that lithostratigraphic correlation of late Adelaidean tillite-bearing sequences is now possible for all major Australian basins (Preiss et al., 1978; Coats & Preiss, 1979; Walter, in press). Early Adelaidean sequences still present many obstacles to correlation, not the least of which is the elusive problem of the age of the base of the Adelaidean in its stratotype. Caution is advised, therefore, in the application of the term "Adelaidean" to sequences older than the first late Precambrian glacials, outside the Adelaide Geosyncline, unless there are very strong grounds for correlation. Moreover, there is likely to be a large interval of Proterozoic time, between the Carpentarian and the Adelaidean, for which no chronostratigraphic nomenclature or stratotype have yet been proposed.

Nature and Age of Adelaidean Basins

Major geosynclinal systems were initiated on several other continents during the late Proterozoic (after ca 1 000 Ma), e.g. Appalachian-Caledonian, Cordilleran, Pan-African, South China. The inception of these systems may be related to a major breakup of large continental landmasses during the late Proterozoic (e.g. Sawkins, 1976). In Australia, this development may be represented by the Adelaide Geosyncline (partly intracratonic and possibly partly related to a rifted continental margin), but there are also many epicratonic, platformal basins of deposition, as well as fault-controlled intracratonic troughs. The latter have in general been more deformed by subsequent, mostly Palaeozoic fold movements. The location of basins described is shown in Fig. 1.

The Adelaide Geosyncline is situated to the east of the Gawler Craton, which had been stabilised by about 1400 Ma, and is separated from it by a zone of depositional flexuring, the Torrens Hinge Zone (Thomson, 1969). The relatively undeformed cratonic cover of the northern part of the Gawler Craton is known as the Stuart Shelf, where the sequences are thinner and less complete than those in the Adelaide Geosyncline. Although thicknesses are very variable, aggregate maximum thicknesses of Adelaidean sediments increase from west to east across the Adelaide Geosyncline (e.g. from about 5 km to 15 km in the southern Flinders Ranges).

Early Adelaidean events include the extrusion of basic volcanics (Shelf and Geosyncline) and the deposition of evaporitic sequences and later cyclic shelf-carbonate and deltaic complexes (Geosyncline only). The late Adelaidean record is characterised by two major glacial epochs, followed by deposition of thick marine shelf clastic sequences (Geosyncline, and less completely on the Shelf).

In central Australia, three east-west oriented basins (Officer, Amadeus and Ngalia) share a broadly similar tectonic history. The present limits of each basin are defined by prominent Palaeozoic tectonic trends, and each basin has undergone compressional deformation and basin-directed thrusting during the Palaeozoic. During the late Proterozoic, however, they may not have been discrete and separate basins, and palaeogeographic trends were probably at an angle to the superimposed tectonic trends. Early Adelaidean basal blanket sandstones possibly extended continuously between the three basins, and were followed by major carbonate deposition, especially in the Amadeus Basin. The early Adelaidean record is thus of a single clastic-carbonate sequence, as distinct from the complex, multiple evaporitic and carbonate-clastic cycles of the Adelaide Geosyncline. Direct correlation of early Adelaidean formations of these basins with those of the Adelaide Geosyncline is not yet possible. In the late Adelaidean record, however, lithological comparisons with the Adelaide Geosyncline are so close as to imply interconnection of basins from the Adelaide Geosyncline, through the central Australian basins to the Kimberley Region of northern Western Australia. A very widespread late Adelaidean platform cover is therefore envisaged, with thicker sequences in certain intracratonic troughs and possibly grading in the south-east into a miogeoclinal continental shelf basin (the Adelaide Geosyncline). A fourth central Australian basin, the Georgina Basin, contains relatively thin Adelaidean sequences, though great thicknesses, especially of late Adelaidean glacials, are developed in grabens.

ADELAIDE GEOSYNCLINE

Stratigraphic classification

Mawson & Sprigg (1950) defined the late Proterozoic sequence, with a type area near Adelaide, as the Adelaide System, divided into four "series": Torrensian (oldest), Sturtian, and Marinoan (youngest). Sprigg (1952) added the pre-Torrensian Willouran "Series" in the northern regions. Subsequent regional mapping by the Geological Survey of South Australia showed that the boundaries of these "series" were not easily mappable away from the type area. Following the recommendations of the Australian Code of Stratigraphic Nomenclature, Thomson *et al*. (1964) proposed an independent lithostratigraphic subdivision of the Adelaidean rocks, based on stratotypes in the Flinders Ranges (Table 1). The old "series" terms are now employed in a chronostratigraphic sense. As such they are useful in discussions of geological history, even though their boundaries can be located precisely only in their type area. These boundaries fall within continuous stratigraphic sequences, and do not correspond to the lithostratigraphic unit boundaries. Thus the Burra Group contains all type Torrensian rocks, the Torrensian-Sturtian boundary, and earliest Sturtian rocks. The base of the overlying Umberatana Group is everywhere either a disconformity or an angular unconformity; the Umberatana Group comprises the Sturtian (i.e. lower) glacials, an interglacial sequence, and the lower part of the Marinoan sequence, including the upper glacials. The Wilpena Group is of late Marinoan age and entirely post-dates the glaciations. The Wilpena Group is disconformably overlain in all sections by Early Cambrian successions: the youngest formation of the Wilpena Group is the Rawnsley Quartzite (Pound Subgroup) that contains the well known Ediacara assemblage of metazoan fossils. Willouran rocks are referred to the Callanna Beds, occurring as more or less disrupted sequences in anticlinal cores and diapirs. The type area of the lowest Callanna Beds is on the margin of the Mount Painter Inliers (Coats, 1971).

There are many stratigraphic uncertainties, especially in the early Adelaidean sequences: in particular (1) the age of the base of the Adelaidean (2) the relationship of the Burra Group to the underlying Callanna Beds, (3) the stratigraphy of the Callanna Beds, (4) the definition of a Torrensian-Willouran boundary in the northern areas (in the type area near Adelaide, Torrensian sediments transgressed on the basement highs, and no Willouran sediments are known) and (5) the correlation of early Adelaidean sequences with those of the other late Proterzoic basins of Australia. These problems are discussed in greater detail below.

Tectonic setting

The term "Adelaide Geosyncline" was used by Sprigg (1952) to refer to the depositional basin of the thick Adelaidean and Cambrian sequences that were folded during the Cambro-Ordovician Delamerian Orogeny (Thomson, 1969). The Torrens Hinge Zone is an approximately meridional zone of transition between these thick sequences of the fold belt and the thinner, less complete and relatively flat lying sequences of the Stuart Shelf to the west. Within the fold belt, there are inliers of pre-Adelaidean metamorphics in the south (e.g. the Houghton Inlier east of Adelaide), in the north-east Flinders Ranges (Mount Painter Inliers) and in the far north-west (Denison Inlier of the Peake and Denison Ranges). During the Delamerian Orogeny, a complex, sinuous and branching system of folds was imposed on the sedimentary fill of the Adelaide Geosyncline. Zones of differing tectonic style and trend to a large extent parallel earlier sedimentary facies belts.

The central Flinders Ranges occupy a zone of gently folded thick Adelaidean and Cambrian cover, bounded by marginal faults.

To the east lies the Curnamona Cratonic Nucleus (Thomson, 1976), a relatively stable area during deposition and subsequent orogeny. The central Flinders Ranges zone is essentially symmetrical in terms of sedimentary and tectonic style, but fold arcs to the north and south tend to be asymmetrical, with tectonic trends parallel to depositional facies boundaries. In the southern arc, for example, the inferred depositional depth of water and the intensity of subsequent folding and metamorphism increase from west to east. Most of the clastic sediment, especially in the Burra Group and Wilpena Group, had a westerly provenance. However, the Sturtian and Marinoan glacials had at least a partial easterly source of clasts (Murrell, 1977), the tillites of the Marinoan glacials being mainly confined to the inferred deeper water zones of the fold arcs. Willouran, Sturtian and Marinoan sequences occur in the Barrier Ranges of western New South Wales, in an easterly extension of the Adelaide Geosyncline. There is widespread evidence of intrabasinal syndepositional tectonism especially in the Sturtian, partly related to basement faulting and partly to diapiric intrusion of Callanna Beds. Coats (1973) presents evidence of phases of diapirism from early Sturtian to the Delamerian Orogeny.

Sedimentary History

The Adelaide Geosyncline is viewed as a complex of deeply subsiding intracratonic basins opening to the southeast on to a possible ancient continental shelf, though it is not known how far to the east of the presently exposed belt a continental margin may have existed. Its sedimentary history has recently been summarised by Preiss et al. (in press). There is evidence of rifting early in its history (widespread Willouran volcanics), development of shelf-carbonate and deltaic cycles in the Torrensian, glaciation in the early Sturtian, followed by marine transgression and regression in the late Sturtian, and a second major glaciation in the Marinoan. The stratigraphy of the major lithostratigraphic subdivisions is summarised in Tables 2-5,

Callanna Beds (Table 2). Deposition in the Adelaide Geosyncline began with a widespread basal clastic blanket followed by shelf carbonates which are locally stromatolitic. Basic volcanics are known from all areas, including uplifed blocks in central Flinders Ranges diapirs, and from the equivalent Poolamacca Group of the Barrier Ranges (Cooper and Tuckwell, 1971); they reflect a major tensional phase. In the Peake and Denison Ranges and north-west Flinders Ranges very thick sequences of mixed clastics and carbonates, with evaporite pseudomorphs, accumulated under restricted conditions. Similar sequences, though probably not as thick, occur more or less disrupted in anticlinal cores and diapirs in the central Flinders Ranges, but their stratigraphy has not yet been fully documented.

Callanna Beds are not known from the Adelaide region, where the type Torrensian sediments transgressed directly on to crystalline basement highs.

On the Stuart Shelf, the Callanna Beds have possible equivalents in the Beda Volcanics and Backy Point Formation (coarse clastics) (Mason et al., 1978). These rest unconformably on weathered red, feldspathic, kaolinitic sandstone of the Pandurra Formation, which has never been found within the Adelaide Geosyncline. The Pandurra Formation could be either basal Willouran or pre-Adelaidean.

Burra Group. The stratigraphy of the Burra Group is summarised in Table 3. The nomenclature for the type Torrensian sequence in the Adelaide region (from the base of the Aldgate Sandstone to the top of the Glen Osmond Slate) was erected by Mawson & Sprigg (1950), while the units from the northern areas were named in the course of geological mapping by the Geological Survey of South Australia

(Thomson et al. 1964). The early Sturtian Belair Subgroup is now included in the Burra Group, as is the River Wakefield Subgroup, which was originally though to be Willouran. The base of the Burra Group is marked by an influx of relatively immature feldspathic and pebbly sands with abundant heavy mineral lamination (grains are of rutile-bearing hematite) that occur in the Rhynie Sandstone, lower Aldgate Sandstone and Emeroo Quartzite, Humanity Seat Formation and Blue Mine Conglomerate. In the Adelaide area, the Aldgate Sandstone rests unconformably on the metamorphics of the Houghton Inlier, but elsewhere the base of the Burra Group is rarely seen. In places it rests disconformably on Willouran volcanics, but elsewhere there may be a transition into the upper parts of the Callanna Beds. The remainder of the Burra Group is characterised by repeated cycles of silts, sands and carbonates. The lithologies within successive cycles are very similar to each other, making assignment of isolated sequences to a particular cycle difficult. Typically, such cycles commence with platform carbonates (e.g. the organic-rich dolomites, sandy dolomites, siltstones, black cherts, reworked sedimentary magnesite and stromatolites of the Skillogalee Dolomite described by Forbes, 1960, 1961, Preiss, 1973 a; Uppill, 1979) and pass up into fine clastics (e.g. the siltstones and fine sandy siltstones of the Woolshed Flat Shale and River Wakefield Subgroup), that grade laterally westward into more sandy sequences. The fine clastics are capped by eastward-thinning coarse feldspathic sandstones (e.g. Undalya and Bungaree Quartzites). These cycles may be interpreted as eastward prograding deltaic complexes. The Skillogalee Dolomite typifies the platform carbonates, which were probably deposited in lagoonal and marginal marine environments at the start of major transgressions, but similar sequences occur also in the River Wakefield Subgroup and in the upper parts of the Burra Group.

The Burra Group is not known from the Stuart Shelf, nor from the Barrier Ranges of western New South Wales.

Umberatana Group (Table 4). In all regions of the Adelaide Geosyncline, Stuart Shelf and western New South Wales, the Umberatana Group and its equivalents rest disconformably or with low angle unconformity on lower Adelaidean sediments (chiefly the Burra Group in the Adelaide Geosyncline), reflecting widespread early Sturtian tectonism. In the central and south-east Flinders Ranges the oldest tillites (Pualco Tillite) and associated fine clastics and ironstones (Holowilena Ironstone, Benda Siltstone and Braemar Iron Formation facies) occur in structurally controlled basins, and reflect the first phase of Sturtian glaciation. The second phase is represented by the disconformably overlying basinal sandstones, siltstones (with some dropstones) and minor tillites of the Wilyerpa Formation, which passes southwestwards into equivalents of the well-known Sturt Tillite of the Adelaide region.

Around the Mount Painter Inliers, very thick Sturtian glacial successions occur in a fault-controlled basin. Coats (1973) and Coats and Forbes (1977) now consider these glacials (the Yudnamutana Subgroup) to be equivalent to the older phase in the southeast part of the Adelaide Geosyncline, being unconformably overlain by conglomerates related to the younger phase. However, the Yudnamutana Subgroup lacks iron formations, and Murrell et al. (1977) rejected this correlation and the concept of two major phases of Sturtian glaciation. Despite the still uncertain position of the Yudnamutana Subgroup, the existence of two phases in the central and southeastern regions of the Adelaide Geosyncline is well established. The Yancowinna Subgroup of the Barrier Ranges, comprising the Yangalla, Mulcatcha and Waukeroo Formations, and McDougalls Well Conglomerate, includes tillites that represent the Sturtian glaciation, possibly its younger phase (Coats, pers. comm.).

The younger Sturtian tillites are almost everywhere overlain by very thinly laminated siltstones of the Tapley Hill Formation, with thin black shales and flaggy carbonaceous dolomites at the base. These beds reflect a major post-glacial transgression; the Tapley Hill Formation is very widespread over all the Adelaide Geosyncline and much of the Stuart Shelf, and has equivalents in western New South Wales (lower part of Euriowie Subgroup: Cooper and Tuckwell, 1971).

In the southwestern part of the Adelaide Geosyncline, the upper Tapley Hill Formation displays evidence of shallowing of depositional water depth, and an important regression is inferred, culminating in the Brighton Limestone (Preiss, 1973a; Preiss & Kinsman, 1978). The top of the Brighton Limestone defines the Sturtian-Marinoan boundary in the type area near Adelaide, but the limestone lenses out towards the east, reflecting the deeper water conditions of the eastern Adelaide Geosyncline, where the deposition of drab coloured silts persisted uninterrupted into the Marinoan.

Along the southwestern margin of the Adelaide Geosyncline and over much of the Stuart Shelf, early Marinoan red silts, sands and muds were deposited in marginal marine (e.g. mudflat) environments. In the central Flinders Ranges, the early Marinoan sequences largely comprise platform carbonates, with interbedded silts (e.g. the Etina and Trezona Formations). The Marinoan glaciation is best represented in the southeastern (e.g. Pepuarta Tillite) and northeastern (e.g. Mount Curtis Tillite) regions of the Adelaide Geosyncline. The approximate equivalents of these tillites to the west are the sandstones (with local tillite at the top, e.g. Mawson, 1949) of the Elatina Formation. The Reynella Siltstone Member (Thomson, 1966a), a poorly sorted gritty red siltstone, partly massive and resembling the matrix of the Elatina Formation tillite, is widespread over the Adelaide, south Flinders Ranges and Stuart

Shelf regions. Although it is not a tillite, it does contain rare pebbles that may be of glacial derivation. In the Barrier Ranges, New South Wales, the Marinoan glaciation is represented by the Teamsters Creek Subgroup, comprising the Nunduro Conglomerate, Dering Siltstone with dropstones, Gairdner's Creek Quartzite and Alberta Conglomerate (Cooper & Tuckwell, 1971).

Wilpena Group (Table 5). The Marinoan glacials and their non-glacial equivalents are generally conformably overlain by the Nuccaleena Formation (laminated pink "cap dolomite"), which marks the onset of post-glacial transgression. It grades up into the overlying succession, and is regarded as the basal formation of the Wilpena Group, except in the Adelaide region, where the Seacliff Sandstone at the base of the Wilpena Group contains interbeds of similar pink dolomite. The Brachina Formation and overlying ABC Range Quartzite reflect a major transgressive-regressive deltaic cycle, as described by Plummer (1978), who also demonstrated intertonguing of the two formations in the southwest Flinders Ranges. The upper Wilpena Group represents a second major transgressive-regressive cycle, the sediments of which are mainly restricted to the Flinders Ranges; they were either not deposited, or were subsequently eroded off before the Early Cambrian transgression, on the Stuart Shelf and in the Adelaide region. Early Cambrian sediments are everywhere disconformable on the Adelaidean. In the Flinders Ranges, Cambrian rocks rest on the Pound Subgroup, most commonly the Rawnsley Quartzite, but in places the disconformity has cut below this level on to the Bonney Sandstone.

In the Barrier Ranges, the Farnell Group (commencing with a laminated dolomite) is at least in part equivalent to the Wilpena Group: it contains siltstones and quartzites, but exact correlation with units of the Wilpena Group is uncertain. The uppermost formation of the Parnell Group (Lintiss Vale Formation) has been correlated by Daily (1974) with the basal Cambrian Uratanna Formation on the basis of trace fossils.

Geochronology

Geochronological data on the Adelaidean stratotype are still extremely limited; they include equivocal Rb/Sr data on basement metamorphics and early Adelaidean volcanics, and Rb/Sr whole rock isochrons from sediments and volcanics on the Stuart Shelf. Within the Adelaide Geosyncline, however, the overprinting effects of the early Palaeozoic Delamerian Orogeny prevent unambiguous inter-preation of the data. Where necessary, dates quoted in this paper have been recalculated using the decay constant $\lambda Rb^{87} = 1.42 \times 10^{-11}$.

On the Gawler Craton, high grade metamorphism and subsequent extrusion of acid volcanics (Galwer Range Volcanics) had ceased by about 1 400 Ma ago. The basic Roopena Volcanics unconformably overlie the basement rocks, and were dated at 1317±30 Ma (Compston *et al.*, 1966; Thomson, in press.) Although early work favoured correlation of the Roopena Volcanics with the Willouran Wooltana Volcanics of the Mount Painter region, recent drilling and stratigraphic studies have revealed a younger suite of basic volcanics, the Beda Volcanics, on the eastern Stuart Shelf (Mason *et al.*, 1978). A preliminary Rb/Sr dating of 1076±34 Ma is quoted by Thomson (in press).

The Wooltana Volcanics of the fold belt occur not far above the base of the Adelaidean sequence in the Flinders Ranges. Age determination of them is therefore crucial to determining the age of the base of the Adelaidean. Compston *et al.*, (1966) and Cooper (1975) suggested an age of about 800 Ma for these volcanics, although this estimate is based on very poorly defined isochrons. Mason *et al.*, (1978) now prefer correlation with the Beda Volcanics of the Stuart Shelf, but this would suggest that the Wooltana

Volcanics have been partially updated by a younger event. Giles & Teale (1979) present geochemical data that support the Beda - Wooltana correlation.

Within the fold belt just east of Adelaide, the Houghton Inlier of high grade metasedimentary rocks has been strongly affected by Palaeozoic retrograde metamorphism. Cooper & Compston (1971) dated some of the freshest metasediments in the inlier at 849 ± 31 Ma. The metasediments are unconformably overlain by basal Burra Group (Aldgate Sandstone).

On the Stuart Shelf, upper Adelaidean sediments are essentially flat-lying. There the Tapley Hill Formation has been dated at 750 ± 53 Ma, while a less well defined isochron on the Woomera Shale Member (equivalent to the Brachina Formation) gives an age of 676 ± 204 Ma (Thomson, in press.). Despite the large error, these dates are mutually consistent, and show that the sediments have escaped Delamerian overprinting.

No unequivocal interpretation of all the age data is as yet possible, but the following conditional conclusions may be drawn.

(1) The late Adelaidean, beginning with the Sturtian glaciation, commenced not long before about 750 Ma.

(2) If the dating of about 850 Ma on the Houghton Inlier really represents the age of a high grade metamorphism, then the Torrensian at least must be younger than about 800-850 Ma, thus leaving only a short span of time for deposition of the Burra Group. On the other hand, the 850 Ma basement age has not been duplicated elsewhere, and awaits confirmation as representing a unique geological event.

(3) The Wooltana Volcanics could be about 800 Ma old, thus post-dating the possible young metamorphism of the Houghton Inlier basement, or they may correlate with the Beda Volcanics of the

Stuart Shelf (about 1100 Ma). If the latter, the young metamorphism of the basement would have to be of Willouran age, but there is no evidence of Willouran sediments being involved in the inlier.

These questions were previously considered in relation to stromatolite biostratigraphy (Preiss, 1977); then it was concluded that the available rediometric data favoured an age of about 800 Ma for the base of the Adelaidean, but now the likely correlation of the Beda Volcanics with the Wooltana Volcanics renders this less probable, and implies that the younger ages of around 800 Ma from within the fold belt may result from partial overprinting.

Biostratigraphy. Stromatolites of the Adelaide Geosyncline have been studied and described (Preiss, 1972, 1973a, 1973b, 1974) and their biostratigraphic application and problems summarised (Preiss, 1977). Most were newly described forms, not previously known from other regions, although they could be assigned to groups defined by Russian authors. In previous publications, it has been considered that the Russian forms Linella ukka, Inzeria cf. I. tjomusi, Gymnosolen cf. G. ramsayi and Conophyton garganicum occur in the Adelaide Geosyncline. Recently, however, Dr. I.N. Krylov has examined this material and concluded that only Conophyton garganicum can be validly assigned to a Russian form (Preiss & Krylov, in press); the others are all endemic to South Australia, although a close comparision can be made of those from the Umberatana Group with certain as yet unpublished forms from the Late Riphean and Vendian of the Patom Region of the USSR.

Adelaidean stromatolite occurrences may thus be summarised as follows:

Callanna Beds: Acaciella cf. A. australica and Gymnosolen f. (Preiss, 1973 c); Conophyton garganicum (Preiss, 1973 b).

Burra Group: Baicalia burra, Tungussia wilkatanna. (Preiss, 1972, 1974).

Umberatana Group: Acaciella augusta, ?Boxonia melrosa (Preiss, 1972); Inzeria conjuncta, I. multiplex, Inzeria f., Jurusania burrensis, Katavia costata, Kulparia kulparensis (Preiss, 1973b) Linella munyallina, Linella f., ?Omachtenia f., Tungussia etina (Preiss, 1974); Gymnosolen f. occurs in boulders in the Tapley Hill Formation (Preiss, 1973 b).

Wilpena Group: Tungussia cf. T. julia (Walter, Krylov et al., 1979); Linella f. (Preiss, unpubl.)

Initially, the early Adelaidean assemblage with Baicalia, Tungussia and Conophyton garganicum was compared with Middle Riphean assemblages of the USSR (Glaessner et al., 1969, Walter, & Preiss, 1972) and a correlation of the early Adelaidean Callanna Beds and Burra Group with the Middle Riphean (1350 ± 50 Ma to 850 ± 50 Ma) was suggested. This was consistent with the then widely accepted 1300 to 1400 Ma estimate for the base of the Adelaidean (Thomson, 1966b). The subsequent discovery in the Callanna Beds of stromatolites of Late Riphean aspect (Acaciella, Gymnosolen: Preiss, 1973b) indicated an overlap in the time ranges of apparently Middle and Late Riphean groups in South Australia. On the basis of the geochronological data then available, and on the known occurrence of some forms of Baicalia in the Late Riphean, Preiss (1977) suggested that the early Adelaidean was best considered as a partial equivalent of the Late Riphean, which implied an upward extension in the time range at least of Conophyton garganicum. However, it is now clear that except for Conophyton garganicum, none of the critical early Adelaidean stromatolites is identical to known Russian forms, and that correlations should not be based on group-level identifications alone. Thus from a biostratigraphic point of view, the age of the base of the Adelaidean remains unresolved. If the Beda Volcanics-Wooltana Volcanics correlation (see above) and the Beda age estimate of about 1100 Ma are accepted, then the Callanna Beds at least must be Middle Riphean (this would be in agreement with the known time range of Conophyton garganicum in the USSR, but would require a downward extension in the time ranges of Acaciella and Gymnosolen).

The Ediacara assemblage (Jenkins & Gehling, 1978) of soft-bodied metazoan fossils is so far known only within a relatively narrow interval in the lower part of the Rawnsley Quartzite. Its biostratigraphic significance was discussed by Glaessner (1971), who recorded nine species of medusoids, three species of Chondrophora, one species of Conulata, two species of Scyphozoa and four species of Pennatulacea (all Coelenterata), five species of polychaete worms, two species of arthropods and one genus of uncertain affinity. Glaessner (1971) listed the known distribution of similar faunas throughout the world. Their age range can be defined only in general terms; they generally overlie the youngest late Precambrian tillites and appear to be restricted to beds between about 700 Ma and the base of the Cambrian in age.

THE AMADEUS BASIN

The late Proterozoic succession of the Amadeus Basin has long been recognised; e.g. Madigan (1932) subdivided it into a lower Pertaknurra "Series" and upper Pertatataka "Series". Wells et al. (1967) and Wells et al. (1970) summarised the stratigraphy as interpreted from regional mapping of the Amadeus Basin. More detailed studies include those of Clarke (1975) on the Heavitree Quartzite and Walter (1972) on the Bitter Springs Formation, while important revisions to the stratigraphy were proposed by Preiss et al. (1978).

The late Proterozoic sequence can be correlated in part with the Adelaidean of the Adelaide Geosyncline on lithostratigraphic grounds, in particular on the basis of late Adelaidean tillites. However, the early Adelaidean successions of the two basins are only broadly similar, and cannot be matched directly on a formation by formation basis. Nor is the age relationship between the bases of the successions known. The stratigraphy of the Adelaidean sequence in the Amadeus Basin is summarised in Table 6.

The basal Heavitree Quartzite unconformably overlies various granitic and metamorphic basement rocks belonging to the Arunta Complex, along the present northern limit of exposure of the Amadeus Basin. At the southern margin, the equivalent Dean Quartzite rests unconformably partly on metamorphic basement of the Musgrave Block, and partly on older sediments and volcanics. Clarke (1975) subdivided the Heavitree Quartzite into four members: a basal siltstone (?lacustrine), a pebbly sandstone and conglomerate (?fluvial), an open marine to littoral sand, and an upper quartzitic member, also interpreted as open marine grading up to littoral. Current direction measurements suggested sediment transport from the east and north-east.

The predominantly carbonate Bitter Springs Formation conformably overlies the Heavitree Quartzite along the northern margin of the Basin. A more shaly sequence in the south is referred to the Pinyinna Beds. The lower Gillen Member of the Bitter Springs Formation contains minor stromatolitic dolomite not far above the base, but most of it consists of siltstone, shale and fine grained dolomite, with local evaporites (Stewart, 1979). Sediments of the Gillen Member are frequently complexly deformed in response to basinward directed thrusts originating in the Arunta Complex to the north. The overlying Loves Creek Member consists of stromatolitic limestone and dolomite (Walter, 1972). Microfossils are abundantly preserved in very early diagenetic black cherts (e.g. Schopf, 1968). Red silty dolomite, spilitic volcanics, siltstone and sandstone are minor constituents.

The contact with overlying (late Adelaidean) sediments is everywhere a disconformity (cf. the base of the Umberatana Group in South Australia). The Areyonga Formation, of Sturtian age, is characterised by tillite, with associated conglomerate, sandstone, siltstone and dolomite. This unit was originally thought to be very extensive, but Preiss et al. (1978) showed that the more widespread upper arkosic sandstone formerly included in the Areyonga Formation, lies disconformably on the tillites or on older units. The Areyonga Formation (redefined to exclude the sandstone) is preserved only as erosional remnants along this disconformity; the sandstone was defined as a new formation (Pioneer Sandstone), and was regarded as a possible non-glacial equivalent of the upper (Marinoan) tillites. In the extreme east of the Amadeus Basin, the most complete section of rocks equivalent to the Umberatana Group is preserved above the Areyonga Formation. The Aralka Formation is a sequence of thinly laminated grey to green siltstones closely comparable with the Tapley Hill and Amberoona Formations of South Australia. Immediately above the Areyonga Formation tillites, which are here thicker than in the western Amadeus Basin, there are thinly laminated carbonaceous dolomites and shales (cf. at the base of the Tapley Hill Formation in South Australia). These were included by Walter and Wells (in Preiss et al., 1978) in the Areyonga Formation, but they overlie the tillites with a sharp contact and grade into the overlying siltstones. They are thus better included in the Aralka Formation, and mark the beginning of the post-glacial transgression. The upper parts of the Aralka Formation contain many of the facies represented in the Umberatana Group of South Australia, e.g. the Ringwood Member consists of sandy, oolitic and stromatolitic limestones indistinguishable from the Etina Formation; the Limbla Member contains gritty limestones (cf. Etina Formation) and festoon cross-bedded sandstones, similar to sandstone interbeds in the upper parts of the Willochra Subgroup. In these eastern sections, the Olympic Formation represents the Marinoan glaciation; it contains tillite with abundant glaciated clasts and a red silty matrix, minor sandstone, conglomerate, siltstone and sandy dolomite. It is probably disconformable on the Aralka Formation (Wells, 1969).

Upper Marinoan sequences of the Amadeus Basin are also closely comparable to those of the Adelaide Geosyncline. A thinly laminated pink to buff dolomite, analogous to the Nuccaleena Formation, caps the Olympic Formation tillites, and was included by Walter and Wells (in Preiss et al., 1978) in that formation. The overlying Pertatataka Formation is dominantly siltstone and shale (red, green, grey) with fine grained sandstone interbeds. In the western Amadeus Basin, the Pertatataka Formation overlies the Pioneer Sandstone conformably, and contains a thin, lenticular orthorquartzite with clay intraclasts near the middle of the section. This sand influx may represent a similar regressive phase to that of the ABC Range Quartzite. The Pertatataka Formation thus correlates best with the Brachina Formation to Bunyeroo Formation of the Adelaide Geosyncline. In the eastern part of the Amadeus Basin, the Cyclops Member (thin bedded platy sandstone) and the Waldo Pedlar Member (siltstone, thin bedded sandstone and minor quartzite) may reflect similar regressive phases. The Julie Formation gradationally overlies the Pertatataka Formation and consists of oolitic limestone and dolomite and minor silty limestone. Stromatolites are locally present in the eastern sections where the formation is thicker (Walter, Krylov et al. 1979). The Julie Formation has a similar stratigraphic position to the Wonoka Formation, but although there are lithological similarities the Julie Formation contains more limestone with obvious shallow water features.

The lower part of the Arumbera Sandstone is the youngest Precambrian unit in the Amadeus Basin. The Arumbera Sandstone, which conformably overlies the Julie Formation has been divided into three members (Daily, 1972), the upper two of which contain probably Early Cambrian trace fossils and disconformably overlie the lower member. This disconformity may reflect the Peterman Ranges Orogeny recorded in the south-west Amadeus Basin. The lower member may be a partial correlative of the Pound Subgroup; it is of similar facies to the Bonney Sandstone, consisting of red siltstone overlain by fine to coarse grained red sandstone.

Geochronology

The sedimentary sequence in the Amadeus Basin is younger than the most recent metamorphic event in the Arunta Block, dated at 1053±50 Ma (Marjoribanks & Black, 1974). An earlier estimate of an "apparent maximum age" of the Bitter Springs Formation of 1145 Ma (quoted by Wells *et al*., 1967) was based on a single sample and an assumed initial Sr^{87}/Sr^{86} ratio and is thus clearly too old. The age of the Bitter Springs Formation must lie between 1050 Ma and 700-800 Ma (approximate age of the Sturtian glacials); this age range is consistent with Walter's (1972) correlation with the Late Riphean (950 ± 50 Ma to 680 ± 20 Ma) of the USSR.

Compston & Taylor (1969) obtained a Rb/Sr isochron age of 715±45 Ma on samples from the Winnall Beds and Pertatataka Formation, but the significance of this date is uncertain, since the rocks contain a large proportion of detrital minerals (e.g. "subgreywackes") and the samples span almost the whole thickness of the formation (Walter, 1972). Such a date is a little older than ages obtained from presumed equivalents on the Stuart Shelf and the Kimberley Region (see below).

Biostratigraphy

Stromatolites from the Amadeus Basin have been described by Walter (1972). The Bitter Springs Formation contains an assemblage that has no groups in common with the Burra Group of South Australia. The stromatolites are mainly new forms of groups known from the Late Riphean of the USSR: Inzeria intia, Boxonia pertaknurra, Minjaria pontifera, Jurusania nisvensis, Kotuikania juvensis, Tungussia erecta. Also present are new groups (Acaciella australica, Kulparia alicia, Basisphaera irregularis) and Linella ?avis (previously known from the Vendian of the USSR). Walter (1972) interpreted this as a typical Late Riphean assemblage, and assigned a Late Riphean age to the Bitter Springs Formation.

The Boord Formation (a probable western equivalent of the Areyonga Formation) contains a distinctive but completely new stromatolite, Tesca stewartii (Walter, Krylov et al., 1979). These stromatolites may have biostratigraphic value in the future if other occurrences are found.

The Ringwood Member and the Julie Formation both contain new forms of the long-ranging stromatolite group Tungussia (T. inna and T. julia respectively) (Walter, 1972; Walter, Krylov et al., 1979).

The Arumbera Sandstone I contains Rangea, an element of the Ediacara Metazoan assemblage (Daily, 1972), supporting correlation with the Pound Subgroup, and Arumberia banksi, provisionally regarded as a coelenterate (Glaessner & Walter, 1975).

NGALIA BASIN

The Ngalia Basin is tectonically similar to the Amadeus Basin, and is situated to the north of it. It is significantly smaller, however, and contains a less complete record of Adelaidean sedimentation (Table 7), principally because of more marked hiatuses and disconformities. The basal Vaughan Springs Quartzite, which conformably overlies the basement of the Arunta Complex, has been closely compared with the Heavitree Quartzite, (Clarke, 1975), and correlation of these units is widely accepted. Indeed, outcrops of quartzite, tightly infolded into the basement, are almost continuous between the two basins. The Vaughan Springs Quartzite is mostly a well sorted pink quartzite, with hematitic pebbly sandstone at the base. In the lower part, it contains the siltstones and fine, glauconitic sandstones of the Treuer Member. Wells (1978) reported "foetid stromatolitic dolomite, in places with black chert and shale... considered to be the preserved remnant of an older formation" below the upper Adelaidean units, and considered it a possible equivalent of the Bitter Springs Formation of the Amadeus Basin.

Along the northwestern margin of the Ngalia Basin, local remnants of upper Adelaidean sediments are preserved beneath the more widespread Palaeozoic sequences. A very thin diamictite (about 2 m) with a greenish silty matrix (the Naburula Formation) unconformably overlies the granitic basement and represents the Sturtian glacials; it is overlain by thinly laminated silty shales with grey dolomite interbeds similar to those above the Areyonga Formation in the Amadeus Basin, and above the Sturtian tillites in South Australia (Preiss et al., 1978). The overlying green Rinkabeena Shale correlates in part with the Aralka Formation, but is much thinner and does not contain differentiated members. It is followed, with erosional contact, by tillites of Marinoan age, the Mount Doreen Formation (Wells, 1972), which consists of diamictite with large glaciated erratics set in a greenish silty matrix, pebbly sandstone and conglomerate. An unnamed laminated pink-buff dolomite, locally stromatolitic, and similar to the "cap dolomite" overlying tillite of the Olympic Formation, caps the glaciogenic sequence, and grades up into red shales. The whole Adelaidean succession is truncated by Ordovician sandstones in this section.

Elsewhere, the latest Precambrian-Early Cambrian Yuendumu Sandstone unconformably overlies the older sequences. It is a red-brown fine to medium grained sandstone, with local coarse basal arkose, and is a lithological correlative of the Arumbera Sandstone of the Amadeus Basin. Like the Arumbera Sandstone, it contains trace fossils in its upper part, and has been divided into three members. Burek et al. (1979) found an unconformity separating the lower member from the upper part with trace fossils, and correlated the lower member with the Precambrian Arumbera Sandstone I. Magnetostratigraphic (polarity) data given by them are consistent with this correlation, though not conclusive.

Geochronology

Cooper et al. (1971) dated glauconite from the Treuer Member of the Vaughan Springs Quartzite by both K/Ar and Rb/Sr isochron techniques. K/Ar dating of 5 samples gave ages ranging from about 1 000 to 1 200 Ma, while the Rb/Sr isochron (obtained by joining only two points, as the others lie off that line) gave an estimated minimum age of 1 253 Ma. These dates are all older than the youngest basement metamorphism at 1053±50 Ma occurring between the Amadeus and Ngalia Basins (Marjoribanks and Black, 1974). The basal quartzites of the two basins can be confidently correlated and indeed almost traced continuously between them. These old glauconite ages are therefore of uncertain significance; they are almost certainly older than the age of sedimentation, and may reflect an inherited age from incomplete homogenisation during syngenetic growth of the glauconite. Alternatively, the glauconite could be detrital, but no unmetamorphosed sedimentary sequences of that age are known from the vicinity of the Ngalia Basin.

OFFICER BASIN

The Officer Basin is a third area of late Proterozoic to mid-Palaeozoic sedimentation in central Australia. Like the

Amadeus and Ngalia Basins to the north, its present area of outcrop is oriented east-west, and its northern margin is at least partly determined by Palaeozoic tectonics. The Adelaidean portion of the Officer Basin succession (Table 8) shows close links with the Adelaide Geosyncline. The Musgrave Block of high grade metamorphic basement rocks now separates the Amadeus from the Officer Basin, and has a long and complex history. Although the ages of high grade metamorphism and subsequent granitic intrusives have been variously interpreted, early Adelaidean clastic-carbonate sequences (the Pindyin Beds and Wright Hill Beds) are known to be younger than 1100 Ma granitic intrusives (Major, 1973 a,b). However, at the western end of the Musgrave Block, a largely volcanic complex (the Bentley Supergroup of Daniels, 1974) overlies the metamorphic basement. Volcanics of the Tollu Group within it have been dated at 1037±140 Ma (Compston and Nesbitt, 1967). These are unconformably overlain by the Townsend Quartzite, which is generally correlated with the Pindyin Beds to the east. The Pindyin Beds consist of basal conglomerate, feldspathic sandstone, medium to coarse quartzite with cross-bedding and clay pebbles, shale, siltstone and lenticular chert, with thin limestone and dolomite bands near the top (Major, 1973a). The Wright Hill Beds (oolitic black chert, grey chert, feldspathic quartzite with quartz and feldspar granules) apparently overlie the Pindyin Beds though the contact is not exposed (Major, 1973b). These sequences are tentatively correlated with parts of the Burra Group. In the Western Australian part of the Officer Basin, there are isolated outcrops of carbonate rocks thay may be partial equivalents of these early Adelaidean sequences, e.g. the Ilma Beds (Lowry, 1970) and dolomites at the central Neale area contain stromatolitic dolomites with *Baicalia* cf. *B. burra* (Preiss, 1976), suggesting comparison with the Burra Group of South Australia. The Woolnough

Hills Diapir apparently intrudes a sequence of dolomites containing Acaciella f. indet. (Preiss, 1976) and microfossiliferous cherts comparable with those of the Bitter Springs Formation have been found in the Madley Diapirs by Walter (Casey, 1978, p. 50).

At the eastern end of the Officer Basin Krieg (1973) recorded a sequence of siltstones with interbedded white quartzites, resting unconformably on the Musgrave Block basement. These were tentatively correlated with the earliest Sturtian Belair Subgroup, and are unconformably overlain by the Chambers Bluff Tillite. This unit of greenish pebbly siltstones and shales with glaciated clasts and with feldspathic quartzite interbeds, is associated with sedimentary ironstones; it may represent the earlier of the two Sturtian glacial phases (Coats, in press.) The Wantapella Volcanics (vesicular basalt) conformably overlie the Chambers Bluff Tillite and are the only volcanics known to be associated with Sturtian tillites. Equivalents of the remainder of the Umberatana Group disconformably overlie the volcanics: the Tapley Hill Formation has a basal feldspathic sandstone and conglomerate member, followed by typical laminated siltstone and shale; the overlying Rodda Beds consist of grey-green siltstone with partly silty or sandy dolomite interbeds, and minor feldspathic and calcareous sandstone and conglomeratic bands (Krieg, 1973). These correspond to the middle of the Umberatana Group, while a second tillite above this sequence probably represents the Marinoan glaciation (R.B. Major, pers. comm. in Krieg, 1973; Coats, in press). In the western Officer Basin, the Punkerri Beds are a lithostratigraphic equivalent of the Pound Subgroup, and also contain elements of the Ediacara metazoan assemblage (Major, 1974). The whole Adelaidean sequence in the north-east Officer Basin was folded prior to the deposition of the succeeding early to mid Palaeozoic clastic sequences.

Geochronology

Six shale samples from the Chambers Bluff Tillite yielded a Rb/Sr whole rock isochron of 651±87 Ma (Webb, 1978). This is younger than the expected age of sedimentation, but may reflect the folding that produced the angular unconformity between Adelaidean and Palaeozoic rocks in the area.

BANGEMALL BASIN

Although predating the bulk of the Adelaidean, deposition occurred also to the west of the Musgrave Block in the important Bangemall Basin. The Bangemall Group unconformably overlies folded early Proterozoic sequences, and forms an east-west oriented arcuate outcrop area, showing important facies changes between western, northern and eastern zones (Daniels, 1966; Brakel & Muhling, 1976). The sequence in the western zone consists dominantly of dolomite, shale and chert, overlying basal coarse sandstone, in the lower part, and passes upwards into siltstones, shales, black cherts and fine sandstones with an intercalation of turbidites introduced from the northwest. There are local minor acid volcanic contributions. The basal sequence in the northern zone is dominantly dolomitic, but with a local wedge of arkose and conglomerate. The eastern zone contains basal terrestrial coarse clastics, passing up into finer clastics.

Geochronology

Gee et al. (1976) dated small rhyolite bodies not far above the base of the Bangemall Group in the central part of the basin at 1075±42 Ma (Rb/Sr whole rock isochron) while black shales from higher in the sequence yielded an age of 1057±80 Ma by the same method (Compston & Arriens, 1968). These dates suggest a correlation with the Bentley Supergroup acid volcanics of the western Musgrave Block, and also approximate contemporaneity with the Beda Volcanics of the Stuart Shelf. Thus if the correlation of the Beda Volcanics with early Adelaidean volcanics of the Adelaide Geosyncline is correct, then the Bangemall Group may overlap in age with the earliest deposition in the Adelaide Geosyncline.

Biostratigraphy

The Bangemall Group contains numerous stromatolites, of which Baicalia capricornia and Conophyton garganicum australe, although not identical to any Russian forms, are most closely comparable to those of Middle Riphean (1350±50 Ma to 950±50 Ma) assemblages (Walter, 1972. The occurrence of Acaciella cf. A. australica in the Bangemall Group (Grey, 1978) is thus older than the type occurrences in the Bitter Springs Formation; it may however be of similar age to Acaciella cf. A. australica from an early Willouran dolomite of the Peake and Denison Ranges, South Australia, if the Beda Volcanics correlation is correct.

GEORGINA BASIN

Late Proterozoic sequences in the southwestern Georgina Basin were originally referred to the Field River Beds (Smith, 1963) and the Mopunga Group (Smith 1964). Recent mapping by the Bureau of Mineral Resources (Walter, in press) has led to the subdivision of these sequences and more precise correlation with the better known successions of the Amadeus Basin. In the Huckitta 1:250 000 map sheet, area, the Arunta Complex basement is unconformably overlain by the Mount Cornish Formation, locally a very thick sequence of green silty diamictite and green varve-like siltstone. The basal 26 m of the originally defined type section (Smith, 1964) are lithologically distinct from the remainder of the sequence, consisting of feldspathic grits, fine red sandstone and stromatolitic dolomite. This basal unit has now been assigned to the early Adelaidean Yackah Beds (Walter, in press). Elsewhere in the Huckitta area, thinner glacial sequences of the Mount Cornish Formation are overlain disconformably by the coarse grained Oorabra Arkose and succeeding Mopunga Group (Table 9). The Elkera Formation was originally included in the Grant Bluff Formation by Smith (1964), though much of it was shown as Mount Baldwin Formation on the Huckitta map sheet. Thus Walter's (1972) record of the stromatolite *Georginia howchini* from the Mount Baldwin Formation is now placed in a dolomite in the Elkera Formation, which Walter (in press) correlates with the Julie Formation of the Amadeus Basin. The Mount Baldwin Formation is now considered to be entirely Cambrian.

On the Hay River 1:250 000 map sheet area, all the Adelaidean rocks were formerly assigned to the Field River Beds. A new subdivision is proposed by Walter (in press). The early Adelaidean is represented by the Yackah Beds, consisting of fine to coarse sandstone, shale and dolomite, that nonconformably overlie granitic basement. The stromatolite *Acaciella australica* has now been recognised from the Yackah Beds, suggesting possible correlation with the Bitter Springs Formation of the Amadeus Basin (Walter *et al.*, in press). The late Adelaidean succession commences with the disconformably overlying Yardida Tillite, which is lithologically similar to the Mount Cornish Formation and also attains great thicknesses in grabens. The succeeding formations are assigned to the Keepera Group (Walter, in press): the Black Stump Arkose correlates in lithology and stratigraphic position with the Oorabra Arkose, and by analogy with the Pioneer Sandstone of the Amadeus Basin, it is considered a possible facies variant of the Marinoan tillites. The possibly disconformably overlying Wonnadinna Dolomite is considered by Walter (in press) as equivalent to the "cap dolomites" above Marinoan glacials elsewhere, but it is much thicker and lithologically dissimilar. The gradationally overlying Gnallan-a-Gea Arkose apppears to have no lithological equivalent elsewhere, but Walter (in press) suggests that it may correlate approximately with the Waldo Pedlar Member of the eastern Amadeus Basin. The thinly bedded sandstone, locally with interbedded siltstone, of the Grant Bluff Formation (type section on the Huckitta map sheet area) was originally considered as early Cambrian, but Burek et al. (1979) have argued from magnetostratigraphy that it and its underlying formations are older. It is now considered equivalent to the lithologically very similar Cyclops Member of the Amadeus Basin, and a significant time break is inferred before the deposition of the Adam Shale, from which Walter, Shergold et al. (1979) have described Early Cambrian acritarchs.

At central Mount Stuart, and in its vicinity, situated between the Ngalia and Georgina Basins, diamictite unconformably overlies the Arunta Complex. Preiss et al. (1978) noted lithological similarities with the older of the Sturtian glacials in South Australia. At Central Mount Stuart, where it occurs at the base of the Central Mount Stuart Formation, the diamictite passes up without obvious unconformity into a thick clastic sequence, equivalents of which contain a late Precambrian coelenterate fauna near the top (Wade, 1969; Walter, in press). If the glacials are indeed earliest Sturtian, this would imply a major hiatus within the Central Mount Stuar Formation but this is far from certain. Parts of the formation resemble the Cyclops and Waldo Pedlar Members of the Pertatataka Formation of the Amadeus Basin. Walter (in press) correlates the upper part with the Arumbera Sandstone I, on lithologic and biostratigraphic grounds.

De Keyser (1972) described an isolated downfaulted wedge of late Proterozoic sediments, lying unconformably over metamorphic basement and dipping under fossiliferous Middle Cambrian strata, in the Burke River area, eastern Georgina Basin. This sequence, the Mount Birnie Beds, commences with a tillite, containing rounded to sub-rounded facetted and polished clasts in a purple to brown silty matrix (the Little Burke Tillite). As pointed out by de Keyser (1972) the Mount Birnie Beds are closely comparable to the Moonlight Valley Tillite and overlying sequence of the East Kimberley Region (see below). The Tillite is overlain by a typical pink to cream "cap dolomite", followed by red ferruginous sandstone, then red and green shale, with thinly bedded red micaceous quartz sandstone, sandy siltstone, shaly sandstone with rare dolomite lenses at the top. On lithostratigraphic grounds, it is most likely to be a Marinoan glacial and post-glacial sequence.

Geochronology

Shales from unspecified levels in the Field River Beds have yielded Rb/Sr whole rock isochron ages of about 770 and 600 Ma (Compston & Arriens, 1968).

KIMBERLEY REGION, WESTERN AUSTRALIA

The geology of the Kimberley Region has recently been summarised by Plumb & Gemuts (1976). Early Proterozoic meta-sediments and metavolcanics, and high grade metamorphic and igneous complexes, intruded by 1800 Ma old granites, form the basement to thick platform cover sequences, the youngest of which are of Adelaidean age (Table 10), and include well documented tillites, e.g. (Dow 1965). The radiometric ages of possible early Adelaidean sequences in the Kimberley Region are not yet well defined, nor can they be confidently correlated with those of other basins. In the East Kimberleys, east of the basement inlier exposed in the Halls Creek Mobile Zone, clean quartz sandstone (Wade Creek Sandstone) unconformably overlaps sediments of probably mid-Proterozoic age (e.g. the Bungle Bungle Dolomite that contains abundant stromatolities and microfossiliferous cherts), and passes upwards into laminated green Helicopter Siltstone. Compston & Arriens (1968) quote an age of 1106 ± 110 Ma for the Mount John Shale Member of the Wade Creek Sandstone. In places within the Halls Creek Mobile Zone, the Glidden Group (black shale, micaceous sandstone, well sorted quartz sandstone, shale and subgreywacke) unconformably overlies the early Proterozoic basement; a shale from the Glidden Group has been dated at 1008±25 Ma. In the northern part of the Halls Creek Mobile Zone, the Carr Boyd Group of grossly similar lithologies (quartz sandstone, subgreywacke, conglomerate, micaceous sandstone, siltstone, shale) has been dated by shale whole rock isochrons from three successive horizons: 1160±125 Ma, 1057±80 Ma and 881 ± 85 Ma (compston & Arriens, 1968). Thus these three areas of the Kimberley Region received clastic sediments between 800 and 1200 Ma ago, and the sequences are in part at least of early Adelaide age, and in part older.

To the east of the Kimberleys lies the pre-Adelaidean Birrindudu Basin, in which dolomite, siltstone, shale, chert and sandstone of the Limbunya Group were deposited (Sweet, 1977). These are unconformably overlain by a number of mutally unconformable sequences, all of which underlie the eastern extension of the late Adelaidean Duerdin Group; Sweet (1977) considered these sequences, deposited in the Victoria River Basin, to be Adelaidean also. The lowest of them, the Wattie and Bullita Groups (sandstone, siltstone, shale, dolomite, chert) and probably equivalents of the Tolmer Group that outcrops south of Darwin (Sweet, 1977). Cloud & Semikhatov (1969) described the stromatolite *Inzeria tjomusi* from the Tolmer Group, and indicated that the then accepted age estimate of the Tolmer Group (600-700 Ma) was consistent with the known age range of that form of stromatolite (Late Riphean, 950-650 Ma). However, on the basis of Sweet's (1977) correlation, the Tolmer Group must be much older than this, for the Bullita Group is unconformably overlain by the Wondoan Hills Formation, from which glauconite has yielded a K/Ar minimum age of 1080±14 Ma and a Rb/Sr isochron age of 1165±30 Ma. The Wondoan Hill Formation and overlying Stubb Hill Formation (both consisting of sandstone, siltstone, shale and minor dolomite) are followed unconformably by the Auvergne Group of the Victoria River Basin. Sweet (1977) correlated the Angalarri Siltstone of the Auvergne Group with the Helicopter Siltstone of the East Kimberleys, but quotes a Rb/Sr whole rock isochron age of 820±80 Ma. If this is the age of deposition, it would imply a long time break between the Angalarri Siltstone and the 1100 Ma old Wade Creek Sandstone (immediately below the Helicopter Siltstone) in the East Kimberleys.

Late Adelaidean glaciogenic sequences are widespread and well developed in the Kimberley Region, frequently being associated with glaciated pavements (Harms, 1959; Dow & Gemuts, 1969). Use of the tillites as stratigraphic markers has been widely accepted. Separate stratigraphic nomenclature has been developed in the three major areas of outcrop of glaciogenic sequences, i.e. the East Kimberleys, the Mount Ramsay area, and the West Kimberleys. Only in the Mount Ramsay area are there lower and upper glacials together in the same sections. Dow & Gemuts (1969) expressed some uncertainty regarding correlation between the three areas, but tentatively correlated the glacials of the East Kimberleys (Moonlight Valley and Fargoo Tillites) with the first glacials of the Mount Ramsy area (Landrigan Tillite). This was accepted by later authors, and correlation with the Walsh Tillite of the West Kimberleys was added (e.g. Plumb & Gemuts, 1976). Dunn *et al.* (1971) considered these earlier tillites to be of Sturtian age, and the younger tillites of the Egan Formation (Mount Ramsay area only) to be Marinoan.

Recent reexamination of the late Adelaidean tillite-bearing sequences of the Kimberley Region by Coats & Preiss (1979) has suggested more precise correlations, both within the Kimberleys and with other Australina basins. It was suggested that the glaciations in the Kimberleys be named after tillites that occur together in the same stratigraphic sections, i.e. Landrigan and Egan glaciations. The revised correlations imply that only the Landrigan Tillite is of Sturian age, while the more widespread tillites (Moonlight Valley and Fargoo Tillites of the East Kimberleys, Egan Formation of the Mount Ramsay area and Walsh Tillite of the West Kimberleys) are all of Marinoan age. These correlations are based on specific lithological comparisons of sequentially consistent successions, both within the three areas of the Kimberleys, and with other late Proterozoic basins in Australia. Continuity of sedimentation in shallow shelf seas across a large part of the Australina continent is implied.

The late Adelaidean stratigraphy of the Kimberleys is summarised below. In the Mount Ramsay area, a relatively thick sequence of diamictites with green, silty matrix and interbedded sandstone and laminated siltstone (the Landrigan Tillite) accumulated in a graben, while the thickness of its equivalent outside the graben is greatly reduced. Greywacke of the Stein Formation occurs above the Landrigan Tillite only within the graben, and is followed by thinly laminated siltstones of the Wirara Formation. Outside the graben, the base of the Wirara Formation is marked by a lenticular brown-weathering dolomite and thinly laminated silty shale. The Wirara Formation resembles the Tapley Hill Formation of the Adelaide Geosyncline, but is dominantly mauve-coloured. It grades up into the Mount Bertram Sandstone, with cross-bedding, load casts and red shale bands. The Wirara Formation and Mount Bertram Sandstone represent the late Sturtian-early Marinoan interglacial phase.

Marinoan glaciation is represented in the West Kimberleys by the Walsh Tillite, in the Mount Ramsay area by the Egan Formation, and in the East Kimberleys by the Fargoo Tillite and overlying Moonlight Valley Tillite (best regarded as representing two phases of Marinoan glaciation). These tillites are all characterised by a predominantly red silty, argillaceous or dolomitic matrix, and become shaly and sparsely pebbly in their upper parts. In each case they are overlain by well-laminated pink dolomites, with interbedded red shale, that are similar to the "cap dolomites" of the other basins described above. The overlying sequences in the three areas reflect transgression and then regression: they commence with red-brown to grey-green medium grained sandstone with grit bands, ripple marks, water escape structures and minor flute casts (Jarrad Sandstone Member in the East Kimberleys, Yurabi Formation in the Mount Ramsay area and Traine Formation in the West Kimberleys). These pass up into finer clastics similar to the Brachina Formation of the Adelaide Geosyncline and Pertatataka Formation of the Amadeus Basin (micaceous siltstone, shale and fine sandstone of the Ranford Formation in the East Kimberleys, McAlly Shale in the Mount Ramsay area and Throssell Shale in the West Kimberleys. Regression is marked by the incoming of coarse clastics above these formations, in particular the very mature orthoquartzites and quartz pebble conglomerates of the Mount Forster Sandstone (East Kimberleys) and Tean Formation (Mount Ramsay area). In the West Kimberleys, it is represented by the orthoquartzite in the upper part of the Estaughs Formation. These all correspond in lithology and stratigraphic position to the regressive ABC Range Quartzite of the Adelaide Geosyncline, and possibly the sandstone units in the Pertataka Formation of the Amadeus Basin.

A second Marinoan transgressive phase is represented only in the Mount Ramsay area (reddish-brown immature feldspathic sandstone with interbedded siltstone of the Lubbock Formation) and East Kimberleys (maroon micaceous shale, siltstone and rare fine grained sandstone of the Elvire Formation). The latter corresponds closely in lithology and stratigraphic position to the

Bunyeroo Formation of the Adelaide Geosyncline, and the upper part of the Pertatataka Formation of the Amadeus Basin. Similarly, the overlying Boonall Dolomite corresponds to the Wonoka and Julie Formations, though the three formations at the top of the East Kimberley succession appear to lack obvious lithostratigraphic equivalents elsewhere (Timperley Shale, Nyuless Sandstone and Flat Rock Formation). These formations could be expected to be time-equivalents of the Pound Subgroup. The late Adelaidean units of the Kimberleys are overlain unconformably in many places by the Early Cambrian Antrim Plateau Volcanics.

Geochronology

A reexamination of Bofinger's (1967) geochronological study and the recent age determinations of Adelaidean sediments of the Stuart Shelf, South Australia, are consistent with the revised lithostratigraphic correlations (Coats & Preiss, 1979). They concluded that the widely quoted dating of the earlier glaciation (724±30 Ma) was unreliable because it was based on a combination of data from the lower glacials, upper glacials and interglacials. Separation of the data according to the individual formations they were based on failed to produce well aligned meaningful isochrons. However, the data for Marinoan post-glacial shales are more reliable, as they are based on single formations and produced better aligned isochrons. These dates support the correlation of the Ranford Formation and Throssell Shale (672±70 Ma and 670±84 Ma respectively) and the correlation of these formations with the Stuart Shelf equivalents of the Brachina Formation of the Adelaide Geosyncline (676±204 Ma) as proposed by Coats & Preiss (1979). The dating of the Elvire Formation at 639±47 Ma (Bofinger, 1967) is consistent with its stratigraphic position.

TASMANIA

Exposures of Precambrian rocks in Tasmania are confined largely to the western half of the island (Fig. 1). The oldest rocks containing macrofossils are of Middle Cambrian age. This fact, together with the structural complexity and separation of segments of the Precambrian, and the scarcity of radiometric data, has rendered regional stratigraphic interpretation difficult. The summary presented here is based largely on Williams (1978).

The less metamorphosed upper Precambrian sequences (generally of upper greenschist facies) are thought to be younger than the Frenchman Orogeny, which involved multiple folding and an earlier main phase of metamorphism affecting older metasediments. These older rocks, including garnetiferous schist, quartzite, conglomerate and amphibolite form the Tyennan and Forth Geanticlines.

The upper Precambrian may be tentatively subdivided into three main sequences representing three depositional basins. The oldest of these, the Rocky Cape Group, has been studied by Gee (1971) and others and is widespread in the northwest corner of Tasmania. Component formations from the base are: Cowrie Siltstone, at least 2440 m thick, cream to red brown laminated siltstone, with black pyritic shale near the base; Detention Subgroup, 1400 m thick, orthoquartzite, fine grained, cross-bedded, interdigitating with siltstone: Irby Siltstone, 760 m thick, siltstone, partly black, dolomite, sandstone, subgreywacke; Jacob Quartzite, 1130 m thick, orthoquartzite, cross-bedded. This group appears to represent a stable shelf environment with palaeoslope toward the northwest. There was a shoreline to the southeast (Tyennan Geanticline) and a possible foreland to the northwest.

The next main sequence is represented by the Burnie Formation (Gee, 1977), and possibly the Oonah Formation (Oonah Quartzite and Slate of Blissett, 1962) which are considered to have been deposited in a slightly younger trough to the east of the basin in which the Rocky Cape Group accumlated. The Arthur Lineament, a metamorphic belt with transitional boundaries, separates the two depositional areas. The Keith Metamorphics in the Arthur Lineament are considered to have been derived from the adjacent Rocky Cape Group, Burnie Formation, and their correlatives. The 500 m thick Burnie Formation comprises black slaty mudstone, siltstone, sandstone, quartz-wacke (with greywacke texture and graded bedding) and minor pillow lavas. Turbidity currents, as indicated by ripple marks, flute casts and scours, flowed in a northerly direction transversely to a north-northeasterly-trending trough. East of Burnie, the Badger Head Group has a similar lithology and is correlated with the Burnie Formation (Gee & Legge, 1974). To the south, near Zeehan, the Oonah Formation (minimum thickness 2100 m) and its correlatives contain quartzite, micaceous quartzite, siltstone and greenish, grey or black shale with local limestone and dolomite, spilitic lavas and pyroclastics.

The uppermost sequence of the upper Precambrian comprises mainly the Smithton Dolomite, deposited in the Smithton Trough with angular unconformity on the Rocky Cape Group. The Penguin Orogeny (minimum age about 720 Ma; Solomon & Griffiths, 1974) is inferred to have preceded deposition of the Smithton Dolomite: five phases of folding have been demonstrated near Burnie, associated with the Penguin Orogeny (Gee, 1977). The Smithton Dolomite is up to 1500 m thick and comprises dolomite, chert, oolitic limestone, carbonaceous siltstone, beds with mud cracks and stromatolites, and locally, a basal quarzite and conglomerate. To the south, near Zeehan, the Success Group of fine and coarse grained sandstone, 820 m thick, is probably equivalent to the Smithton Dolomite.

A 30 m thick diamictite bed overlies the Smithton Dolomite. It contains dolomite and chert clasts up to 2 m in size, some of which are clearly derived from the Smithton Dolomite. Others, however, are fine grained dark grey dolomites containing the stromatolite Baicalia cf. B. burra (Griffin & Preiss, 1976), and these have no obvious local source. The stromatolites closely resemble Baicalia burra, and the associated lithology resembles that of the Skillogalee Dolomite in the Adelaide Geosyncline. The clasts could therefore have had a distant provenance, supporting a glacial origin for the diamictite, although other proven glacial characteristics are lacking. Although the age and origin of the diamicite are uncertain, it may be tentatively correlated with the Cottons Breccia of King Island (Jago, 1974). The Cottons Breccia contains diamictites, and is overlain by a sequence of siltstones and basic volcanics; a laminated pink dolomite, similar to the Nuccaleena Formation and other Marinoan "cap dolomites" occurs immediately above the breccia. If the breccia is of glacial origin, it may be a correlative of the Marinoan glacials of the Adelaide Geosyncline and other basins. Such a correlation would be consistent with the known superposition of the breccia above a strongly deformed sequence that is intruded by granitic rocks (Williams, 1978), themselves dated at 817±60 Ma by a Rb/Sr whole rock isochron, 734 Ma by Rb/Sr on muscovite, and 724 Ma by K/Ar on muscovite (McDougall, 1965).

A third occurrence of possible glaciogenic sediments has been recorded by Jago (in press) in the Wedge River Beds in the Wedge River area of southern Tasmania. These lie unconformably below fossiliferous Middle Cambrian, but appear not to have been involved in the Frenchman Orogeny.

Vidal (1976b) has described the ?acritarch Bavlinella faveolata in the Cottons Breccia and in the diamictite overlying the Smithton Dolomite. He considers this to be a probable index fossil for the Vendian, and suggests that these units are of

Vendian age. While this is quite consistent with other stratigraphic data as outlined above, it should be noted that neither the biogenicity nor the stratigraphic range of Bavlinella are beyond dispute (see Muir, 1977).

CONCLUSIONS AND SUMMARY OF GEOLOGICAL HISTORY OF ADELAIDEAN BASINS

Interpretation of the age of the base of the Adelaidean (the time during which the late Precambrian sediments of the Adelaide Geosyncline were being deposited) at present depends on the correlation of early Willouran volcanics in the Geosyncline with the Beda Volcanics of the Stuart Shelf. On the basis of this correlation, and the dating of the Beda Volcanics, all Precambrian sediments younger than about 1100 Ma in the other basins have been tentatively included in the Adelaidean. Age control on early Adelaidean sediments in the Adelaide Geosyncline and in the central Australian basins is still extremely limited. Tentative correlation of late Adelaidean formations throughout Australia is summarised in Table 11.

The ages of late Adelaidean sediments, including the products of two major glaciations, chiefly in the South Australian, central Australian and Kimberley Region basins, are now better defined as a result of new Rb/Sr shale dates on the Stuart Shelf, and of stratigraphic reinterpretation of previous radiometric data (Kimberley Region). The Sturtian glaciation is probably only a little older than about 750 Ma, while the Marinoan one took place between about 750 Ma and about 670 Ma ago, but closer to the latter. In all basins there is a stratigraphic break between the latest Adelaidean sediments and the overlying Early Cambrian sequences.

Biostratigraphy has assisted very broad correlation and age assessment. Because of the predominance of endemic stromatolites in the late Precambrian of Australia, only limited correlation is possible with the stromatolitic sequences of the USSR. The best agreement between stromatolite-based correlations and those based on lithostratigraphy and geochronology is in the Bitter Springs Formation (with a Late Riphean assemblage) and in the Umberatana Group (whose assemblage suggests an age near the Late Riphean-Vendian boundary). The early Adelaidean of the Adelaide Geosyncline is anomalous from a stromatolite biostratigraphy point of view, since the oldest stromatolites (early Willouran) have a Late Riphean "aspect", while overlying Torrensian forms resemble those of the Middle Riphean of the USSR.

Palaeomagnetism has great potential for precise stratigraphic correlations in the future, but so far only the youngest Adelaidean sequences from the central Australian basins have been studied for magnetostratigraphy.

The history of Adelaidean basins and surrounding regions may be summarised as follows:

<u>Approximately 1100 to 1000 Ma period</u> (Fig. 2)

Stuart Shelf: Rifting with basic volcanics and deposition of coarse clastics in grabens.

Adelaide Geosyncline: Initial platform sands and carbonates, then rifting with basic volcanics, possibly also during this period, followed by mixed carbonates and immature clastics deposited under evaporitic conditions.

Musgrave Block: Folding and granite intrusion in east; thick acid volcanic complexes at western end; basic and acidic volcanics and sediments in northwest.

Bangemall Basin: Mixed clastics and carbonates, with very minor acid volcanics. Finer clastics and turbidites in later stages.

Arunta Block: Metamorphism and migmatisation in an east-west zone between the future Amadeus and Ngalia Basins.

Kimberley Region and Victoria Basin: Fine and medium clastic deposition.

Tasmania: Deposition of clastics of the Rocky Cape region, but age unknown.

Approximately 1000 to 800 Ma period (Fig. 3)

Adelaide Geosyncline: A possible high grade metamorphic belt in the south at this time, followed unconformably by deposition of mixed clastic - carbonate sequences. Cyclic sedimentation of west-derived deltaic complexes; platform carbonates in marginal marine to lagoonal environments. Minor tectonism at end of this time.

Stuart Shelf: No deposition known.

Central Australian Basins: Basal blanket quartzites, followed by shelf carbonates. Minor tectonism in all basins at end of this time; early Adelaidean sequence best preserved in Amadeus Basin, but severely eroded in other basins.

Approximately 800 to 700 Ma period (Fig. 4)

Tasmania: A period of folding and intrusion of granite, dolerite (Penguin Orogeny).

Widespread Sturtian glaciation is recorded in all other Basins.

Adelaide Geosyncline: Oldest Sturtian glacials deposited in fault controlled troughs, and frequently associated with sedimentary iron formations. Younger Sturtian glacials more widespread - tillites with associated sandstones, laminated siltstones. Post-glacial transgression, covering whole Adelaide Geosyncline and Stuart Shelf.

Officer Basin: Sturtian glacials possibly of earlier phase. Basic volcanics. Post-glacial transgression.

Amadeus Basin, Ngalia Basin, Georgina Basin: Probable younger Sturtian glacials; post-glacial transgression.

Glacials of Central Mount Stuart could be earlier phase, but this is not certain.

Kimberley Region: Probable younger Sturtian glacials and post-glacial transgression, chiefly in graben.

Approximately 700 to 570 Ma period (Fig. 5).

(i) Regressive phase in all basins, reflected in the western Amadeus Basin, the Georgina Basin in the Ngalia Basin as a major hiatus. Adelaide Geosyncline, Officer Basin, eastern Amadeus Basin and graben in Kimberley Region: Deposition more or less continuous, but regressive phase continued. Minor hiatus before Marinoan glaciation.

(ii) Marinoan glaciation: Tillites deposited in eastern Adelaide Geosynline, Barrier Ranges, eastern Amadeus Basin, Ngalia Basin, Burke River area, and widespread in the Kimberley Region. Predominantly feldspathic sandstone deposition in western Adelaide Geosyncline, Stuart Shelf, western Amadeus Basin, Georgina Basin.

(iii) Post-glacial transgression, followed by regressive phase, represented in Adelaide Geosyncline, Stuart Shelf, Amadeus Basin, Georgina Basin, Burke River area, the Kimberley Region, and perhaps also in the Ngalia Basin, though subsequently mostly eroded there.

(iv) Another major transgressive - regressive cycle, recorded only in the Adelaide Geosyncline, (not Stuart Shelf), Amadeus Basin, Ngalia Basin, western Georgina Basin and East Kimberley Region only.

(v) Adelaidean sedimentation terminated by tectonism, probably related to Peterman Ranges Orogeny (southern Amadeus Basin). Hiatus between latest Adelaidean and Early Cambrian sequences in all basins.

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TABLE 1

Summary of lithostratigraphy[1], chronostratigraphy, geochronology and biostratigraphy of the Adelaide Geosyncline.

Chronostratigraphic Subdivisions	Lithostratigraphic Subdivisions	Geochronology and Biostratigraphy
Early Cambrian	HAWKER GROUP	Abundant shelly faunas.
	——disconformity——	
	WILPENA GROUP	
	Pound Subgroup	Ediacara assemblage of metazoa.
Marinoan	Wonoka Formation	Stromatolite *Tungussia* f. nov.
	Brachina Formation	Rb/Sr isochron 676 ± 204 Ma. (Shelf)
	UMBERATANA GROUP	
	upper glacials	
	interglacial sequence including carbonates	Stromatolite assemblage suggesting Late Riphean - Vendian boundary
	Tapley Hill Formation	Rb/Sr isochron 750 ± 53 Ma. (Shelf)
Sturtian	lower glacials: upper phase	
	——disconformity——	
	lower glacials: lower phase	
	——disconformity or angular unconformity ——	
	BURRA GROUP	
	Belair Subgroup	
	Mixed carbonates and clastics	
Torrensian	Skillogalee Dolomite	Stromatolites *Baicalia burra*
	Rhynie Sandstone	*Tungussia Wilkatanna*.
	CALLANNA BEDS	
Willouran	Mixed carbonates, clastics, former evaporites	
	Wooltana Volcanics (Geosyncline)	Rb/Sr isochron ??approx. 800 Ma.
	Beds Volcanics (Shelf)	Rb/Sr isochron 1076 ± 34 Ma.
	Carbonates	Stromatolites *Acaciella*, *Gymnosolen*
	Basal clastics	
		Pre-Burra Group metamorphics Rb/Sr isochron ?849 ± 32 Ma.

[1] Only selected formations shown.

TABLE 2

Stratigraphy of the Callanna Beds, Adelaide Geosyncline, and equivalents in New South Wales.

Thicknesses are extremely variable; figures give only an approximate indication of maximum thicknesses.

STUART SHELF.	PEAKE & DENISON RANGES.	CENTRAL FLINDERS RANGES.	MOUNT PAINTER	BARRIER RANGES, N.S.W.
hiatus	Very thick sequences (up to 8 km) of mixed clastics and evaporitic carbonates: carbonaceous silts, immature micaceous sands with halite casts, dolomites and limestones with gypsum casts, cryptalgal laminates, LLH stromatolites.		hiatus	hiatus
	------contacts generally disrupted------			
Backy Point Formation and Beda Volcanics (150 m)	Cadlareena Volcanics (750 m)	unnamed volcanics	Wooltana Volcanics (2 400 m)	Wilangee Volcanics (60 m)
	Coominaree Dolomite (80m) Stromatolites: Acaciella f. Gymnosolen f.	sequences cannot be identified with certainty	Wywyana Formation (460 m) marble, amphibolite	Boco Formation (30 m) Dolomite with stromatolites: ?Omachtenia f.
---disconformity--	Younghusband Conglomerate (30 m)		Paralana Quartzite (1 220 m)	Christine Judith Conglomerate (150 m)
?Pandurra Formation				Lady Don Quartzite (150 m)
--unconformity--	--unconformity--		--unconformity--	---unconformity---
Roopena Volcanics, metamorphic basement.	Peake Metamorphics (basement)	inferred granitic basement not exposed	Radium Creek Metamorphics (basement)	Wilyama Complex (basement)

TABLE 3

Stratigraphy of the Burra Group, Adelaide Geosyncline.
There is no record of Burra Group deposition on the Stuart Shelf and in the Barrier Ranges, New South Wales. Thicknesses are extremely variable; figures give only an approximate indication.

ADELAIDE REGION	FLINDERS RANGES South-west	South-east	North-west	North-east
UMBERATANA GROUP				
------- regional disconformity or angular unconformity -------				
BURRA GROUP				
Belair Subgroup (300 m) alternating siltstones, feldspathic quartzites.		Belair Subgroup (up to 3 600 m) alternating siltstones, feldspathic quartzites.	hiatus	hiatus
Glen Osmond Slate (450 m) Siltstone.		Saddleworth Fm. (4 000 m) Siltstone.		
Beaumont Dolomite (130 m) Carbonaceous dolomite, siltstone.	Unnamed dolomitic sandstones.	Auburn Dolomite (600 m) Carbonaceous, cherty dolomite, siltstone. Watervale Sandstone Member	Unnamed dolomitic siltstone, dolomite (280 m+)	
Stonyfell Quartzite (300 m)		Undalya Quartzite (200-600 m)		
Woolshed Flat Shale (300 m)		Woolshed Flat Shale (300 m)	Myrtle Springs Formation Siltstone, sandstone, minor dolomite	
Montacute Dolomite (120 m) Blue-grey, cherty with magnesite.	Skillogalee Dolomite (380 m) Blue-grey dolomite, black chert, magnesite, dolomitic sandstone. Stromatolites: *Baicalia burra*.	(upper member)	Skillogalee Dolomit (upper member) (Maximum thickness ÷ 000 m)	
Castambul Dolomite (350 m) Pale dolomite, siltstone.	Pale dolomite, siltstone, sandstone, sandy dolomite. Stromatolites: *Baicalia burra*, *Tungussia wilkatanna*.	(lower member)		(lower member)
Aldgate (300-1 000 m) Sandstone	Emeroo (1 370 m) Quartzite	Bungaree Quartzite (500 m) River Wakefield Subgroup (700 m) Siltstone, sandstone, dolomite. Rhynie Sandstone (1 200 m)	Copley Quartzite (1 980 m) Unnamed siltstones, quartzites.	Wortupa Quartzite (300 m) Opaminda Formation Dolomitic siltstone (380 m) Blue Mine Conglomerate (460 m) Woodnamoka Phyllite (1 370 m) Humanity Seat Fm. (2 080 m)
Feldspathic sandstones with heavy mineral laminations.				
-major unconformity-	---disconformity---	--?transition--	--?transition--	----disconformity----
Metamorphics of Houghton Inlier	CALLANNA BEDS: unnamed volcanics	CALLANNA BEDS equivalents	CALLANNA BEDS	CALLANNA BEDS: Wooltana Volcanics

TABLE 4

Stratigraphy of the Umberatana Group, Adelaide Geosyncline. Thicknesses are extremely variable; figures give only an approximate indication of maximum thicknesses.

SOUTH-WEST	CENTRAL FLINDERS RANGES	SOUTH-EAST	NORTH-EAST
WILPENA		GROUP	
UMBERATANA		GROUP	
Reynella Siltstone Member granule-bearing red siltstone. (110 m)	Elatina Formation (60 m) sandstone, minor tillite.	unnamed siltstones Grampus Quartzite (50 m) Pepuarta Tillite (1500 m) Gumbowie Arkose Member (80 m)	Yerelina Subgroup: Balparana Sandstone (215 m) Mount Curtis Tillite (90 m) Fortress Hill Formation (1 830 m) --- disconformity ---
Willochra Subgroup (600 m) red, grey, green sandstone, siltstone, shale; mudcracks, ripple marks.	Trezona Formation (150 m) stromatolitic and intraclastic limestone. Enorama Shale (360 m)	Enorama Shale (800 m) green silty shale	Enorama Shale (150 m) Green silty shale. Amberoona Formation (1 220 m) grey-green siltstone.
Brighton Limestone (0-300 m) oolitic and stromatolitic limestone	Etina Formation (1 000 m) sandy, oolitic and stromatolitic limestone; siltstone.	Tarcowie Siltstone (660 m) grey siltstone, fine sandy.	
Tapley Hill Formation (1 550 m) Very thinly laminated carbonaceous siltstone, calcareous in upper part. Basal very thinly laminated black shale, dark grey flaggy dolomite.			
Sturt and Appila (540 m) Tillites ------dusconformity------ hiatus	Wilyerpa Formation (0-850m) siltstone, sandstone, minor tillite. ------disconformity------ Holowilena Ironstone (120 m)	Wilyerpa Formation (0-6000m) siltstone, sandstone, minor tillite ------disconformity------ Benda Siltstone Braemar Iron Fm. facies (260 m) Pualco Tillite (3300 m) ------unconformity------	?conglomerate (900 m) ------disconformity------ ? Yudnamutana Subgroup (280m) Lyndhurst Formation (1860 m) Bolla Bollana Tillite Fitton Formation (2960 m) ------unconformity------
BURRA GROUP		BURRA	GROUP

TABLE 5

Stratigraphy of the Wilpena Group, Adelaide Geosyncline and Stuart Shelf. Thicknesses are very variable; figures give only an approximate indication of maximum thicknesses.

STUART SHELF	ADELAIDE REGION	FLINDERS RANGES
Lower Cambrian:		
Andamooka Limestone	NORMANVILLE GROUP	HAWKER GROUP
----------------disconformity ----------	----------	----------
	WILPENA GROUP	
hiatus	hiatus	Pound Subgroup (2 400 m) Rawnsley Quartzite (white) Bonney Sandstone (red)
		Wonoka Formation (3 360 m) Silty limestone, calcareous siltstone.
Yarloo Shale Red shale, siltstone.		Bunyeroo Formation (1 500 m) Red shale, siltstone.
Simmens Quartzite (100 m) White quartzite.	ABC Range Quartzite equivalent (460 m) White orthoquartzite.	ABC Range Quartzite (150 m) White quartzite with mud-cracks, clay intraclasts.
Corraberra Sandstone (75 m) Red sandstone. Woomera Shale, Tregolana Shale (160 m) Mainly red silty shale.	Brachina Formation equivalent (560 m) Red and green siltstone, fine grained sandstone.	Brachina Formation (2 750 m) Red and green siltstone, fine grained sandstone; grades basinwards into green Ulupa Siltstone.
Nuccaleena Formation (0-3 m) Laminated pink dolomite.	Seacliff Sandstone (93 m) White to brown sandstone with interbedded pink laminated dolomite.	Nuccaleena Formation (0-140 m) Laminated pink to red brown dolomite; purple shale.
__________	conformable but relatively sharp contact	__________
	UMBERATANA GROUP	

TABLE 6

Adelaidean
Stratigraphy of the Amadeus Basin.
Thicknesses give an indication of approximate maxima only.

Southern Amadeus Basin	Alice Springs Area	Northeast Amadeus Basin
Mount Currie Conglomerate (?Cambrian)	Arumbera Sandstone II (Early Cambrian)	Arumbera Sandstone II
------unconformity------	-----disconformity------	------disconformity------
	Arumbera Sandstone I Red siltstone, red sandstone.	Arumbera Sandstone I (260 m) Red siltstone, red sandstone.
	Julie Formation Flaggy dolomite, partly oolitic. Approx. 10 m.	Julie Formation Grey oolitic and stromatolitic limestone, silty limestone 540 m.
Winnall Beds Cross-bedded sandstone, siltstone. 2 100 m. (precise correlation uncertain)	Pertatataka Formation Red, green and dark grey siltstone, shale. Quartzite interbed. 650 m.	Pertatataka Formation Red, green and dark grey siltstone, shale. Waldo Pedlar Member and Cyclops Member. Thin-bedded sandstone, siltstone. 60 m.
		unnamed pink flaggy dolomite
	Pioneer Sandstone Medium to coarse feldspathic sandstone. 170 m.	Olympic Formation Red diamictite with numerous glaciated clasts; minor sandstone, sandy dolomite. 190 m.
-----disconformity-----	-----disconformity-----	-----disconformity-----
	hiatus	Aralka Formation Laminated green and grey siltstone. Total thickness 1 000 m. Limbla Member Festoon cross-bedded sandstone; sandy limestone. 140 m. Ringwood Member Sandy, oolitic and stromatolitic limestone, dolomite. 160 m.
	lowest beds of Aralka Formation approx. 10 m.	
(precise correlation uncertain) Inindia Beds Sandstone, siltstone, diamictite, minor oolitic chert. 2 100 m.	Areyonga Formation Grey-green diamictite, conglomerate, sandstone. 250 m.	Areyonga Formation Grey-green diamictite, conglomerate, sandstone. 300 m.
------disconformity------	------disconformity------	------disconformity------
Pinyinna Beds Dolomite, limestone, rare stromatolites, siltstone. 210 m.	Bitter Springs Formation Loves Creek Member Grey stromatolitic limestone black chert, dolomite, dolomitic red siltstone. 200 m. Gillen Member Siltstone, grey dolomite. 400 m.	Bitter Springs Formation Loves Creek Member Grey stromatolitic limestone, black chert, dolomite, siltstone, spilitic volcanics. 110 m. Gillen Member Siltstone, grey dolomite, gypsum. 360 m.
Dean Quartzite (1 170 m) Quartzite, conglomeratic quartzite.	Heavitree Quartzite Quartzite, pebbly sandstone, siltstone. 300 m.	Heavitree Quartzite Quartzite, pebbly sandstone, siltstone. 300 m.
---conformable to unconformable contact--------	---major unconformity---	-----major unconformity-----
Dixon Range Beds, Bloods Range Beds	Arunta Complex	Arunta Complex

TABLE 7

Adelaidean Stratigraphy of the Ngalia Basin.

Note that not all of these units are exposed in any single section.

Early Cambrian: Yuendumu Sandstone II. Red-brown sandstone.

----------disconformity----------

Late Adelaidean: Yuendumu Sandstone I. (200 m)

Red-brown sandstone, basal arkose

-- unconformable relationship over Vaughan Springs Quartzite --

hiatus

unnamed red shale

unnamed pink-buff laminated dolomite

Mount Doreen Formation (240 m)

diamictite, pebbly sandstone, conglomerate.

----------disconformity----------

Rinkabeena Shale (100 m)
Green silty shale, unnamed black shale, laminated grey dolomite.

Naburula Formation (2 m).
Diamictite.

------nonconformable relationship on basement of Arunta Complex-----

Early Adelaidean: unnamed dolomite, black shale, chert.

Vaughan Springs Quartzite (1 650 m)
Quartzite, pebbly sandstone.

Treuer Member: Thin bedded glauconitic sandstone, siltstone.

-------major nonconformity----------

Pre-Adelaidean Arunta Complex

TABLE 8

Adelaidean stratigraphy of the Officer Basin.
(note that not all of these units are found in any single section)

Early Cambrian: Observatory Hill Beds

--------disconformity to angular unconformity--------

Late Adelaidean: Punkerri Beds (1 200 m). Red and white sandstone, metazoan fossils of Ediacara assemblage.

---------no stratigraphic relationship seen---------

hiatus

unnamed siltstone, fine sandstone, minor tillite (600 m).

Rodda Beds (1 200 m). Siltstone, limestone, dolomite, calcareous sandstone.

Tapley Hill Formation (700 m). Laminated siltstone. Basal ferruginous feldspathic quartzite, conglomerate at base.

Wantapella Volcanics (290 m) Vesicular basalt.

Chambers Bluff Tillite (520 m). Diamictite, gritty siltstone, quartzite, ironstone.

---------------------disconformity--------------------

Belair Subgroup equivalents (1 000m) Siltstone, shale, quartzite.

----nonconformable relationship on basement of Musgrave Block ------------------------------------

Early Adelaidean: Wright Hill Beds (3 400m). Oolitic chert, quartzite, sandstone, siltstone.

(Ilma Beds of Western Australian portion of Officer Basin may be equivalents and contain stromatolite Baicalia cf. B. burra.)

---------no stratigraphic relationship seen ----------

Pindyin Beds (430 m). Sandstone, quartzite, conglomerate, shale, chert, dolomite.
(Townsend Quartzite of Western Australian portion of Officer Basin probable equivalent.)

----major nonconformity or unconformity on Musgrave-Block basement -----------------------------------

(Townsend quartzite unconformable on ?earliest Adelaidean volcanics)

TABLE 9

Adelaidean stratigraphy of the southern Georgina Basin.

	Huckitta area	Hay River Area
Early Cambrian:	Mount Baldwin Formation Red sandstone, siltstone.	Adam Shale Green pyritic shale.
	------disconformity------	----disconformity----
Late Adelaidean:	MOPUNGA GROUP Elkera Formation (220 m) Siltstone, dolomite, sandstone, shale. Stromatolite *Georginia howchini*.	hiatus
		MOPUNGA GROUP
	Grant Bluff Formation (160m) Thin bedded sandstone, siltstone.	Grant Bluff Formation (210m) Thin bedded sandstone, siltstone.
	Elyuah Formation (130 m) Green and red shale, basal pebbly arkose.	Gnallan-a-Gea Arkose (1 450 m). Coarse arkose.
	------disconformity------	
	KEEPERA GROUP	KEEPERA GROUP
	Oorabra Arkose (25 m)	Wonnadinna Dolomite (460 m)
		Black Stump Arkose (700 m)
	------disconformity------	----disconformity-----
		unnamed dolomite, shale.
	Mount Cornish Formation (380 m) Diamictite, varve-like siltstone.	Yardida Tillite (2 900 m) Diamictite, varve-like siltstone.
	------disconformity------	----disconformity-----
Early Adelaidean:	Yackah Beds (26 m) Feldspathic grit, dolomite.	Yackah Beds (240 m) Feldspathic sandstone, shale, dolomite. Stromatolite *Acaciella australica*.
	---major nonconformity---	---major nonconformity----
Pre-Adelaidean:	Arunta Complex	Arunta Complex

TABLE 10

Adelaidean stratigraphy of the Kimberley Region.

	WEST KIMBERLEY	MOUNT RAMSAY AREA	EAST KIMBERLEY
Early Cambrian:		Lally conglomerate and Antrim Plateau Volcanics	
		-------------angular unconformity-------------	
Late Adelaidean:			ALBERT EDWARD GROUP Flat Rock Formation (300 m). Shale, dolomitic sandstone, conglomerate.
			Nyuless Sandstone (40 m).
			Timperley Shale (1 250 m).
		LOUISA DOWNS GROUP	Boonall Dolomite (30 m).
		Lubbock Formation (1 800 m)	Elvire Formation (100 m).
	MOUNT HOUSE GROUP	Sandstone, siltstone.	Maroon shale, siltstone. 639 $\pm$ 47 Ma.
	Estaughs Formation (80 m). Orthoquartzite overlying purple sandstone, siltstone.	Tean Formation (120 m) Orthoquartzite, conglomerate.	Mount Forster Sandstone. (100 m). Orthoquartzite, conglomerate. -----disconformity------
			DUERDIN GROUP
	Throssell Shale (150 m). Micaceous siltstone, shale.	McAlly Shale (1 500 m) Micaceous siltstone, shale.	Ranford Formation (560 m) Micaceous siltstone, fine sandstone.
			Johnny Cake Shale Mem. 672 $\pm$ 72 Ma.
	Traine Formation (50 m). Sandstone.	Yurabi Formation (210 m) Sandstone.	Jarrad Sandstone Mem.
	unnamed dolomite.	unnamed dolomite.	unnamed dolomite.
	Walsh Tillite (60 m)	Egan Formation (190 m) Diamictite, shale sandstone, dolomite.	Moonlight Valley Tillite (0 - 140 m)
	--major disconformity--		----disconformity----
		---disconformity---	Frank River Sandstone (230 m)
			Fargoo Tillite (0-200 m) ---unconformity---
		KUNIANDI GROUP	
		Mount Bertram Sandstone (180 m).	
		Wirara Formation (480 m)	
		Stein Formation (0-210 m)	
		Landrigan Tillite (20-330 m) ---major disconformity---	
?Early Adelaidean:			Helicopter Siltstone (160 m)
			Wade Creek Sandstone
			Mount John Shale Mem. 1106 $\pm$ 110 Ma.
			-----unconformity-----

TABLE 11 ..... disconformity or unconformity TABLE 11A

Correlation of late Adelaidean formations across Australia.

AGE	WEST KIMBERLEYS	MOUNT RAMSAY AREA	EAST KIMBERLEYS
		Antrim Plateau	Antrim Plateau
EARLY CAMBRIAN		Volcanics	Volcanics
		Lally Conglomerate	
		....	....
LATE			ALBERT EDWARD GROUP Flat Rock Formation
ADELAIDEAN		LOUISA DOWNS GROUP	Nyuless Sandstone
Marinoan			Timperley Shale
		Lubbock Formation	Boonall Dolomite
	MOUNT HOUSE GROUP		Elvire Formation
	upper Estaughs Formation	Tean Formation	Mount Forster Sandstone
	lower Estaughs Formation		....
	Throssell Shale	McAlly Shale	DUERDIN GROUP Ranford Formation
			Johnny Cake Shale Member
	Traine Formation	Yurabi Formation	Jarrad Sandstone Member
	unnamed dolomite	unnamed dolomite	unnamed dolomite
	Walsh Tillite	Egan Formation	Moonlight Valley Tillite
	....	....	....
			Frank River Sandstone
			Fargoo Tillite
			....
		KUNIANDI GROUP	
		Mount Bertram Sandstone	
Sturtian			
		Wirara Formation	
		Stein Formation	
		Landrigan Tillite	
		....	
EARLY ADELAIDEAN (no correlation implied)			Helicopter Siltstone

TABLE 11B

NGALIA BASIN	WEST AMADEUS BASIN	EAST AMADEUS BASIN	SW GEORGI
Yuendumu Sandstone III	Arumbera Sandstone III	Arumbera Sandstone III	[illegible]
Yuendumu Sandstone II	Arumbera Sandstone II	Arumbera Sandstone II	
Yuendumu Sandstone I	Arumbera Sandstone I	Arumbera Sandstone I	KEEPERA GR
	Julie Formation	Julie Formation	Elkera For
	Pertatataka Formation	Pertatataka Formation	
	unnamed sandstone	Cyclops Member	Grant Bluf
			Elyuah For
			MOPUNGA GR
unnamed dolomite, shale	local unnamed dolomite	unnamed dolomite	
Mount Doreen Formation	Pioneer Sandstone	Olympic Formation	Gorabra Ark
			Aralka Form
			Limbla Me
			Ringwood
Rinkabeena Shale			
unnamed dolomite, shale	unnamed dolomite	unnamed dolomite, shale	
Naburula Formation	Areyonga Formation	Areyonga Formation	Mount Corni
unnamed dolomite, shale	Bitter Springs Formation	Bitter Springs Formation	Yackah Beds

TABLE 11 c

SW GEORGINA BASIN	SE GEORGINA BASIN	BURKE RIVER AREA	OFFICER BASIN
Mount Baldwin Formation	Red Heart Dolomite		Observatory Hill Beds
	Adam Shale		
....	....		....
			WILPENA GROUP
KEEPERA GROUP Elkera Formation	KEEPERA GROUP		
Grant Bluff Formation	Grant Bluff Formation	MOUNT BIRNIE BEDS unnamed siltstone	
Elyuah Formation	Gnallan-a-Gea Arkose		
		unnamed sandstone	
MOPUNGA GROUP	MOPUNGA GROUP Wonnadinna Dolomite	unnamed dolomite	
Oorabra Arkose	Black Stump Arkose	Little Burke Tillite	UMBERATANA GROUP unnamed sandstone siltstone, diamictite
....	....	....	
Aralka Formation			Rodda Beds
Limbla Member			
Ringwood Member			
			Tapley Hill Formation unnamed sandstone member
			....
	unnamed dolomite shale		
Mount Cornish Formation	Yardida Tillite		Wantapella Volcanics
....	....		Chambera Bluff Tillite
			....
Yackah Beds	Yackah Beds		Belair Subgroup equivalent

TABLE 11D

...AS IN	STUART SHELF	WEST ADELAIDE GEOSYNCLINE	EAST ADELAIDE GEOSYNCLINE
...ry Hill Beds	Andamooka Limestone	Parachilna Formation	
		Uratanna Formation	
...ROUP		WILPENA GROUP Pound Subgroup:	WILPENA GROUP Pound Subgroup:
	WILPENA GROUP	Rawnsley Quartzite	Rawnsley Quartzite
		Bonney Sandstone	Bonney Sandstone
		Wonoka Formation	Wonoka Formation
	Yarloo Shale	Bunyeroo Formation	Bunyeroo Formation
	Simmens Quartzite	ABC Range Quartzite	ABC Range Quartzite
	Corraberra Sandstone	Brachina Formation	
	Tregolana and Woolshed Shale		Ulupa Siltstone
		Seacliff Sandstone	Seacliff Sandstone,
	Nuccaleena Formation	Nuccaleena Formation	Nuccaleena Formation
... GROUP ...ndstone ... diamictite	UMBERATANA GROUP Reynella Siltstone M. Whyalla Sandstone	UMBERATANA GROUP Reynella Siltstone Member Elatina Formation	UMBERATANA GROUP unnamed siltstone Grampus Quartzite Pepuarta Tillite Gumbowie Arkose Member
	Willochra Subgroup	Willochra Etina Formation Subgroup	Enorama Shale Tarcowie Siltstone
...l Formation ...ndstone	Tapley Hill Formation Woocalla Dolomite (in part) McLeay Beds	Brighton Limestone Tapley Hill Formation Tindelpina Shale Member Sturt Tillite, Appila Tillite	Tapley Hill Formation Tindelpina Shale Member Wilyerpa Formation
... Volcanics			Benda Siltstone
...luff Tillite			Pualco Tillite
...group ...nt		BURRA GROUP	BURRA GROUP

TABLE 11E

EAST ADELAIDE GEOSYNCLINE	BARRIER RANGES		KING ISL.
	FARNELL GROUP		
	Lintiss Vale Formation		
WILPENA GROUP			
Pound Subgroup:			
Rawnsley Quartzite	Camels Hump Quartzite		
Bonney Sandstone			
Wonoka Formation	Fowlers Gap Formation		
Bunyeroo Formation			
ABC Range Quartzite	Faraway Hills Quartzite		unnamed s volcani
	Sturts Meadows Siltstone		
Ulupa Siltstone			
Seacliff Sandstone,			
Nuccaleena Formation	Mantappa Dolomite		unnamed d
UMBERATANA GROUP unnamed siltstone	TORROWANGEE GROUP Nunduro Conglomerate		Cottons B
Grampus Quartzite	Dering Siltstone		
Pepuarta Tillite			
Gumbowie Arkose Member	Gairdners Creek Quartzite		
Enorama Shale	Alberta Conglomerate		
Tarcowie Siltstone	Floods Creek Formation	Yowahro Formation	
Tapley Hill Formation	Mitchie Well Formation	Tanyarto Formation	
Tindelpina Shale Member	Corona Dolomite		
Wilyerpa Formation	Yangalla Formation	Wammerra Formation	
Benda Siltstone	Mulcatcha Formation	Waukeroo Formation	
Pualco Tillite	POOLAMACCA GROUP		
BURRA GROUP			

TABLE 11F

BARRIER RANGES		KING ISLAND
FARNELL GROUP		
Lintiss Vale Formation		
Camels Hump Quartzite		
Fowlers Gap Formation		
Faraway Hills Quartzite		unnamed siltstones, volcanics
Sturts Meadows Siltstone		
Mantappa Dolomite		unnamed dolomite
TORROWANGEE GROUP Nunduro Conglomerate		Cottons Breccia
Dering Siltstone		
Gairdners Creek Quartzite		
Alberta Conglomerate		
Floods Creek Formation	Yowahro Formation	
Mitchie Well Formation	Tanyarto Formation	
Corona Dolomite		
Yangalla Formation Mulcatcha Formation	Wammerra Formation Waukeroo Formation	
POOLAMACCA GROUP		

FIGURE CAPTIONS.

Fig. 1 Location of major Precambrian sedimentary basins, basement blocks and provinces in Australia, showing those basins that received Adelaidean sedimentation.

Fig. 2 Distribution and dominant facies of early Adelaidean sedimentation in Australia, period approximately 1100 Ma to 1000 Ma.

Fig. 3 Distribution and dominant facies of early Adelaidean sedimentation in Australia, period approximately 1000 Ma to 800 Ma.

Fig. 4 Distribution and dominant facies of late Adelaidean sedimentation in Australia, period approximately 800 Ma to 700 Ma.

Fig. 5 Distribution and dominant facies of late Adelaidean sedimentation in Australia, period approximately 700 Ma to 570 Ma (base of Cambrian).

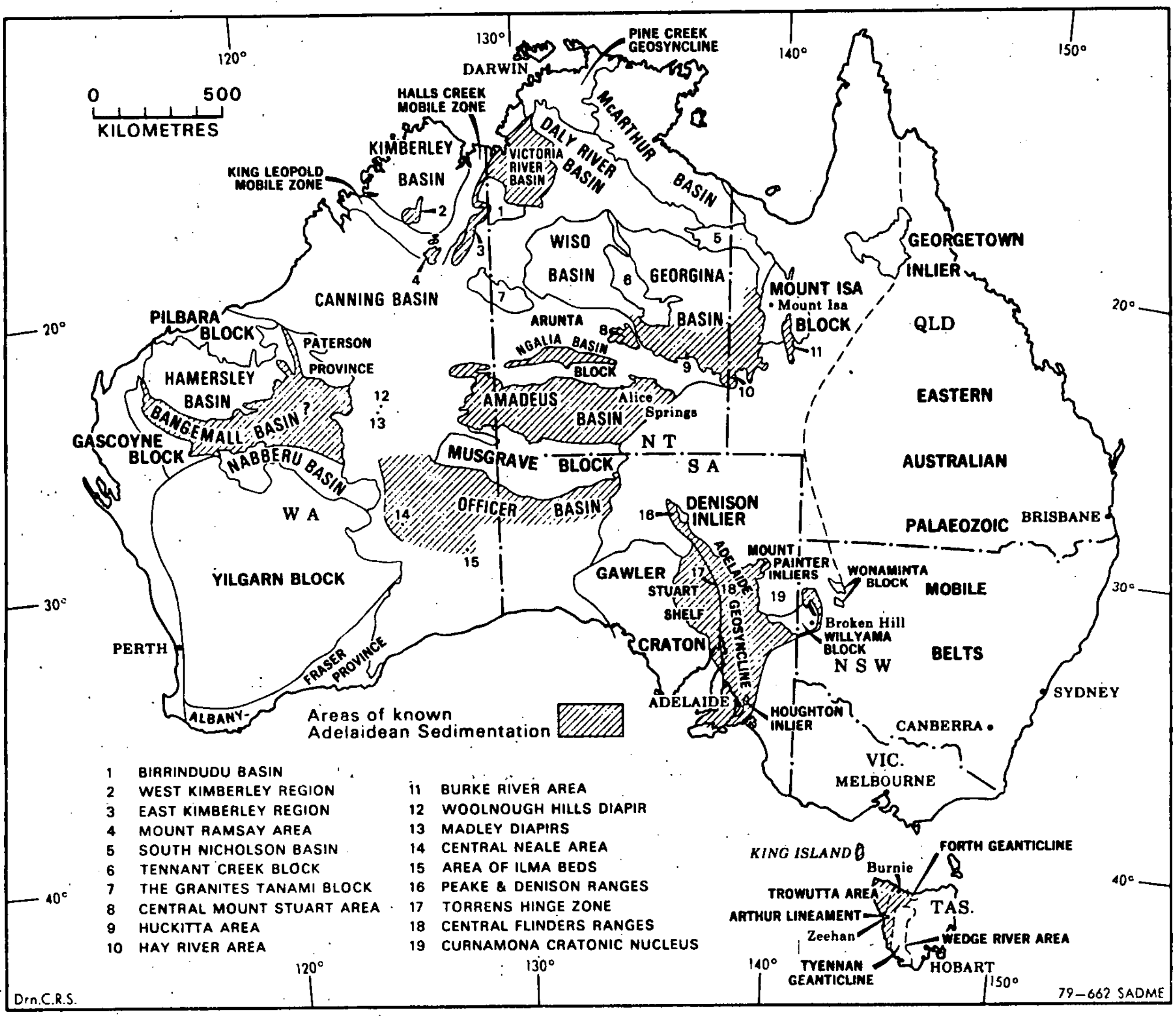
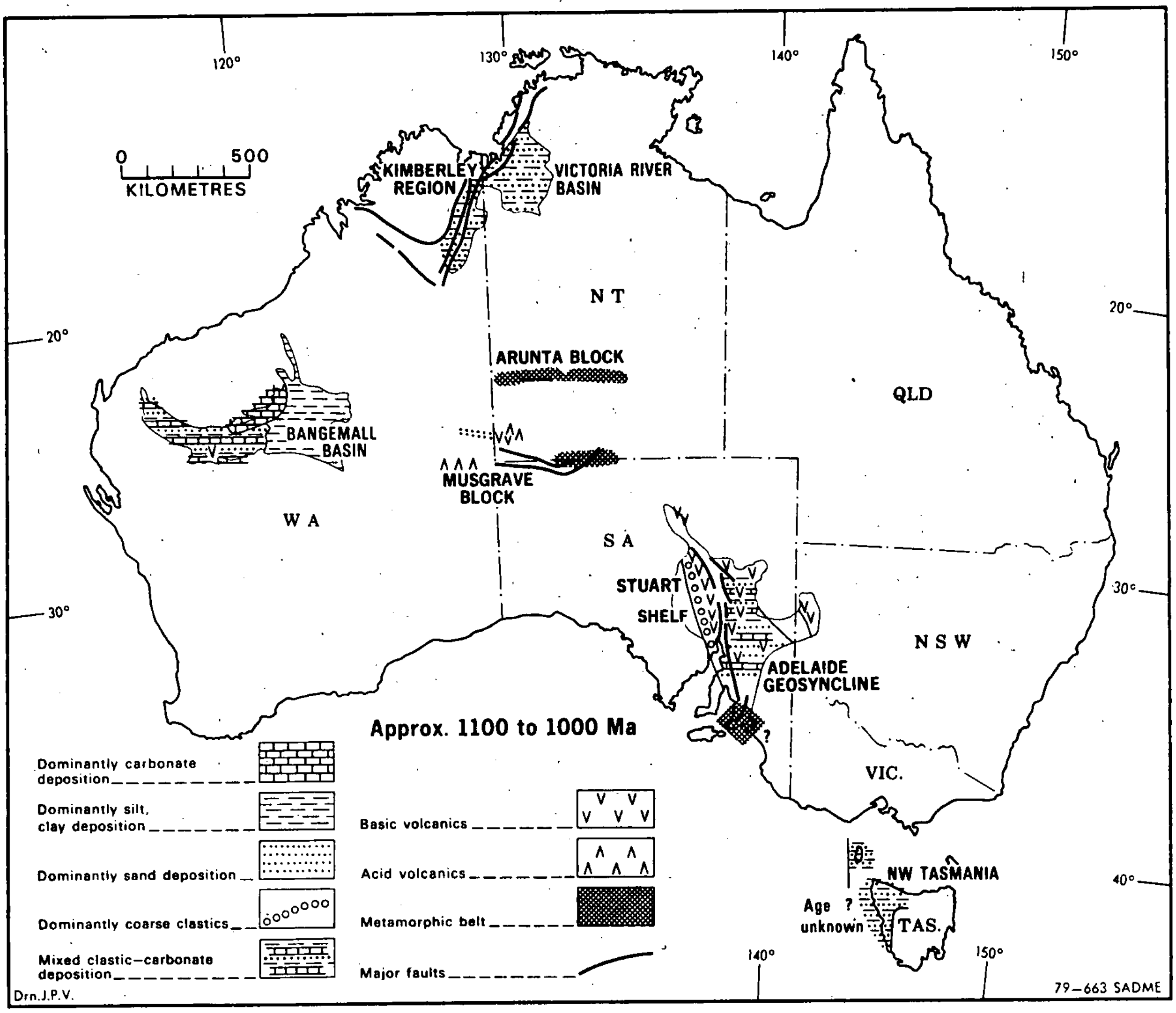

0 500
KILOMETRES
120°
130°
140°
150°
20°
30°
40°
DARWIN
PINE CREEK GEOSYNCLINE
HALLS CREEK MOBILE ZONE
KIMBERLEY BASIN
KING LEOPOLD MOBILE ZONE
VICTORIA RIVER BASIN
DALY RIVER BASIN
McARTHUR BASIN
WISO BASIN
GEORGINA BASIN
CANNING BASIN
MOUNT ISA BLOCK
Mount Isa
GEORGETOWN INLIER
QLD
PILBARA BLOCK
PATERSON PROVINCE
ARUNTA
NGALIA BASIN
BLOCK
HAMERSLEY BASIN
AMADEUS BASIN
Alice Springs
EASTERN AUSTRALIAN PALAEOZOIC MOBILE BELTS
BANGEMALL BASIN ?
GASCOYNE BLOCK
NABBERU BASIN
MUSGRAVE BLOCK
NT
SA
WA
OFFICER BASIN
DENISON INLIER
BRISBANE
YILGARN BLOCK
GAWLER
STUART SHELF
CRATON
ADELAIDE GEOSYNCLINE
MOUNT PAINTER INLIERS
WONAMINTA BLOCK
Broken Hill
WILLYAMA BLOCK
NSW
PERTH
FRASER PROVINCE
ALBANY
ADELAIDE
HOUGHTON INLIER
SYDNEY
CANBERRA
VIC.
MELBOURNE
Areas of known Adelaidean Sedimentation
KING ISLAND
FORTH GEANTICLINE
Burnie
TROWUTTA AREA
ARTHUR LINEAMENT
Zeehan
TAS.
WEDGE RIVER AREA
TYENNAN GEANTICLINE
HOBART
1 BIRRINDUDU BASIN
2 WEST KIMBERLEY REGION
3 EAST KIMBERLEY REGION
4 MOUNT RAMSAY AREA
5 SOUTH NICHOLSON BASIN
6 TENNANT CREEK BLOCK
7 THE GRANITES TANAMI BLOCK
8 CENTRAL MOUNT STUART AREA
9 HUCKITTA AREA
10 HAY RIVER AREA
11 BURKE RIVER AREA
12 WOOLNOUGH HILLS DIAPIR
13 MADLEY DIAPIRS
14 CENTRAL NEALE AREA
15 AREA OF ILMA BEDS
16 PEAKE & DENISON RANGES
17 TORRENS HINGE ZONE
18 CENTRAL FLINDERS RANGES
19 CURNAMONA CRATONIC NUCLEUS
Drn.C.R.S.
79—662 SADME

Fig. 1.



120°
130°
140°
150°
20°
30°
40°
0 500
KILOMETRES
KIMBERLEY REGION
VICTORIA RIVER BASIN
N T
ARUNTA BLOCK
QLD
BANGEMALL BASIN
MUSGRAVE BLOCK
W A
S A
STUART SHELF
ADELAIDE GEOSYNCLINE
N S W
VIC.
NW TASMANIA
Age ? unknown
TAS.
Approx. 1100 to 1000 Ma
Dominantly carbonate deposition
Dominantly silt, clay deposition
Dominantly sand deposition
Dominantly coarse clastics
Mixed clastic–carbonate deposition
Basic volcanics
Acid volcanics
Metamorphic belt
Major faults
Drn.J.P.V.
79–663 SADME

Fig. 2.

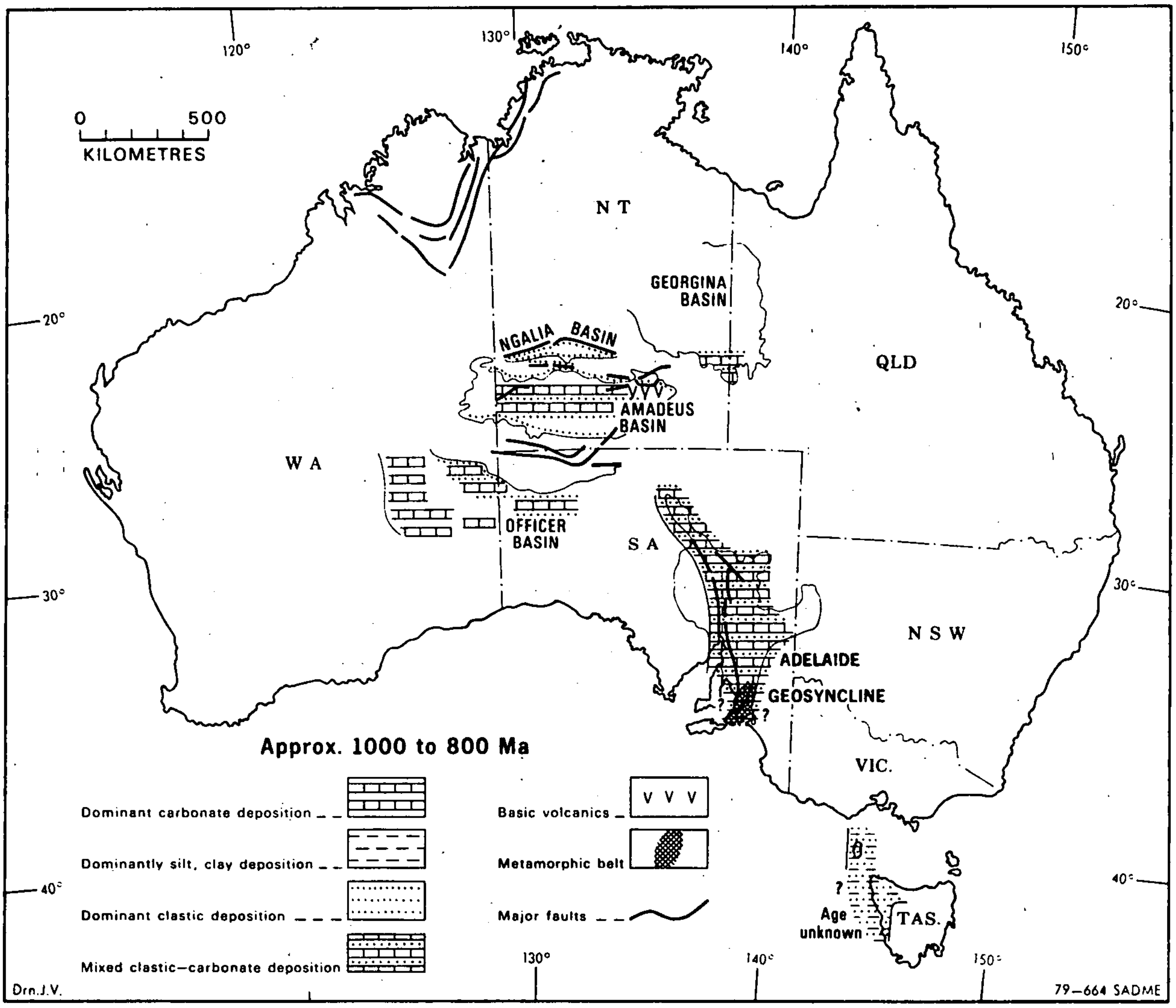

120°
130°
140°
150°
20°
30°
40°
0 500
KILOMETRES
N T
GEORGINA BASIN
NGALIA BASIN
AMADEUS BASIN
QLD
W A
OFFICER BASIN
S A
N S W
ADELAIDE
GEOSYNCLINE
VIC.
TAS.
Age unknown
Approx. 1000 to 800 Ma
Dominant carbonate deposition
Dominantly silt, clay deposition
Dominant clastic deposition
Mixed clastic—carbonate deposition
Basic volcanics
V V V
Metamorphic belt
Major faults
Drn.J.V.
79—664 SADME

Fig. 3.

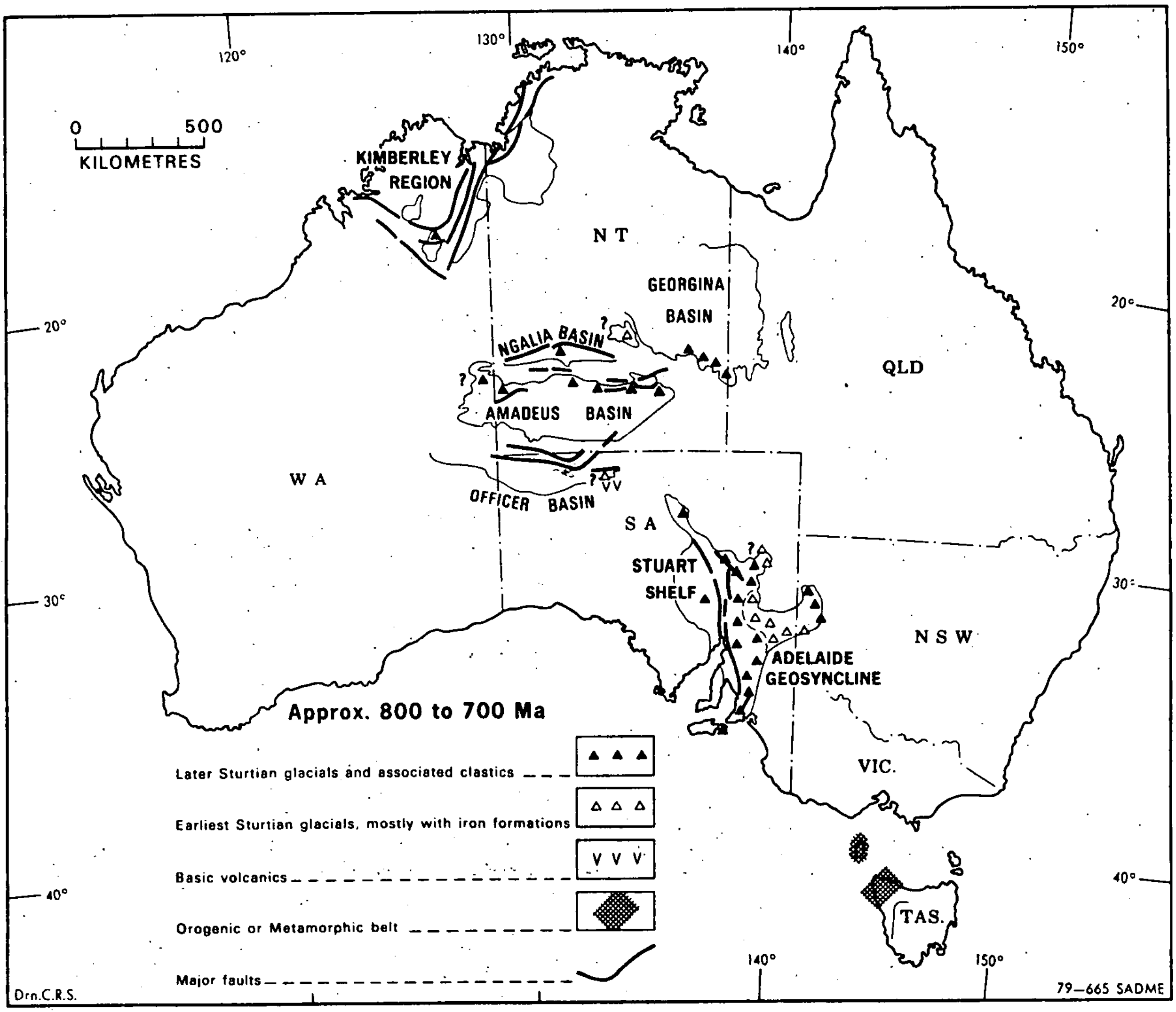

0 500
KILOMETRES
120°
130°
140°
150°
20°
30°
40°
KIMBERLEY REGION
N T
GEORGINA BASIN
NGALIA BASIN
AMADEUS BASIN
QLD
W A
OFFICER BASIN
S A
STUART SHELF
ADELAIDE GEOSYNCLINE
N S W
VIC.
TAS.
Approx. 800 to 700 Ma
Later Sturtian glacials and associated clastics
Earliest Sturtian glacials, mostly with iron formations
Basic volcanics
Orogenic or Metamorphic belt
Major faults
Drn.C.R.S.
79—665 SADME

Fig. 4.

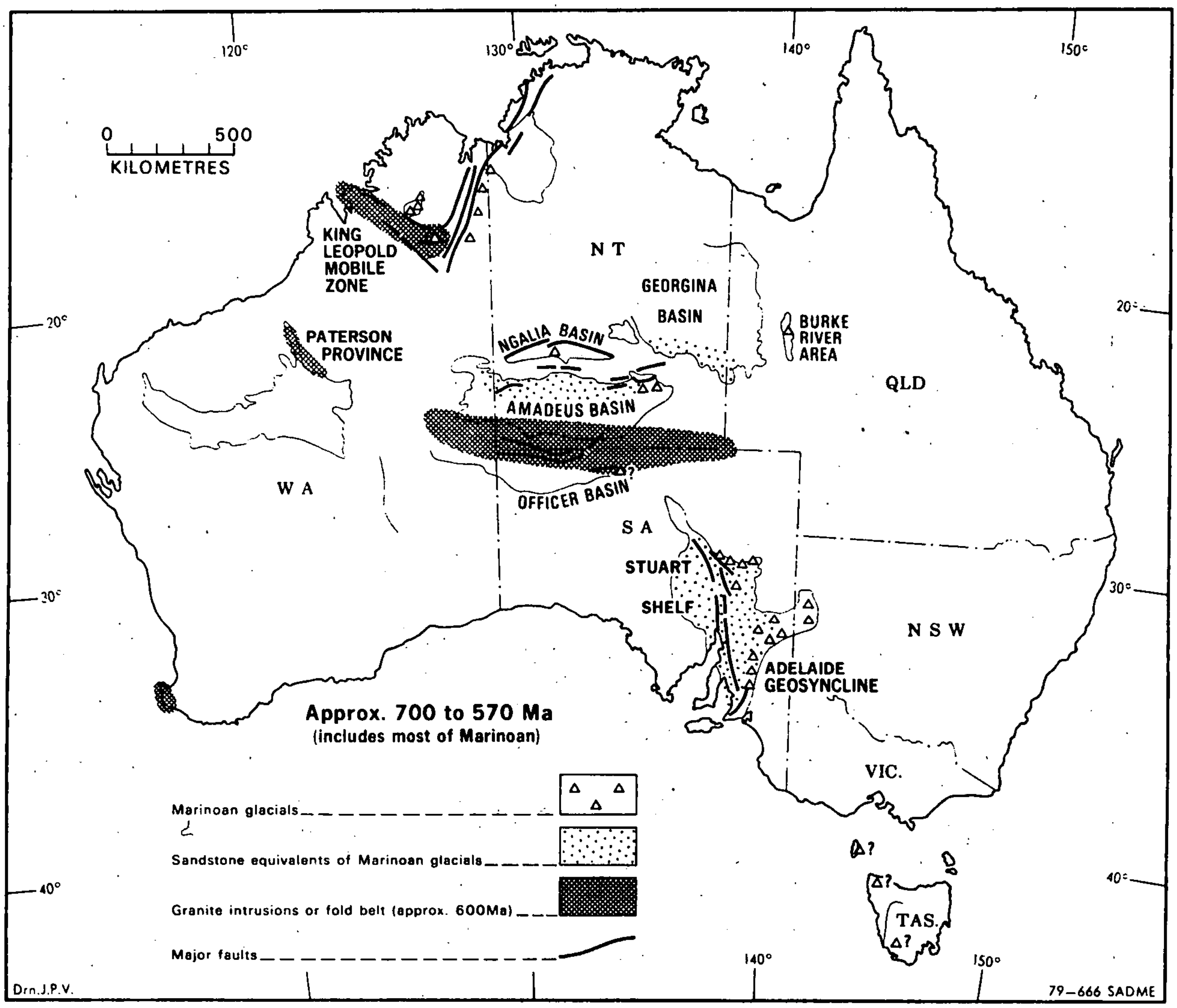

120°
130°
140°
150°
20°
30°
40°
0 500
KILOMETRES
KING
LEOPOLD
MOBILE
ZONE
N T
GEORGINA
BASIN
BURKE
RIVER
AREA
PATERSON
PROVINCE
NGALIA BASIN
AMADEUS BASIN
QLD
W A
OFFICER BASIN
S A
STUART
SHELF
N S W
ADELAIDE
GEOSYNCLINE
Approx. 700 to 570 Ma
(includes most of Marinoan)
VIC.
TAS.
Marinoan glacials
Sandstone equivalents of Marinoan glacials
Granite intrusions or fold belt (approx. 600Ma)
Major faults
Drn.J.P.V.
79—666 SADME

Fig. 5.