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DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
REGIONAL MAPPING SECTION

REPORT ON A.N.U. SYMPOSIUM ON ISOTOPIC AGE-DETERMINATIONS WITH REFERENCE TO CORRELATION OF PRECAMBRIAN ROCKS 2.12.64.

by

B. P. Thomson,
Senior Geologist.

4th January, 1965.

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ABSTRACT

The Australian Precambrian stratigraphy is discussed with the aid of rock correlation data obtained from the Bureau of Mineral Resources and age-determinations made by the Department of Geophysics, Australian National University.

An Australian Precambrian time scale is proposed and referred to four major Precambrian geosynclinal sequences in Australia.

Several diagrams outline tentative correlations of South Australian rock units with the proposed Australian time-rock scale.

GENERAL

The writer arrived in Canberra on the evening of 30th November and returned to Adelaide on the evening of 3rd December. He there contributed an outline of the South Australian Precambrian data at a symposium on Australian Precambrian correlations organized by the Department of Geophysics, Australian National University. Assistance was given to B.M.R. officers immediately prior to the symposium in preparing a correlation chart showing thicknesses of Australian Precambrian rock units and isotope age-determinations obtained by A.N.U. research workers in collaboration with the B.M.R. and State Surveys. A photograph of this chart will shortly be available. The B.M.R. chart is the culmination of the current regional mapping programmes by B.M.R. and a number of State Surveys and much painstaking A.N.U. laboratory work. The B.M.R. chart presents the best available data on Australian Precambrian age-dating and stratigraphy.

The correlation chart presented in this report (fig. 1) was compiled by the writer from notes made after much discussion with Dr. B. P. Walpole and Mr. B. Roberts of the B.M.R. and Dr. W. Compston of A.N.U. It represents only part of the available data shown on the B.M.R. chart. It neglects thickness of the rock units which are here plotted against the absolute time scale in the most likely

relative time positions and from lithological correlations with dated rocks. It probably incorporates a number of errors in correlation which may be corrected when the B.M.R. chart is available for detailed study. This report is presented for the guidance of the Survey geologists who are mapping the Precambrian of this State.

AN AUSTRALIAN PRECAMBRIAN TIME SCALE

A number of papers on Precambrian stratigraphy were presented at the symposium by American[3] and Canadian[1] geochronologists. It was apparent that the Americans and Canadians could not agree on time subdivisions even in contiguous areas. The terms Proterozoic and Archaean do not appear to be accepted by the Americans. The Russians in part use these terms although in a rather different sense to the Canadians, so there is consequently much uncertainty as to when a standard international Precambrian time scale will be adopted. Precambrian time subdivisions based on Australian stratigraphy are suggested in this report as a basis for correlation of Australian regional mapping data.

The extensive regional mapping done in Australia in the last 15 years and recent age-determinations have shown that in Australia we are well endowed with at least 4 major Precambrian geosynclinal sequences ranging in age from about 3000 million years up to the base of the Cambrian at about 600 million years. Each of these sequences has a time span roughly equivalent to the Phanerozoic (i.e. Paleozoic + Mesozoic + Cainozoic).

The youngest of these Precambrian sequences is the Adelaide "System" (System is an inadequate time-rock term to apply to the larger time span now associated with the Precambrian sequence in the Adelaide Geosyncline). The time term "Adelaide" is however retained in the sense envisaged by Mawson as are the smaller time subdivisions Marinoan, Sturtian, Torrensian and Willouran which have been used by the Geological Survey here since systematic regional mapping began. No modifications are required to the proposals made in Quarterly Geological Note No. 9 on Precambrian rock groups in the Adelaide

Geosyncline.

The next cycle is represented by the McCarthur and Tawallah Groups which have been mapped by B.M.R. geologists in the major geosyncline in the West Carpentaria region of Northern Territory and Queensland. The B.M.R. proposes to associate this with the "Carpentaria" time subdivision. The next older cycle is represented by the Mt. Bruce Super-Group in the Nullagine Basin in northwestern W.A. The Super-Group includes the Wyloo, Hamersley and Fortescue Groups as proposed by the Geological Survey of W.A. A tentative time name may be "Nullagine." The oldest known Precambrian sedimentary cycle or cycles may be represented by the Roebourne Group of the "Pilbara System" or the impressive geosynclinal sequences also now mapped by Horwitz and Sofoulis of the W.A. Geological Survey in the Kalgoorlie-Norseman Region. A tentative time term for this is "Yilgarn." It will be the task of the Geological Survey of Western Australia to define the "Nullagine" and "Yilgarn" or "Pilbara" time subdivisions.

The following table shows tentative age limits of the four Australian Precambrian time subdivisions:-

1.	Adelaide	600 to 1400 m. years (span 800 m. years)
2.	Carpentaria	1400 to 1750 m. years (span 350 m. years)
3.	"Nullagine"	1750 to 2500 m. years (span 750 m. years)
4.	"Yilgarn"	+ 2500 m. years (span 1000? m. years)

Detailed evidence for these subdivisions is presented in fig. 1.

There will be problems in applying the time terms to geographically isolated sequences with atypical lithology - e.g. greywacke geosynclinal sediments of possible Adelaide age in the Gnalta area of western N.S.W. However in most areas there will eventually be some time limits set by age-determinations. The writer is sure that when the Australian Precambrian is systematically mapped on 1:250,000 scale and an adequate number of stratigraphic sections have been carefully studied, lithology and rock relationships will establish correlations throughout Australia based essentially on geological evidence.

THE ADELAIDE "SYSTEM"

The problem of the base of the Adelaide System has been discussed by the writer in a recent report entitled "The Lower Boundary of the Adelaide System and Older Basement relationships in South Australia" (G.S. 3034, RB 59/138 D.M. 433A/64). The Adelaide System was assumed to have begun at about 1400 m. yrs. by extrapolation of Callanna Beds thickness below the Willouran basic volcanics, which probably have an age of about 1340 m. years. This time limit appeared to fit provisional correlations shown on a B.M.R. - A.N.U. correlation chart prepared in January 1964 for the A.N.Z.A.A.S. Annual Congress at Canberra. Early Adelaide age-reference points in West Carpentaria are glauconite (1380 + m. years) in the Crawford Formation of the Roper Group and silicate minerals in dolerite sills (1280 m. years) intruding this Group in the Northern Territory.

The discovery of the Marinoan and Sturtian glacials with pavements in the Kimberley area of Western Australia has encouraged the use of the Marinoan and Sturtian time terms by B.M.R. geologists and has highlighted the great value of the glacials as inter-regional time-rock units.

The finding of two glacials by the B.M.R. in the Amadeus Basin region has likewise meant a great advance in correlation. See "Report on Visit to Amadeus Basin, September 1964" by R. C. Mirams, R. P. Coats and C. R. Dalgarno. G.S. 2995, R.B. 59/99, D.M. 433/64).

THE GAWLER RANGE VOLCANICS, CORUNNA CONGLOMERATE AND INTER-REGIONAL CORRELATIONS.

The time gap of about 150 m. years indicated by the ages of the younger Gawler Range Volcanics (1490m.) and the Roopena Volcanics (1340m.) suggested to the writer (G.S. 3034) that erosion of the site of the future Adelaide Geosyncline occupied this time interval up to about 1400 m. years ago. The Gawler Range volcanics were excluded from the Adelaide System owing to their compositional contrast with the basic Willouran volcanics.

The new B.M.R. chart indicates that the remarkable McArthur River Group of carbonates over 15,000 feet thick were probably deposited in the West Carpentaria Geosyncline during this time interval.

The Packsaddle Microdiorite (1480 m. years) in the underlying Tawallah Group is the feeder to the Hobble Chain Rhyolite extrusive, which is correlated with the youngest Gawler Range Volcanic (rhyolite breccia, 1490 m. yrs.). Farther east in Queensland, the acid Croydon Volcanics are also about the same age (1500 m. years).

The dominantly clastic Tawallah Group and possibly the thick clastic sequence of the Bresnahan Group in Western Australia were probably in part deposited during the time interval that established the regional unconformity between Older Precambrian basement and overlying Gawler Range Volcanics and Corunna Conglomerate on Eyre Peninsula. Probably South Australia was a source region for the sedimentary basins represented by the northern thick clastic sequence.

Figures 2 and 3 illustrate the scheme as outlined above.

THE GRANITE PROBLEM

The Canadian Precambrian time scale proposed by the Geological Survey of Canada is based mainly on orogenic cycles associated with granite intrusion and metamorphism. The orogenies associated with granite intrusion (e.g. Grenville) extend over 100 million years or more. The ages have been largely determined by the K/Ar method. The Australian data represented on the latest chart compiled by the B.M.R. are based mainly on Rb/Sr age-determinations, considered by some authorities to be less susceptible to metamorphism than K/Ar ages. The samples include numerous minerals and rocks in sequence e.g. illite, glauconite and lavas.

Datings on granites do not clearly establish Australia-wide orogenic episodes. There may however be remarkable consistency within a single geosyncline as in the West Carpentaria and Katherine-Darwin region where (according to P. Leggo and B. P. Walpole pers. comm.) many granites are dated consistently at 1760 m. yrs. There also appear to be consistent granite ages at about 460 m. years flanking the Lower Palaeozoic Kanmantoo Trough in South Australia. (W. C. Compston pers. comm.).

The granite ages from Eyre Peninsula, Mt. Painter and the Willyama Block on the other hand appear to cover a time span from

1540 to 1670 m. yrs. and to the writer point to the establishment of "Older Precambrian Crystalline Basement" over this interval. Gawler Range Volcanics and Corunna Conglomerate rest on this basement in Eyre Peninsula. The regional unconformity there was established prior to 1530 m. years and probably after 1590 m. years. The age of the Moonabie Formation there exceeds 1590 m. years but it is still possible that this sedimentary unit was deposited in Carpentaria time.

R. T. Pidgeon of A.N.U. (unpublished thesis, pers. comm. W. Compston) has demonstrated that in the Barrier Ranges of N.S.W., the Mundi Mundi Granite intruding the Willyama Complex has an age of 1540 m. years as also have the massive pegmatite bodies within the Willyama Complex. The regional metamorphism is about 1640 m. years.

The Mundi Mundi Granite age is comparable with that of the main mass of Gawler Range Volcanics. Tentative granitic equivalents in South Australia are the Cultana Granite and granitic phases of the Moonta Porphyry. These granites as well as the older granites on Eyre Peninsula appear to be associated with a prolonged positive movement in Southern Australia in Middle Carpentaria time.

FURTHER AGE DATING WORK IN SOUTH AUSTRALIA

(1) Sampling of illitic sediments throughout the four cycles of the Adelaide System is recommended from areas where the effects of the Lower Palaeozoic orogeny may not be strong.

(2) Study of sequences within the Gawler Range Volcanics are suggested to obtain samples of what may be the youngest remaining members of the volcanic pile. It may be possible to narrow the age gap between these rocks and the hypothetical base of the Adelaide System of 1400 m. years.

(3) Detailed study of the Cultana Granite and associated volcanic phases so that the age of the intrusive can be reliably estimated.

(4) Further sampling of the Moonta Porphyry and granitic phases in order to relate metallogenetic epochs and regional tectonics.

(5) Age-dating of Tollu and Skirmish Hill volcanics in W.A., and granites of the N.W. Province in order to date the metamorphism and confirm the probable Yilgarn age of the Mann - Musgrave metamorphics.

(6) Dating of Giles Complex.

CONCLUSION

It is apparent that a big advance is about to be made in the understanding of the geological history of the Australian Precambrian. The application of this knowledge to the study of metallogenic provinces and the search for ore deposits promises to be fruitful.

The writer wishes to express his gratitude to the Director of Mines in being selected to attend the A.N.U. Symposium and participate in the stimulating preliminary liaison work with Dr. B. P. Walpole of the Bureau of Mineral Resources and Dr. W. Compston of A.N.U.

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TIME SCALE			ROCK UNITS					
AUSTRALIAN PRECAMBRIAN SUBDIVISIONS	MILLION YEARS	SOUTH AUSTRALIA	CENTRAL AUSTRALIA	W.A	N.T., KATHERINE. DARWIN	EAST N.T. W. QUEENSLAND	N.E. QUEENSLAND
ADELAIDE — MARINOAN	600	WILPENA GP.	Arumbera Greywacke	LOUISA DOWNS / ALBERT EDWARD GP.			
		UMBERATANA GP. Yerelina Fm. Amberoona Fm.	Grant Bluff Fm.				
ADELAIDE — STURTIAN	700	Yankaninna Fm. Tapley Hill Fm. Yudnamutana Sb Gp.	Pertatataka Fm. / Areyonga Fm. / Beds	KUNIANTI GP. / ORD GP. / Walsh Tillite	TOLMER GP.	Elcho I. Fm. WESSELL GP.	
	800						
ADELAIDE — TORRENSIAN	900	BURRA GP. ? Saddleworth Fm. Auburn Dolomite Undalya Quartzite Woolshed Flat Shale Skilgallee Dolomite Rhynie S.S.		Yinnietharra Pegmatite			
	1000			?			
ADELAIDE — WILLOURAN	1100	? Shale, Wooltana	Bitter Springs Limestone	BANGEMALL GROUP Kurabuka Fm. Fords Ck Shale Top Camp Dolomite		Forsyth Granite	
	1200	CALLANNA BEDS					
	1300	Wooltana Volcanics. Roopena Volcanics	Heavitree Qte (Dean Qte)			dolerite ROPER GP. SOUTH NICHOLSON GP.	
	1400	?		?		Crawford Fm.	
CARPENTARIA	1500	Gawler Ra. Volc. Corunna Conglom. Gawler Ra. Volc. Mundi Mundi Granite NSW			M^t RIGG GP. KATHERINE RIVER GP.	M^cARTHUR GROUP. Pocksaddle Microdiorite TAWALLAH GROUP	Croydon Volcanics
	1600	Charleston Granite Binberrie Adamellite Burkitt Granite (R/A) Willyama No. 1 Metamorphism Pepegoona Porphyry		BRESNAHAN GROUP KUNDERONG S.S. Cherrybooka Conglomerate	PARSONS R.A. GP.		LANGDON R. Fm. Etheridge R. Fm.
	1700			? Boolaloo Granite			
	1800	---METAMORPHISM & GRANITE INTRUSIONS---		WYLOO GP. Ashburton Fm. Tuffaceous siltstone Duck Ck Dolomite Mt M^cGrath Fm. Beasley R Qte Turee Ck Fm.	Edith R. Volcanics	Cliffdale Volcanics. Argylla Volcanics	
	1900				SOUTH ALLIGATOR GROUP		
	2000			HAMERSLEY GROUP Boolgeeda Iron Fm.	GOODPARLA GROUP		
	2100	"Middleback Group"?		Woongarra Volcanics. Weeli Wolli Fm. Brockman Iron Fm. M^t M^cCrae Shale Mt. Sylvia Fm. Wittenoom Dolomite Marra Mamba Iron Fm.			
"NULLAGINE"	2200			FORTESCUE GP. Jeerinah Fm. M^t Jope Basalt Hardey S.S.			
	2300		"Skirmish Hill Volcanics" (W.A.) M^c Harris Basalt (N.T.)	M^t Roe Basalt			
	2400		Mann-Musgrave Metamorphics	?	RUM JUNGLE COMPLEX		
	2500		?				
	2600						
	2700			"Pilbara System" (ROEBOURNE GP)			
"YILGARN"	2800						
	2900						
	3000						

LEGEND

- Upper Glacial – (Marinoan)
- Lower Glacial – (Sturtian)
- Basic volcanic – age determination
- Illite, glauconite – " "
- Granite – " "
- Acid Volcanic

GENERALISED TIME ROCK CHART FOR AUSTRALIAN PRECAMBRIAN MODIFIED FROM BMR CHART ASSEMBLED 30·11·64. & R6/Sr

AGE-DETERMINATIONS BY DEPT. of GEOPHYSICS A.N.U.

FIG. 1

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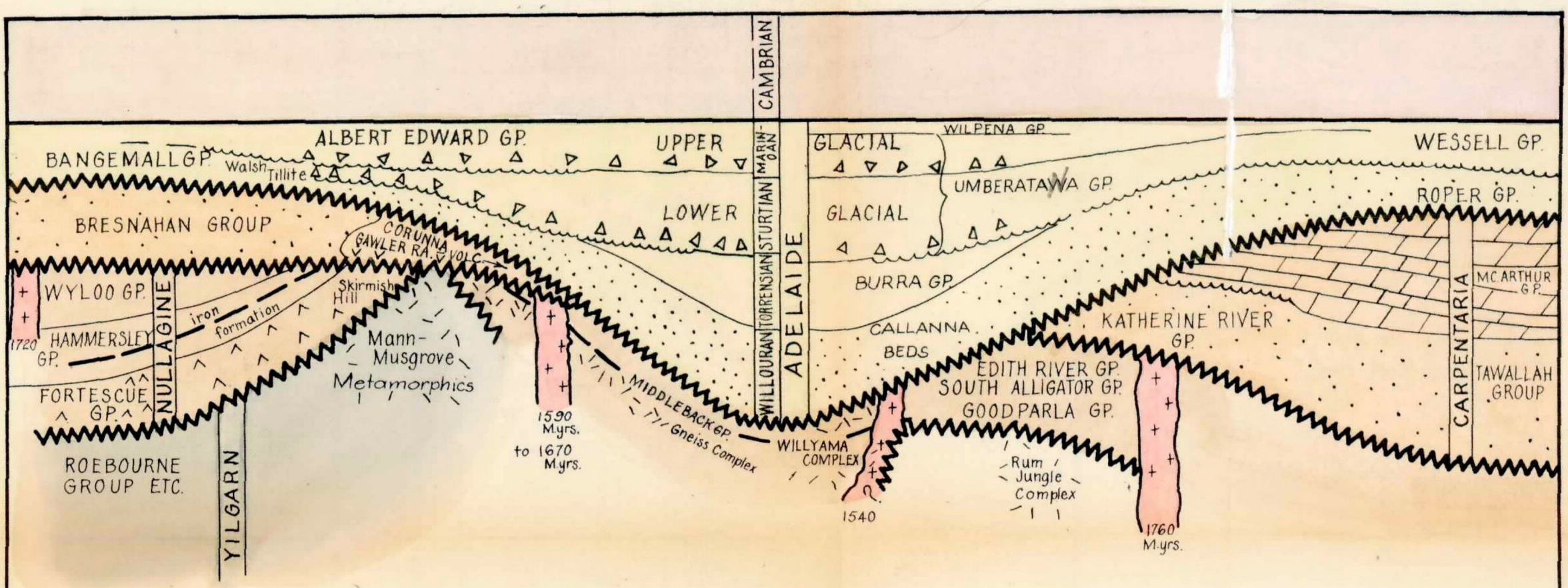
To accompany report by B.P. Thomson



CAMBRIAN

ADELAIDE

CARPENTARIA

NULLAGINE

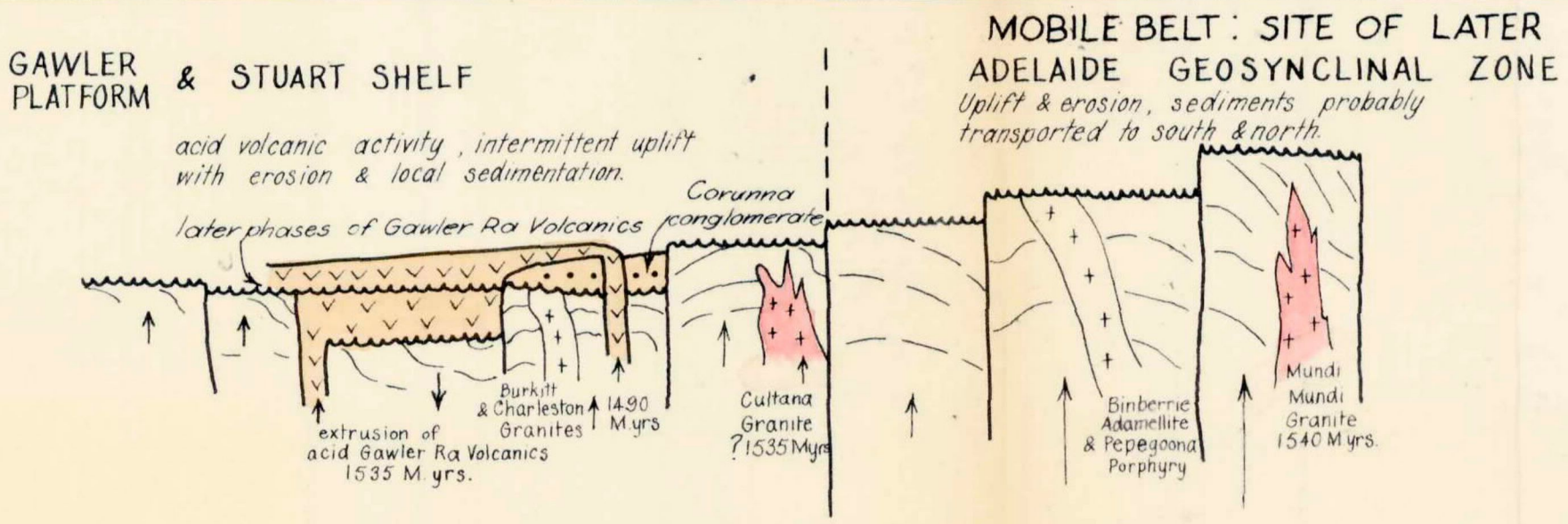
YILGARN

GRANITE INTRUSIONS

METAMORPHISM

AUSTRALIAN PRECAMBRIAN ROCK RELATIONSHIP DIAGRAM

FIG. 2



S.A. DEPT. OF MINES

FIG. 3

DIAGRAM ILLUSTRATING TECTONIC EVOLUTION OF THE ADELAIDE GEOSYNCLINE

To accompany report by B.P. Thomson.

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