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A PROPOSAL FOR TIME-STRATIGRAPHIC SUBDIVISION OF THE AUSTRALIAN PRECAMBRIAN.

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CONTENTS

SUMMARY

Sufficient stratigraphic and radiometric data are now available to provide the basis for a time-stratigraphic subdivision of the Precambrian in Australia.

The data show that a major stratigraphic break occurred from about 2600 to 2300 m.y. and another at about 1800 m.y., and that igneous activity was widespread from 2700 to 2600 m.y., and at about 1800 m.y. and 1500 m.y. Three largely unmetamorphosed rock sequences represent most of the time-interval from 2300 m.y., to the start of the Cambrian.

The terms Archaean and Proterozoic are tentatively retained with a boundary at or before about 2300 m.y. Time-rock subdivision of the Proterozoic is proposed in terms of the three unmetamorphosed rock sequences deposited after 2300 m.y. The oldest time-rock unit is to be defined from the Hamersley Range area of Western Australia and is tentatively named the Lower Proterozoic ("Nullaginian") System with a base dated at about 2300 m.y. The other units are the Carpentarian and Adelaidean Systems which have bases dated at about 1800 m.y. and 1400 m.y., respectively. The top of the Adelaidean System is defined by the base of the Cambrian.

The boundaries between the proposed time-rock units have ages comparable with those of boundaries between some overseas Precambrian subdivisions based on plutonic events.

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Introduction

In the past decade many of the Precambrian rocks of Australia have been investigated for the first time, and vast areas previously known only from sketchy reconnaissance have now been mapped at 1:250,000 scale. Some areas (e.g. the Mount Isa region of Queensland and the Pilbara region of Western Australia) have been mapped as single integrated projects; others (e.g. the Adelaide Geosyncline) have been subject to continuous and growing scrutiny.

The improvement in stratigraphic knowledge of the Precambrian has been accompanied by an increase in the number of reliable radiometric age determinations available for assessing the time significance of various successions. Together this information is sufficient to justify a new attempt to define objective time-rock units and to assess the role of radiometric age determinations in such definitions.

The purposes of this paper are to set out the stratigraphic and radiometric requirements for a satisfactory time-stratigraphic subdivision of the Precambrian; to suggest where in practice these theoretical requirements may be best fulfilled in Australia; and to describe the subdivision which has been adopted by the Commonwealth Bureau of Mineral Resources.

Former Nomenclature

Many attempts have been made to subdivide the Australian Precambrian succession: a number are shown in Table 1. Of necessity all were based primarily on broad lithological correlations and comparisons of metamorphic grade. Thus the gneissic and crystalline "basement" rocks have been consistently regarded as Archaean or Archaeozoic, and the less deformed sedimentary and metamorphic rocks have generally been described as Proterozoic.

David (1932) proposed a two-fold subdivision of the Proterozoic, and with the notable exception of Hossfeld (1954), most authors accepted this basic subdivision, although they applied different terminology and included different successions in the subdivisions. Hossfeld (1954) divided the Proterozoic rocks of the Northern Territory into three and foreshadowed the subdivision proposed here. However, we consider that all previous classifications are unsatisfactory since they were made without the advantage of radiometric age-determinations now available, and thus could not be used for objective continent-wide correlations.*

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*The classification used by Walpole et al.(1965) (Table 1) was that presented at the 1964 A.N.Z.A.A.S. Conference in Canberra; it represents a stage in the development of the classification presented here.

Principles for Precambrian time-division

Orogenic events and the associated granitic intrusions have been most commonly used to designate the boundaries of Precambrian subdivisions throughout the world. However, each orogenic event extends over a considerable period of time and therefore the definition of the boundaries of subdivisions must be based on a statistical analysis of dates, as has been done by the Geological Survey of Canada (Stockwell, 1964). Thus the boundary is defined in terms of time and not the rocks themselves.

Australia is fortunate in having a number of largely unmetamorphosed rock sequences with interspersed igneous rocks; together the sequences appear to represent the interval of time between about 2300 m.y. and the beginning of the Cambrian. A number of radiometric dates have already been obtained from rocks within these sequences and many more can be expected in the future. Thus, using these dates somewhat as fossils are used for correlations in the Phanerozoic, the Precambrian (after about 2300 m.y. at least) can be subdivided into time-rock units similar to those used in the Phanerozoic. The International Subcommission on Stratigraphic Terminology (I.S.S.T., 1965) has recommended the eventual use of such subdivisions in the Precambrian. Spry & Banks (1955) have also discussed a similar use of radiometric ages for the subdivision of Precambrian time.

A type section is needed to define a time-rock unit; the ideal type sequence:

(i) should span, more or less continuously, the time interval it represents;

(ii) should not be metamorphosed or otherwise altered to a degree whereby the radiometric ages obtained from various rocks do not represent the original age; and

(iii) should have a clearly defined base with a rock-unit at or near it which can be dated.

The top of such a time-rock unit would be determined by reference to the defined base of the next youngest time-rock unit. In this way a succession of time-rock units would represent a continuous span of time without overlaps or gaps caused by discrepencies between the age of the defined top of a unit and the age of the separately defined base of the overlying unit.

The definition of the time-rock unit is clearly not directly dependent on time. The age limits assigned to the units by radiometric dating may change as radiometric techniques are improved and more dates are forthcoming; but for effective use of time-rock units it is essential to have type sequences dated as accurately as possible by radiometric means.

The reader is referred to McDougall *et al.* (1965) and Crook (1966) who have discussed the principles of Precambrian time-rock classification in some detail.

Available data

A chart incorporating stratigraphic and radiometric data was shown by B.P. Walpole and discussed at a symposium on Precambrian Geochronology held at the Australian National University in December 1964. Figure 1 is a simplified version of the chart in which only major depositional sequences, unconformities and igneous intrusions have been incorporated, and the age determinations have been summarized.

Subdivisions		Age in my.	SOUTH AUSTRALIA and N S.W.		NORTHERN TERRITORY		QUEENSLAND	NORTHERN TERRITORY		WESTERN AUSTRALIA		
			FLINDER RANGES-BROKEN HILL	EYRE PENINSULA	SOUTH	CENTRAL	MOUNT ISA AREA	NORTH-EAST	NORTH	KIMBERLEY	PILBARA AREA	"YILGARN BLOCK"
PROTEROZOIC	Adelaidean System	600	Wilpena Group Umberatana Group Burra Group Callana Beds	Tent Hill Formation Tregalana Shale	Arumbera Greywacke Pertatataka Formation Areyonga Formation Bitter Springs Limestone Heavitree Quartzite Bloods Range Beds Mt Harris Beds	Mapunga Group Field River Beds			Tomkinson Group Wessel Group	Albert Edward Group Duerdin Group Glidden Group Osmond Range succession Bungle Bungle Dolomite	Bangemall Group	
	Carpenterian System	1500	Willyama and Mount Painter Complexes	Corunna Conglomerate Gawler Range Volcanics Moonabie Formation Middleback Group		Hatches Ck Group	Lawn Hill Formation Mt Isa Shale Myally Beds Eastern Ck Volcanics Argylla Formation Leichhardt Metamorphics Yaringa Metamorphics	McArthur Group Tawallah Group Cliffdale Volcanics Murphy Metamorphics	Roper Group Mount Rigg Group Katherine River Group South Alligator Group Finniss River Group Goodparla & Batchelor Groups	Mount Parker Sandstone Bastion Group Kimberley Group Speewah Gp Whitewater Volcanics Halls Creek Group	Bresnahan Group	
	Lower Proterozoic	1800			Musgrave-Mann Complex and Arunta Complex	Warramunga Group Arunta Complex					Mount Bruce Supergroup: Wyloo Group, Hamersley Group, Fortescue Group	
ARCHAEAN		2300							Rum Jungle Complex		Roebourne Group (incl. Mosquito Creek Beds)	"Yilgarn Series"
REFERENCES			Compston, et al, 1966 Thomson, 1966 Pidgeon, 1964	Compston, et al, 1966 Thomson, 1966	Forman, 1965 Wilson, et al., 1960 Leggo, P.J. (B.M.R.) pers. comm.	Walpole and Smith, 1960	Carter, et al., 1961 Richards, et al, 1963 Richards, 1966	McDougall, et al, 1965 Dunn, et al., in prep	McDougall, et al., 1965 Walpole, et al., in prep. Roberts, et al., in prep. Leggo, P.J. (B.M.R.) pers comm Richards J. et al., 1966	Dow, et al., 1964 Bofinger, V.M. (B.M.R.) pers. comm. Roberts, et al., 1965 Gellatly, et al., 1965	Halligan and Daniels, 1964 Leggo, et al., 1965 Wilson, et al, 1960	Wilson, et al, 1960 Compston, W (A.N.U.) pers comm.

REFERENCE

Depositional sequences	Dated igneous events
Span of sequence with date 1500 of sediment or volcanic in succession	Granite event
Unconformity	Granite and metamorphic event
Position of sequence uncertain	Basic intrusion
Duration of sequence uncertain	Pegmatite
Position of unconformity uncertain	Possible revised position of event
Glacial beds	
Ages in millions of years	(K) - K/Ar determination (R) - Rb/Sr determination

Figure 1. Chart summarizing main stratigraphic sequences and key age determinations throughout the Precambrian of Australia.

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Major unconformities and igneous activity. Ryan's (1965) paper implies the presence of a major unconformity below his Roebourne Group in the Pilbara region of Western Australia, and Horwitz & Soufoulis (1965) suggest the presence of an unconformity within the "greenstone-whitestone" sequence of the Kalgoorlie-Norseman area. However the oldest confirmed major unconformities in Australia are (i) beneath the Mount Bruce Supergroup in north-west Western Australia (McLeod et al., 1963) and (ii) between the Rum Jungle Complex and sediments of the Pine Creek Geosyncline in the Northern Territory (Rhodes, 1965). The Mount Bruce Supergroup overlies metamorphics and granites of the Pilbara Block in the north; the Pilbara granites and associated pegmatites are considered to be between 2800 and 3000 m.y. old (Leggo et al., 1965). The Yilgarn Block crops out some distance to the south of the Mount Bruce Supergroup and the two have not been seen in contact with one another. The Yilgarn Block however is apparently the older and in the Kalgoorlie-Norseman area and west of Perth contains younger granites and metamorphics dated between 2600 and 2700 m.y. (A. Turek, pers. comm, Wilson et al., 1960). Individual minerals from rocks in both the old blocks have yielded dates between 2200 and 2400 m.y., but these dates are believed to represent minor metamorphism and pegmatite intrusion only (Wilson et al., 1960, Leggo et al., 1965).

The unconformity would therefore appear to represent a period of non-deposition extending from at least 2600 m.y. to about 2300 m.y., the age of the base of the Mount Bruce Supergroup. Granite in the Rum Jungle Complex has been dated at about 2550 m.y. (Richards et al., 1966) and the unconformity above it appears to represent a similar period of time to the Western Australian unconformity.

The next oldest, and the best established, unconformity was developed at about 1800 m.y. Granites in the Katherine-Darwin (P.J. Leggo, pers. comm.), Carpentaria (McDougall et al., 1965), Kimberley (V.M. Bofinger pers. comm.), Mount Isa (Richards et al., 1963), and Pilbara areas of Northern Australia (Leggo et al., 1965) were intruded at about this time and, in the first three of these areas the granites are associated with acid volcanics of a similar age. This period of magmatic activity was used by Walpole & Smith (1960) to define the boundary between their Agicondian and Davenportian Series. The dates available to Walpole & Smith were determined by the K-Ar method (Hurley et al., 1960) on granites from the Katherine-Darwin and Tennant Creek areas and show a considerable scatter (1520-1720 m.y.). Subsequently, Leggo (pers. comm.) using the total-rock Rb-Sr method showed that the same granites from the Katherine-Darwin area give a single age of about 1760 m.y. By analogy, the older granites in the Tennant Creek area, which Walpole & Smith equated with the Katherine-Darwin granites, may also be about 1760 m.y. old.

Later periods of magmatic activity, although widespread, are less obviously related to breaks in the sedimentary sequence. The Gawler Range Volcanics in South Australia (Compston et al., 1966) and the Mundi Mundi Granite and extensive pegmatization near Broken Hill (Pidgeon, 1964) have been dated at abetween 1500 and 1600 m.y. Granites have also been emplaced at about 1600 m.y. in South Australia (Compston et al., 1966).

Richards et al., (1963)using K-Ar methods have dated metamorphics and associated granitic intrusions in north-west Queensland between 1350 and 1460 m.y.; these dates correspond roughly to those which Hurley et al., (1960) obtained (1320 to 1540 m.y.) on granites from the Davenport Range area, Northern Territory, and which Walpole & Smith (1960) used to define the younger limits of their Davenportian Series. In view of the older age indicated by the Rb-Sr method for the Katherine-Darwin granites it is

TABLE 1: NOMENCLATURE APPLIED BY VARIOUS AUTHORS TO SUBDIVISONS OF THE AUSTRALIAN PRECAMBRIAN

David (1914)	David (1932)	David (Browne) (1950)	Noakes (1953, 1956)	Hossfeld (1954)	Dept. of National Development (1958)	Tectonic Map of Australia (1962)	Walpole, Roberts, & Forman (1965)	Proposed
	NEWER PROTEROZOIC Adelaide Series Nullagine Series etc.	UPPER PRECAMBRIAN Adelaide System, Nullagine Series etc.	UPPER PROTEROZOIC = Nullagine; Adelaide System	UPPER PROTEROZOIC Pertaknurra and Pertatataka Series	UPPER PROTEROZOIC UPPER) Adelaide and Nullagine Systems LOWER)	UPPER PROTEROZOIC UPPER Adelaide System LOWER	UPPER PROTEROZOIC	ADELAIDEAN SYSTEM
ALGONKIAN Mosquito Creek Series, Warrawoona Series		MIDDLE PRECAMBRIAN Mosquito Creek Series, Kurrawong Series etc.	LOWER PROTEROZOIC = Mosquito Creek	MIDDLE PROTEROZOIC Davenport Series LOWER PROTEROZOIC Agicondi Series	LOWER PROTEROZOIC	LOWER PROTEROZOIC UPPER Davenport System LOWER Agicondian System	MIDDLE PROTEROZOIC LOWER PROTEROZOIC	CARPENTARIAN SYSTEM LOWER PROTEROZOIC ("Nullaginian")
ARCHAEAN	ARCHAEOZOIC Kalgoorlie Series (Upper Warrawoona) etc. Yilgarn Series (Lower Warrawoona) etc.	LOWER PRECAMBRIAN Kalgoorlie Series, Yilgarn Series	ARCHAEOZOIC = Kalgoorlie-Yilgarn	ARCHAEOZOIC	ARCHAEAN	ARCHAEAN	ARCHAEAN	ARCHAEAN

reasonable to assume that all the Davenport Range granites will be at least as old as the oldest age obtained by Hurley with the K-Ar method (i.e. 1540 m.y.). Richards (1966) has recently shown that the same may apply to the age of the north-west Queensland granites. The granites in both areas may therefore be as old as those at Broken Hill and Gawler Range.

Wilson et al., (1960) have dated the pegmatites in the Musgrave Ranges in central Australia and over a considerable distance along the western and southern margins of the Western Australian Precambrian Shield as 1000-1100 m.y. Granites of about the same age were emplaced in the Albany district of Western Australia (Turek & Stevenson, 1966).

Depositional sequences - Between and overlapping the unconformities and igneous events there is an almost continuous and largely unmetamorphosed record of sedimentation and volcanic activity from about 2300 m.y. to the base of the Cambrian. The sedimentary record before 2600 m.y. is blurred by metamorphism, but the low-grade metamorphics in the Mosquito Creek and Kalgoorlie areas of Western Australia provide some detail of sedimentation in the latest part of the period.

The Mount Bruce Supergroup in the Hamersley Range area of Western Australia provides an apparently continuous sequence of unmetamorphosed rocks extending from about 2300 m.y. to 1800 m.y.: volcanics near the base and top of the Supergroup have been dated at 2250 m.y. (Compston, unpubl. data) and 1850 m.y. (Leggo et al., 1965) respectively. Another volcanic unit within the sequence has been dated at 2100 m.y. (op. cit.). The Supergroup is intruded by a granite with a minimum age of 1720 m.y. (op. cit.) and is unconformably overlain by the undated Bresnahan Group (Halligan & Daniels, 1964). The sediments and volcanics in the Pine Creek Geosyncline in the Northern Territory have not been dated, but dates from underlying and overlying rocks limit the period of their deposition to an interval somewhere between 2550 and 1760 m.y. The Halls Creek Group in the Kimberley region of Western Australia was regionally metamorphosed about 1950 m.y. ago. (V.M. Bofinger, Bureau of Mineral Resources, pers. comm.), but its lower age limit is unknown.

The extrusion of acid volcanics associated with the granitic event dated at about 1800 m.y. marked the start of sedimentation over large areas of north Australia. A feature of the sedimentation is the similarity of sequences in the Kimberley, Carpentaria, and Mount Isa areas. After the initial acid vulcanism a predominantly arenaceous basic volcanic sequence (Kimberley, Tawallah, and Katherine River Groups; Eastern Creek Volcanics and Myally Beds) was deposited and followed by a carbonate-lutite sequence (McArthur Group, Lawn Hill Formation-Mount Isa Shale etc.). This in turn was followed, after a minor break, by a sandstone-shale sequence (Roper and South Nicholson Groups) in the Carpentaria area. Early correlations made between widely separated areas on the basis of these lithologies have been confirmed by age determinations.

Age determinations on igneous rocks and glauconite from the Carpentaria area (McDougall et al., 1965) indicate that, apart from a few minor breaks, sedimentation was continuous from 1790 m.y. (the age of the Cliffdale Volcanics) until about 1250 m.y. (intrusion of dolerite sills into the Roper Group). The age of the base of the Roper Group appears to be about 1400 m.y. In the Mount Isa area sedimentation appears to have taken place between 1775 m.y. and about 1420 m.y. (Richards et al., 1963). In the Kimberley area acid vulcanism apparently occurred spasmodically between about 1820 and 1790 m.y., and sedimentation was then continuous until some time after 1690 m.y. (V.M. Bofinger, pers. comm.); sediments which unconformably overly this sequence have been dated at 1130 m.y. (Glidden Group) and 670 m.y. (Albert Edward Group).

A thick sedimentary sequence was deposited in the Adelaide Geosyncline before the beginning of Cambrian time, but radiometric data on its age are not adequate (Compston et al., 1966). Thomson (1966) has suggested that the Callana Beds overlying basement near Wooltana Homestead in the northern Flinders Range represent the oldest period of deposition in the Geosyncline. Because of a Palaeozoic metamorphism, the Wooltana Volcanics within the Callana Beds have not yet been dated with certainty. Present radiometric data indicate that they are 850 m.y. or older while the shales which immediately overlie the volcanics give a minimum age of either 1200 m.y. or 950 m.y. depending on interpretation of the data, which show a superimposed metamorphic isochron at 465 m.y. Thomson (1966) has correlated the Wooltana Volcanics on lithological grounds with the Roopena Volcanics west of Spencer Gulf, which have been reliably dated at 1345 m.y. These data and their implications have been discussed in detail by Thomson (op. cit.) and Compston et al., (op. cit.). If Thomson's correlation is regarded as valid the base of the sequence in the Adelaide Geosyncline would be about 1400 m.y. old, and similar in age to the base of the Roper Group and its equivalents in northern Australia.

Nowhere else in Australia, apparently, is there a sequence which represents late Precambrian time as completely as that in the Adelaide Geosyncline. The late Precambrian sediments in the Amadeus Basin, Northern Territory, (Wells et al., 1965) and the Bangemall Group in Western Australia (Halligan & Daniels, 1964) have lithological affinities with the Adelaide sequence and can probably be correlated in part. Other minor sequences which have provided age determinations within the time-range of the Adelaide rocks are those already mentioned from the Kimberley and Carpentaria areas, the Wessel Group (790 m.y.), also in the Carpentaria area, and the Cardup Shale (650 m.y. ?) near Perth (Compston & Pidgeon, 1962).

Late Precambrian glacial sediments are known from the Adelaide Geosyncline, central Australia, and the Kimberley region of Western Australia. Radiometric work is currently being undertaken to check whether, as is generally believed, the periods of glaciation were all broadly contemporaneous.

The position of the metamorphic and igneous events in central and Western Australia dated at 1000 to 1100 m.y. has not been determined in relation to the sequence in the Adelaide Geosyncline or any other major sedimentary sequence.

Proposals for subdivision

Considering our knowledge of the Australian Precambrian as summarized in Figure 1 and in the previous section we can first divide Precambrian time into two: an upper part in which further subdivisions might be made in terms of time-rock units, and a lower part which, at present, does not appear to contain sequences which fulfil the conditions necessary for the definition of time-rock units. The boundary lies somewhere between 2250 and 2600 m.y.

The two parts roughly correspond to the subdivisions of Proterozoic and Archaean previously used in Australia. The boundary between the Proterozoic and Archaean as defined by the Canadian Geological Survey is 2390 m.y. (Stockwell, 1964). For the present we therefore propose that these two names be retained for the major time divisions and given era rank. Their use in the future might be discontinued when "Archaean" time-rock units become firmly established.

The known rock sequences of Proterozoic age in Australia can be used to define three major time-rock units: Lower Proterozoic ("Nullaginian") System, Carpentarian System, and Adelaidean System.

Lower Proterozoic ("Nullaginian") System - The oldest Proterozoic sequence at present known in Australia which satisfies the requirements for the definition of a time-rock unit is the Mount Bruce Supergroup (McLeod et al., 1963; Leggo et al., 1965). So far no formal definition of a time-rock unit based on this sequence has been made, but Brown et al., (1966) have tentatively used the name "Nullaginian" System in reference to it. Until the unit is formally defined and named we propose to refer to it as Lower Proterozoic, with or without "Nullaginian" following in brackets. Formal definition of the unit should await more conclusive determination of the age of the base of the Supergroup, which at present is tentatively taken as about 2300 m.y.

The Agicondian Series of Walpole & Smith (1960) is probably similar in age to the Lower Proterozoic ("Nullaginian"), but its type area is not suitable for the definition of a major time-rock unit.

Carpentarian System - The data from the Carpentaria area are adequate for the definition of the time-rock unit Carpentarian System, as proposed by McDougall et al., (1965). Its base is represented by the Cliffdale Volcanics, whose age is about 1800 m.y., this base also defines the top of the Lower Proterozoic ("Nullaginian") System. This unit may correspond to the 'Davenportian Series' proposed by Walpole & Smith (1960). However the name Davenportian is inappropriate since the Davenport Range area does not include a representative sequence for the time-interval involved.

Adelaidean System - Despite general usage of Adelaide System we prefer the adjectival form, Adelaidean System. The term Adelaide System has long been applied to the sequence in the Adelaide Geosyncline. The definition of Adelaide System was formalized by Mawson & Sprigg (1950) and later extended by Sprigg (1952). Thomson (1966) has now defined the base of the Adelaide System at the base of the Paralana Quartzite in the Wooltana area. As previously stated, this base has not been accurately dated, but is tentatively taken at about 1400 m.y., although it might be as young as 850 m.y. (Compston et al., 1966). The top of the system is defined by the base of the Cambrian, the age of which is beyond the scope of this paper.

The glacial record within the Adelaidean may provide the basis for further subdivision of the system (into series) on an Australia-wide basis, but the erection of such subdivisions is not discussed in this paper.

In summary, we propose that the Precambrian in Australia should still be divided into two major erathems, Archaean and Proterozoic, with a boundary tentatively placed at or before about 2300 m.y.; the Proterozoic to be further divided into three systems. The oldest system has not yet been formally named and we propose using Lower Proterozoic ("Nullaginian") System to cover it until it is defined. The Lower Proterozoic System is succeeded by the Carpentarian System, which has a base dated at about 1800 m.y. The youngest system is the Adelaidean System, the base of which, in the light of evidence now available, is taken provisionally at about 1400 m.y.

These subdivisions have been incorporated on Figure 1, which thus shows the age, in these terms, of many sequences throughout Australia. In its future publications the Bureau of Mineral Resources will use this

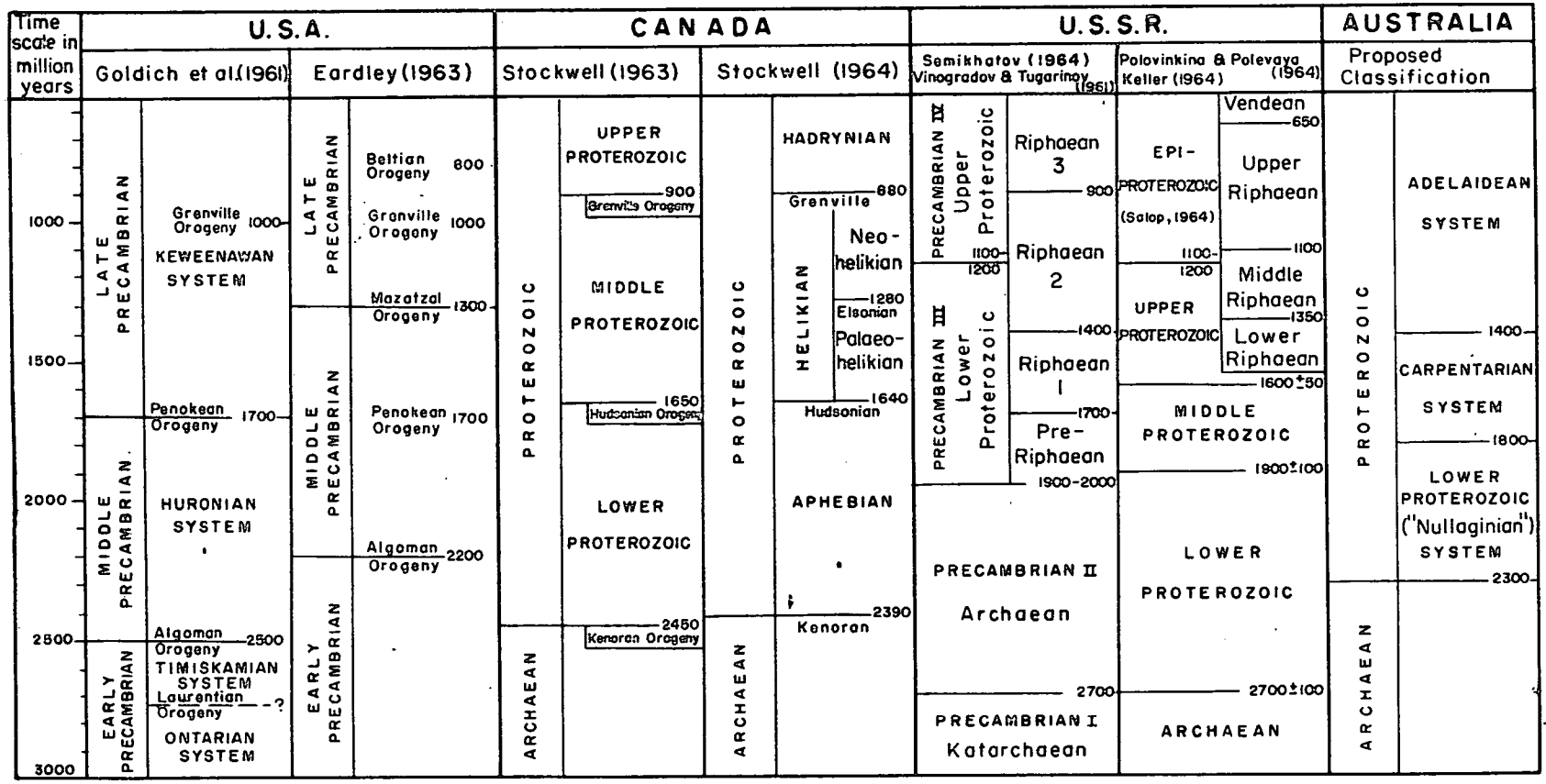

Table 2 — Comparison of selected Precambrian time and time-rock classifications

classification, but will modify it periodically as new information becomes available (i.e. a new name for the Lower Proterozoic System or an improved dating of the base of the Adelaidean).

Comparison with other countries

Despite the increasing number of age determinations being made on Precambrian rocks throughout the world, worldwide correlations must remain speculative. The use of different methods, minerals, and decay constants in age determination and the different treatment of the results obtained make accurate comparisons difficult.* Varying sampling densities can also lead to misinterpretations.

Gastil (1960) and Aldrich et al., (1960) plotted the distribution of Precambrian mineral dates throughout the world and concluded that a number of worldwide tectonic-magmatic events occurred within the following time intervals: 900-1150 m.y.; 1300-1500 m.y.; 1600-1900 m.y.; 2000-2200 m.y.; 2450-2750 m.y. The peaks of the mineral-age distributions occur at 1000 m.y., 1400 m.y., 1750 m.y., 2100 m.y. and 2650 m.y. Salop (1964) recognized five global tectonoplutonic cycles at 600 m.y.; 1000-1100 m.y.; 1400-1500 m.y.; 1800-2100 m.y.; and 2600-2800 m.y. The tectonic events in Australia for the most part correspond to these cycles surprisingly well.

Wilson et al., (1960) compared dates then available from Australia with those from North America and suggested that events dated at 900-1100 m.y., 1600-1700 m.y., and 2300-2400 m.y., were common to both regions. Goldich et al., (1961) reviewed dates available from throughout the world and suggested correlations of Australian events dated at older than 2500 m.y. and 1500-1700 m.y. with similarly aged world-wide events.

A comparison of our proposed subdivisions with overseas subdivisions of the Precambrian is made in Table 2.** Eardley's classification (1963) is quoted for comparison with that of Goldich et al., (1961), which was mainly devised for rocks of the Minnesota region, where the Mazatzal and Beltian orogenies quoted by Eardley are not apparent.

**Glaessner (1966) and Welin (1966) have recently produced tables showing comparisons of Precambrian sequences from different parts of the world. Glaessner has compared time-rock and rock units from the Canadian and Baltic Shields, southern Africa and Australia, and Welin has compared major geological events and the division of the Precambrian of North America and northern Europe. Both tables supplement the information in Table 2.

*For example $1.39 \times 10^{-11}\ yr^{-1}$ has been used for the decay constant in Rb-Sr age determinations quoted here and a reduction of 6 percent in the calculated age is possible owing to uncertainty in this parameter. Furthermore, comparisons between Rb-Sr and K-Ar ages show that the former are usually several percent older, so that 2600 m.y. on the time scale considered here might be equivalent to less than 2500 m.y. on the K-Ar scale employed by the Canadian Geological Survey.

Two Canadian classifications are given to illustrate the changing thoughts in what is considered by many to be the type Proterozoic section of the world. The notable changes in 1964 are (1) the dropping of the terms Upper, Middle, and Lower Proterozoic because of the confusion in their usage, and (2) the recognition of an Elsonian orogeny at 1280 m.y.

Russian literature contains a confusing array of Precambrian nomenclature, but over recent years has been adopting more and more the recommendations of the Committee on Absolute Dating of Geologic Formations, U.S.S.R. Academy of Sciences. We have set out the subdivisions recommended by this Committee in 1961 as quoted by Semikhatov (1964) with modifications to the Riphaean as recommended by Vinogradov & Tugarinov (1961). For comparison we include the subdivisions later recommended by the 12th Session of the Committee in 1963 as quoted by Polovinkina & Polevaya (1964), with the Riphaean subdivided according to Keller (1964).

No recent comprehensive classification of the Precambrian in Africa is available to the authors.

Most countries have based their classifications on the occurrence of orogenies or, as Gilluly (1966) suggests they should be called, plutonic events. Differences exist in the choice of significant plutonic events for subdivision, but most countries recognize their existence.

The difference in the apparent ages of the events may be real, or may be due to the use of different dating techniques. The point of time within a period of plutonic events which is used to define subdivision boundairies is also significant. The Canadian Survey uses the end of "orogenies", defined by a statistical treatment of ages (Stockwell, 1964).

Here it must be remembered that our proposed Australian classification does not depend on plutonic events for its definitions, although in places, plutonic events have initiated the deposition of the sequence of rocks from which our time-rock units are defined. Nevertheless some comparisons can be made with overseas classifications, and it is possible that application of time-rock principles to the overseas classifications would show even more striking similarities in the limits of subdivisions.

We believe that the Australian Precambrian rocks can be used to provide some very important contributions to an eventual world-wide time-rock division of the Precambrian. Much work still remains to be done to finalize the definitions in our Australian classification, but we hope that this paper will provide some stimulus for further research and discussion.

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