CSR OIL & GAS DIVISION

PALYNOLOGY FACILITY

0041

LATE PALAEOZOIC AND MESOZOIC

PALYNOSTRATIGRAPHICAL UNITS

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1 SUMMARY

The basic palynostratigraphical subdivision of the Cooper/Galilee/Eromanga and the Surat/Bowen Basin regions was developed in the 1960s. Since that time, the basic unit nomenclature ("J1", "Tr2a", etc.) applied then has been retained so as to give continuity of reporting, even though the addition of new data has necessitated the revision of the definition and scope of the units and subunits. Now the cumulative effect of these changes is such that there is a variety of usage and interpretation for these units which still bear the same "names" or letter/number codes. Thus, so as to avoid future confusion, it is proposed to introduce the latest modifications to the late Palaeozoic and Mesozoic palynostratigraphical units with a new nomenclature which will distinguish it from the earlier units and interpretations.

The proposed units, together with their general relationships to the superseded units, the lithostratigraphical units and geological age, are presented on the accompanying tables and figures.

2 INTRODUCTION

The palynostratigraphical nomenclature that has been applied to the Permian and Mesozoic sections of the Cooper/Galilee/Eromanga Basins and the Surat/Bowen Basins regions by CSR Oil and Gas Division is a composite nomenclature adapted from units initially established by several workers (e.g. Evans, 1966 and 1967; Paten, 1969; Dettmann and Playford, 1969) during the 1960s. Since their establishment, these units have been modified by varying degrees, both in scope and definition, with the better understanding of the microfloral succession gained from additional sampling accompanying the exploration of these regions. These modifications have come generally as a series of minor changes which, individually, did not necessitate a change to the "name" or letter/number code applied to the unit.

More recently, with the extensive sampling now available from the Surat/Bowen Basins and the Cooper/Eromanga Basins, substantial modification and subdivision of the units has occurred. These modifications are a result of changes in the known ranges of the selected taxa, the understanding of the influence of facies upon the assemblages, and the morphological circumscription of the index taxa. The cumulative effect of these changes is that the palynostratigraphical interpretation, and hence the application to a given section, has changed substantially between a report written in 1984 and one written in the 1970s, and, of late, between the various laboratories now examining and reporting upon these sections. Thus, even though the same palynostratigraphical "names" (e.g. "J4") have been applied, their stratigraphical extent and significance **may** vary among reports and authors. The differences now are such that the retention of the old nomenclature could cause considerable confusion and has become misleading in some parts of the section. Therefore, having outlived their usefulness, they need now to be abandoned and the accompanying units set out on tables 1 to 6 will be adopted by CSR Oil and Gas Division in their place.

The following discussion is not intended to be a comprehensive account or description of the units but rather to give a general account of the philosophy adopted, and to highlight some points of application to the Cooper/Eromanga Basins and the Surat/Bowen Basins. A more detailed account of the microfloral succession and the relation of the various generations of biostratigraphical units applied to these regions is in preparation.

3 NATURE AND SCOPE

The initial palynostratigraphical subdivision of the Surat/Eromanga regions (e.g. Evans, 1966 & 1967) was based essentially upon assemblage zones (zones defined upon general abundance and composition of the microfloras) but also incorporated, in some instances, the appearance or extinction of nominated guide fossils. Assemblage zones are best suited to providing a general correlation for isolated samples but, as their boundaries are ill-defined (unless coincident with an unconformity), they do not enable optimum biostratigraphical resolution in the case of comprehensively sampled petroleum exploration well sections.

In most well sections, where there is an adequate sequence of samples, most emphasis is placed upon defining the boundaries **between** biostratigraphical units. The objective is to define "time lines" but it must be remembered that a biostratigraphical unit need not be (and often is not) a chronostratigraphical unit. Biostratigraphical units define the stratigraphical limits (both vertically and horizontally) of biological events and these are the product of **both** evolution (time significant) and local environmental variation (of **NO** time significance). A chronostratigraphical unit is, by definition, bounded by isochronous surfaces representing the same increment of time throughout its lateral extent. Thus, for a biostratigraphical unit to approach being of chronostratigraphical significance, the variation in the distribution of the biological entities used to define the biostratigraphic unit boundary caused by lateral changes in the environment must be recognised and minimised.

It should be noted that not all biostratigraphical units are directed towards time correlation - for example, they may be used to define the extent of an organic facies or environment. The object of the proposed units, however, is to approximate chronostratigaphical units at least on the local or intra-basinal scale.

To attempt to realize the objective of defining biostratigraphical boundaries which approximate "time lines", several features have been considered desirable and have been given emphasis in defining the palynostratigraphical units proposed.

1. Definition of a boundary is based upon a single taxon where that taxon **has been shown to be** both nearly ubiquitous within the zone and morphologically distinct and robust.

2. The oldest occurrence of a taxon is preferred to its extinction, as the time of extinction can be obscured by reworking or the persistence of relict floras in isolated areas. This criterion presumes that uncontaminated samples (core and sidewall cores but **NOT** ditch cuttings) are available.

3. Emphasis is given to establishing the progenitors of the selected taxon. Utilization of members of a lineage gives a strong time significance on the principle that a species will evolve once only, provided speciation is not a result of polyploidy.

By **definition**, these units are "Interval-Zones" and their boundaries are "Biohorizons", each being defined in this case upon the first appearance of a specified taxon. The **application** of the units, however, is **not** one of the rigid mapping of the first uphole occurrence of the designated taxon but is tempered by a palynologist's assessment of the significance of that occurrence. This assessment is not easily defined but is influenced by the yield, the preservation, the diversity and the associated taxa in relation to that of the preceding and succeeding samples. This is not to say that the **presence** of the **index taxon** will be **assumed** in a poor or restricted assemblage but rather that the particular sample will not be taken as an indicator of the position of the boundary in question. Thus, in application, the proposed units are best suited to a **sequence** of samples which are **free from contamination** and in which the preservation is at least fair. If applied to isolated samples (e.g. outcrop) or a sparsely sampled section, then the result is often best regarded as being broadly defined and thought of as being "no older than" the designated unit.

4 NOMENCLATURE

An alpha-numerical nomenclature has been adopted for the proposed units. It is hierarchical in structure, with the numerical value increasing from oldest to youngest within each geological period. The first character of the unit nomenclature ("P" = spore/pollen, "D" = dinoflagellate) indicates the palynomorph group used to define the unit. The second character ("P" = Permian, "T" = Triassic, "K" = Cretaceous) gives the adopted geological age. The third, fourth, fifth and sixth characters are numerals indicating the relative stratigraphical position - the higher the number, the younger or higher the stratigraphical position. The first numeral (i.e. third character) represents the broad subdivisions which can be applied to approximately 90% of samples examined. In general, they correspond to the majority (those which have proved stable) of the major units of the previous palynostratigraphical subdivisions. The second numeral (i.e. fourth character) corresponds more or less to the subzones of the earlier nomenclature. These subzones are more difficult to apply and so only some 60% of samples can be assigned to this level in the hierarchy. The third and fourth (i.e. fifth and sixth characters) are for the more subtle subdivisions and give scope for inserting new units without disrupting the already established units.

The "International Stratigraphical Code" perhaps "frowns" upon such numerical nomenclatures, preferring to sanction a convention which takes the form of the name of the defining fossil (provided that the name has not been used for a previous biostratigraphical unit). It is felt, however, that the numerical nomenclature adopted here has several practical advantages in terms of its application to the hydrocarbon exploration industry.

1. The numerical sequence indicates the relative stratigraphical position, circumventing the need to know the stratigraphical order of the fossil zones;

2. This system is readily adopted and understood by non-specialist explorationists and managers;

3. The units are amenable to computer data processing;

4. The "alpha-numerical" codes are concise and thus suitable for inclusion on geological cross-sections, logs, etc; and

5. This nomenclature avoids the complications which arise from taxonomic revisions of the index or naming fossil.

The particular format adopted has been designed so as to minimise confusion with the previous alpha-numerical codes which these now replace.

5 CONVENTIONS

In applying the proposed nomenclature, the following conventions will be used to indicate the levels of confidence and limits of biostratigraphical resolution applied to individual samples.

1. Where a sample can be subdivided to the finest level of resolution,

it will be designated as on the accompanying tables (e.g. "PP3.3.1");

2. Where a sample can only be assigned to a lesser level of classification, it will be designated by the first two letters (palynomorph type, adopted age) followed by the numeral or numerals representing the "zone" or "subzone" (e.g. "PP.3", "PP3.3");

3. If the sample can be defined only within a range, the lower and upper limits will be given (e.g. "PP3.2 - PP4");

4. If the sample can be assigned to either of two adjacent subzones, it will be given as a range (e.g. "P3.3.2 - PP4.1");

5. If a sample can be defined within a range in which assignment to a particular subzone is favoured but cannot be definitely made, then the designation is given as for a range followed by a question mark and the favoured unit (e.g. "PP3.2 - PP3.3, ?PP3.3"). For instance, in the case of where the marker species is absent or doubtfully identified and the subordinate taxa would favour, but can not establish, a particular assignment;

6. An attempt should always be made to give a zonal range for a sampled horizon rather than use the expressions "no older than" or "no younger than". For example, if the horizon is able to be defined as "no older than PP3", then it is unlikely that it will be any younger than PP6 and thus it is preferable to indicate this determination as "PP3 - PP6". In the case of cuttings, or where reworking is suspected, these phrases may not be avoidable and they can be abbreviated to "N.O.T." or "N.Y.T." in such instances.

6 AGE RELATIONSHIPS

The relationships of the biostratigraphical units to the international geochronological zones as presently interpreted are set out in fig 1. and represent a consensus based upon the inter-continental correlations of spore/pollen and dinoflagellate microfloras and invertebrate and micropalaeontological faunas. The geochronological zones and the corresponding estimated absolute ages adopted are those of Harland *et al.* 1982.

In accepting the relationship given for the chronozone (period/epoch/age) and "absolute age", several things should be recognised.

1. The period boundaries relative to the various series/stage boundaries have not been agreed upon in the international arena. They have not been defined in Australia as no regional chronostratigraphical units have been established and adopted for Australia as a whole.

2. There are several interpretations as to the relationship of the radiometric ages to the Period boundaries (cf. Harland *et al.* 1982, Odin 1982, Palmer 1983, van Eysinga 1975, van Hinte 1978).

3. The majority of absolute ages are established on igneous rocks and the age relationships of these to the fossiliferous sediments may be contentious.

4. The faunal and floral intra- and inter-continental correlations often are imperfectly known and sometimes conflicting.

5. While the migration times of an organism may not be geologically significant on a basinal scale, and only slightly significant on a continental scale, they can be substantial on a global scale. For example, the initial occurrence of *Cicatricosisporites* spp. in Australia has been taken as approximating the Cretaceous/Jurassic

boundary. This form however, has been found as low as the mid-Callovian (Middle Jurassic) in the western north Atlantic and northern African regions.

It must be recognised therefore that the absolute time relationships of these biostratigraphic units as set out on the accompaning tables are, at best, subjective estimates. Thus, any conclusions based upon them (for example, "Lopatin" time/temperature calculations) must be regarded as being speculative.

7 RELATIONSHIPS WITH EXISTING UNITS

7.1 General Comments

The broad relationship between the proposed biostratigraphical units and those applied to the Surat/Eromanga region up the end of 1984 is summarised in tables 1 - 6. The presented relationship should be regarded as being a generalised guide, especially in respect of the Jurassic. As noted above, the interpretation of the earlier units has changed, as have the taxonomic concepts applied to certain of the species and thus the relationship of individual sections must be established with an historical perspective and in the context of differing interpretive opinions between the various investigators. Additionally, certain of the major units (especially in the Jurassic) have been abandoned in favour of those defined on perhaps less obvious forms but which have proved to be less susceptible to environmental influences or are without the complications of difficult taxonomic subdivision. A detailed account of the historical developments and application of the palynostratigraphical units for the Cooper/Eromanga Basins and Surat/Bowen Basins is in preparation. The present discussion will be limited to notes set out under each Period to assist in the interpretation of the proposed units.

7.2 Devonian

The Early and Middle Devonian units were developed by Price (1980) from the Adavale Basin sequence and remain untested for sections outside this region. The Late Devonian units have been adapted from assemblages described from several localities in western and northern Australia (e.g. Balme 1962, Playford *et al.* 1976). The boundaries of these Late Devonian assemblages are not well known as they have not been recognised in a continuous section.

7.3 Carboniferous

The Carboniferous units are based upon the assemblage zones described by Playford and Helby (in Kemp *et al.* 1977). The selection of the index forms for the definition of the present units has been somewhat arbitrary although the published range charts of the described Carboniferous sections (e.g. Playford 1971, 1976, 1978) have been taken into account.

In terms of the Late Carboniferous and Early Permian units, there is a difference in interpretation given by Paten (1969) and Price (1973, 1976, 1983) and that given by Kemp *et al.* (1977) in terms of the positioning of stage 1 and stage 2 boundaries. **Paten** and **Price** recognised the base of stage 1 as being the oldest occurrence of the monosaccate pollen (*Potonieisporites* spp. and *Plicatipollenites* spp.) while Kemp *et al.* considered the establishment of an abundance of monosaccate pollen as being definitive. Thus stage 1, in terms of Paten and Price, corresponds to the base of *Anabaculites yberti* Assemblage of Kemp *et al.* Similarly, the base of stage 2 was designated by Paten (1969) and Price (1973, 1976, 1983) as being the oldest striate pollen. It is this concept of Paten and Price for the stage 1 and stage 2 boundaries that has been incorporated into the present zonal scheme.

7.4 Permian

The Permian palynostratigraphy of the Cooper and Bowen Basins has been reviewed by Price 1983 and, with few exceptions, the biostratigraphical boundaries of the two nomenclatures correspond. The time span of the Permian Period relative to palynostratigraphical units adopted here is consistent with Harland (1982) rather than the Waterhouse-based (Waterhouse, 1976) positioning indicated by Price (1983).

The major change lies with the subdivision of PP5. Price (1983) indicates that *Microreticulatisporites bitriangularis* extended down only to the base of Black Alley Shale. Subsequent work in the Denison Trough indicates that this taxon extends at least into the upper part of the Ingelara Formation and, in some areas, (e.g. Christmas Creek and Rolleston) into what is presently regarded as being the Freitag Formation and the upper Aldebaran Formation of AAR's nomenclature. Thus the relationship given by Price (1983) of what was "upper stage 5c" and "upper stage 5b" is no longer valid. The significance and usefulness of *M. bitriangularis* is being re-evaluated and is for the present excluded from the proposed nomenclature. The subdivision of PP5 based upon the initial occurrence of *Dulhuntyispora stellata* is applicable only to the Western Australian section and possibly to the Galilee Basin section as this form occurs only rarely in the Cooper and Bowen Basins. At present in the Bowen Basin (apart from the use of the *M evansii* Acme Zone in the Denison Trough and Roma Shelf), PP5 can be subdivided only on broad assemblage characters giving a general indication as to whether the sampled horizon is from the upper, mid or lower part of the unit. Being based upon assemblage characteristics, these subunits have vague boundaries which are partly environmentally influenced. As such, they therefore have been excluded from the present nomenclature.

7.5 Triassic

The Triassic sequences of the Bowen and Cooper Basins remain as the least studied of the Mesozoic sections in terms of palynostratigraphical subdivision. These sections, which are almost exclusively non-marine, can be strongly influenced by local facies effects and the index forms are often sporadic in their distribution. The precise relationship of PT3, PT4 and PT5 to each other and to the lithostratigraphy is uncertain, as in the main area of study, that is, the Ipswich region of Queensland, the section is considered to be incomplete.

7.6 Jurassic

The Jurassic, for reason of its recently recognised economic importance in the Eromanga Basin, has been the subject of intense study and, consequently, is the most modified in terms of palynostratigraphical subdivision. By 1980, it was clear that the established units were difficult to apply and strongly influenced by local floral variation. The absence of recent data in 1978 on either the Surat or Eromanga Basin Jurassic microfloral successions led to difficulties in relating the sand and shale sequences in the two regions. The most testing of these miscorrelations related to the association of the upper Poolowanna Beds and the Birkhead Formation. This partly related to the lack of detailed stratigraphical information on the distribution of *Contignisporites cooksoniae* and some closely related variants and was further aggravated by the mislabelling of a sample from Pandieburra No. 1. Although strong reservations were expressed about the biostratigraphical implications and the correlations at the time with the problems and limitations being identified (Price, 1978) on general microfloral grounds, the correlation was tentatively accepted because of the positive identification of a typical PJ5 (upper J5-6b) association in Pandieburra No.1 at an horizon designated as being 5753ft (Report 13/105). This stratigraphically low position of PJ5 (uJ5-6) made PJ4 (lower J5-6) assignment for the Poolowanna Beds seem possible on the basis of the relative positions of the sampled horizons establised on the basis of log correlation. Recently it has been realised that it is most unlikely that the Pandieburra shale sample, designated as core 3/5753ft, could have come from the stated depth as no shale was logged at that depth. It most probably represents a piece of core 2 as a similar PJ5 (uJ5-6b) assemblage was recovered from core 2/5145ft.

Because of the fickle distribution of *Contignisporites* spp. low in the succession and difficulties in distinguishing the various morphological entities (see Price 1978), the use of *Contignisporites cooksoniae* has been abandoned. This has caused the major change to the biostratigraphical subdivision of the Jurassic. Other modifications have included the PJ3.1/PJ2.2 boundary which is defined upon The presence of *Tsugaepollenites* spp. with a well developed velum rather than *Tsugaepollenites* in general.

The boundary, PJ2.1/PJ2.2, is based upon *Nevesisporites vallatus* but it is acknowledged that similar forms have been seen as low as PT2 (late Early to Middle Triassic). At present it is thought that *N. vallatus* and the Triassic variants can be distinguished morphologically.

In defining the PJ4/PJ5 boundary, care must be taken to distinguish *Murospora florida* from *Matonisporites cooksoniae*. The base of what was "upper J5-6b" was initially based upon the occurrence of *Aequitriradites* sp. 629 and later upon its acme. Its regional biostratigraphical value has been reduced in that it is known to be present as low as basal PJ4.2 but it still is useful, however, as a local unit defining a specialized depositional environment.

The PK1/PJ6 boundary is based upon the appearance of the genus *Cicatricosisporites* where it may be represented by any one of three morphological variants.

7.7 Cretaceous

The Cretaceous palynostratigraphy has remained stable both in the definition of the major units and their application to the Eromanga Basin section. The majority of the modifications relate to the subdivision of the major units and to a greater emphasis being placed upon the oldest occurrence of individual taxa. For example, the position of the *P. pannosus/A. distocarinatus* boundary was originally defined upon the extinction of *C. paradoxa* while the PK6/PK7 boundary, is defined herein by the oldest occurrence of *Crybelosporites* sp. cf. *C. brenneri* (sp. 1255) - an event which is lower in the sequence. An attempt has been made to increase the biostratigraphical resolutions of the non-marine Winton Formation, but this proved to be elusive as the microflora appeared to be strongly facies influenced and displayed a high degree of reworking.

In addition to the spore/pollen subdivision, the marine late Early Cretaceous is amenable to subdivision palynostratigraphically on the basis of phytoplankton. The phytoplankton units and nomenclature presently applied to the Eromanga Basin section is given on Figs 2&5 and is that of Morgan (1980).

The biostratigraphical subdivision of the Australian Mesozoic based upon marine phytoplankton is the subject of a detailed review by Helby *et al.* (in press) and thus any modifications to Morgan's units as they apply to the Eromanga Basin will not be given until that review is published.

8 LITHOSTRATIGRAPHIC RELATIONSHIPS

The relationships of the lithostratigraphical to biostratigraphical units as shown on figures 2, 3 and 4 are intended to give only the general timing of sedimentation with no attempt to imply geographical distribution nor loss of section due to erosion. That is to say the lithostratigraphy represents the maximum known extent for each region.

The relationships as set out on figures 5 to 11 show in a stylized way the palynologically datable erosional and/or non-depositional events that occurred at about the time of deposition and immediately after but exclude more recent erosional events.

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TABLE 1

CSR OIL AND GAS DIVISION - CRETACEOUS NOMENCLATURE

ADOPTED AGE		SPORE/POLLEN ZONES	INTERVAL ZONES CURRENT NOMENCLATURE				INDEX FORMS
CRETACEOUS	LATE						
							Phyllocladidites mawsonii
		A. distocarinatus	PK7				
							Crybelosporites sp. cf. *C. brenneri* (sp. 1255)
	EARLY	*P. pannosus*	PK6				
							Phimopollenites pannosus
		P. paradoxa	PK5	PK5.2			
							Pilosisporites grandis
				PK5.1			
							Coptospora paradoxa
		C. striatus	PK4				
							Crybelosporites striatus
		C. hughesii	PK3	PK3.2			
							Pilosisporites parvispinosus
				PK3.1			
							Foraminisporis asymmetricus
		F. wonthaggiensis	PK2	PK2.2			
							Trilobosporites purverulentus
				PK2.1			
							Foraminisporis wonthaggiensis
		C. australiensis	PK1	PK1.2			
							Cyclosporites hughesii
				PK1.1			
							Cicatricosisporites spp.
JUR.	LATE	UJ5-6c	PJ6				
							Retitriletes watherooensis

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CSR OIL AND GAS DIVISION - JURASSIC NOMENCLATURE

ADOPTED AGES		PRE-1985 USAGE	CURRENT NOMENCLATURE (INTERVAL ZONES)			INDEX FORMS
C.	EARLY	*C. australiensis*	PK1			*Cicatricosisporites* spp.
JURASSIC	LATE	UJ5-6c	PJ6	PJ6.2	PJ6.2.2	*Foraminisporis dailyi*
					PJ6.2.1	*Ceratosporites equalis*
				PJ6.1		*Retitriletes watherooensis*
	LATE / MIDDLE	UJ5-6a-b	PJ5			*Murospora florida*
	MIDDLE	LJ5-6 and J4b	PJ4	PJ4.2		*Perotrilites* sp. 627
				PJ4.1		*Retitriletes circolumenus*
		J4a and J2-3	PJ3	PJ3.3	PJ3.3.2	*Camarozonosporites ramosus*
					PJ3.3.1	*Klukisporites lacunus*
	EARLY			PJ3.2		*Staplinisporites manifestus*
				PJ3.1		*Tsugaepollenites dampieri*
		J1b	PJ2	PJ2.2	PJ2.2.2	*Foraminisporis caelatus*
					PJ2.2.1	*Nevesisporites vallatus*
		J1a		PJ2.1		*Podosporites tripakshii*
			PJ1			*Classopollis classoides*
TR.	LATE	BASAL BUNDAMBA ASSEMBLAGE	PT5			*Polycingulatisporites*

TABLE 2

APRIL 1985

0063

CSR OIL AND GAS DIVISION - TRIASSIC NOMENCLATURE

ADOPTED AGES		PRE-1985 USAGE	CURRENT NOMENCLATURE (INTERVAL ZONES)				INDEX FORMS
JURASSIC	EARLY	J1	PJ1				*Classopollis classoides*
		BASAL BUNDAMBA ASSEMBLAGE	PT5	PT5.2	PT5.2.2		*Retitriletes austroclavatidites*
					PT5.2.1		*Retitriletes rosewoodensis*
TRIASSIC	LATE			PT5.1			*Polycingulatisporites crenulatus/P. mooniensis*
		H I A T U S					
		IPSWICH ASSEMBLAGE	PT4	PT4.2			*Annulispora densata*
				PT4.1			*Annulispora folliculosa*
		H I A T U S					
	MIDDLE	Tr3c-d	PT3				*Lycopodiacidites kuepperi* (sp. 84)
		Tr3a-b		PT2.2			
	EARLY	Tr2b	PT2				*Rugulatisporites trisinus* (sp. 708)
		Tr2a		PT2.1			*Aratrisporites* spp.
		Trlb	PT1				*Lunatisporites pellucidus*
PERMIAN	LATE	Trla	PP6				*Triplexisporites playfordii*

TABLE 3

0064

MAY 1985

CSR OIL AND GAS DIVISION - PERMIAN NOMENCLATURE

ADOPTED AGES		PRE-1985 USAGE		CURRENT NOMENCLATURE (INTERVAL ZONES)				INDEX FORMS
TRI.	EARLY	Trlb		PT1				*Lunatisporites pellucidus*
PERMIAN	LATE	Unit Trla		PP6				*Triplexisporites playfordii*
		upper stage 5	U5b-c	PP5	PP5.2			*Dulhuntyispora stellata*
			U5a		PP5.1			*Dulhuntyispora parvitholus*
		lower stage 5	L5c	PP4	PP4.3			*Dulhuntyispora dulhuntyi*
	EARLY		L5b		PP4.2			*Didecitriletes ericianus* (sp.7)
			L5a		PP4.1			*Dulhuntyispora granulata*
		stage 4	U4b	PP3	PP3.3	PP3.3.2		*Lopadiospora vermithola*
						PP3.3.1		*Acanthotriletes villosus*
			U4a		PP3.2			*Praecolpatites sinuosus* (sp.21)
			L4		PP3.1			*Phaselisporites cicatricosus*
		stage 3	3b	PP2	PP2.2			*Granulatisporites trisinus*
			3a		PP2.1			*Pseudoreticulatispora pseudoreticulata*
		stage 2		PP1				*Protohaploxypinus* spp.
CARB.	LATE	stage 1		PC4				*Potonieisporites* spp.

TABLE 4

0065

FEBRUARY 1985

TABLE 5

CSR OIL AND GAS DIVISION - CARBONIFEROUS NOMENCLATURE

ADOPTED AGES		ASSEMBLAGE ZONES	CURRENT NOMENCLATURE (INTERVAL ZONES)				INDEX FORMS
PERM.	EARLY	stage 2	PP1				
							Protohaploxypinus spp.
CARBONIFEROUS	LATE	stage 1 or *Anabaculites yberti* Assemblage	PC4				
							Potonieisporites spp.
	EARLY	*Grandispora maculosa* Assemblage	PC3				
							Grandispora maculosa
		Anapiculatisporites largus Assemblage	PC2				
							Crassispora invicta
		Grandispora spiculifera Assemblage	PC1				
							Dibolisporites distinctus
DEV.	LATE	*Retispora lepidophyta* Assemblage	PD8				*Retispora lepidophyta*

0066

CSR OIL AND GAS DIVISION - DEVONIAN NOMENCLATURE

ADOPTED AGES		PRE - 1985 USAGE		CURRENT NOMENCLATURE (INTERVAL ZONES)				INDEX FORMS
CARB.	EARLY	*Grandispora spiculifera* Assemblage		PC1				*Dibolisporites distinctus*
DEVONIAN	LATE	*Retispora lepidophyta* Assemblage		PD8				*Retispora lepidophyta*
		"Brewer Conglomerate Association"		PD7				*Verrucosisporites nitidus*
		Unit 5	5b	PD6	6.2			*Spinozonotriletes* sp. 552
	MIDDLE		5a		6.1			*Geminospora lemurata* form 589
		Unit 4		PD5				*Ancyrospora* sp. 565 (*Ancyrospora* sp. *A. de Jersey* 1966)
		Unit 3	3b	PD4	4.2			*Ancyrospora* sp. 566
			3a		4.1			"*Aratrisporites*" sp. 572
		Unit 2		PD3				*Hystricosporites* sp. 497 (*?H. richardsonii*)
	EARLY	Unit 1		PD2				"*Brochozonotriletes*" sp. 528
				PD1				

TABLE 6

0067

TIME RELATIONSHIP OF PALYNOSTRATIGRAPHIC UNITS

0068

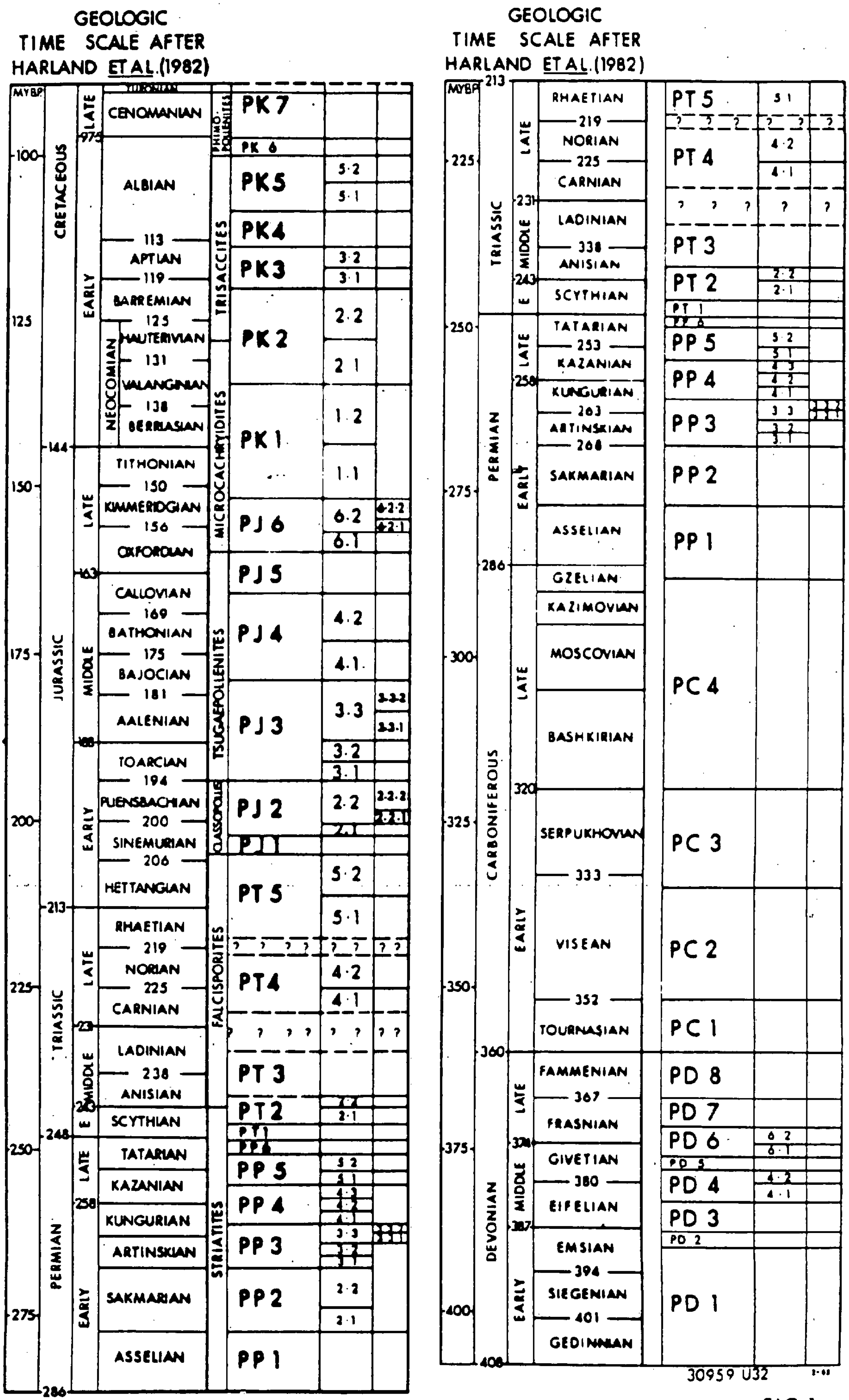


FIG. 1

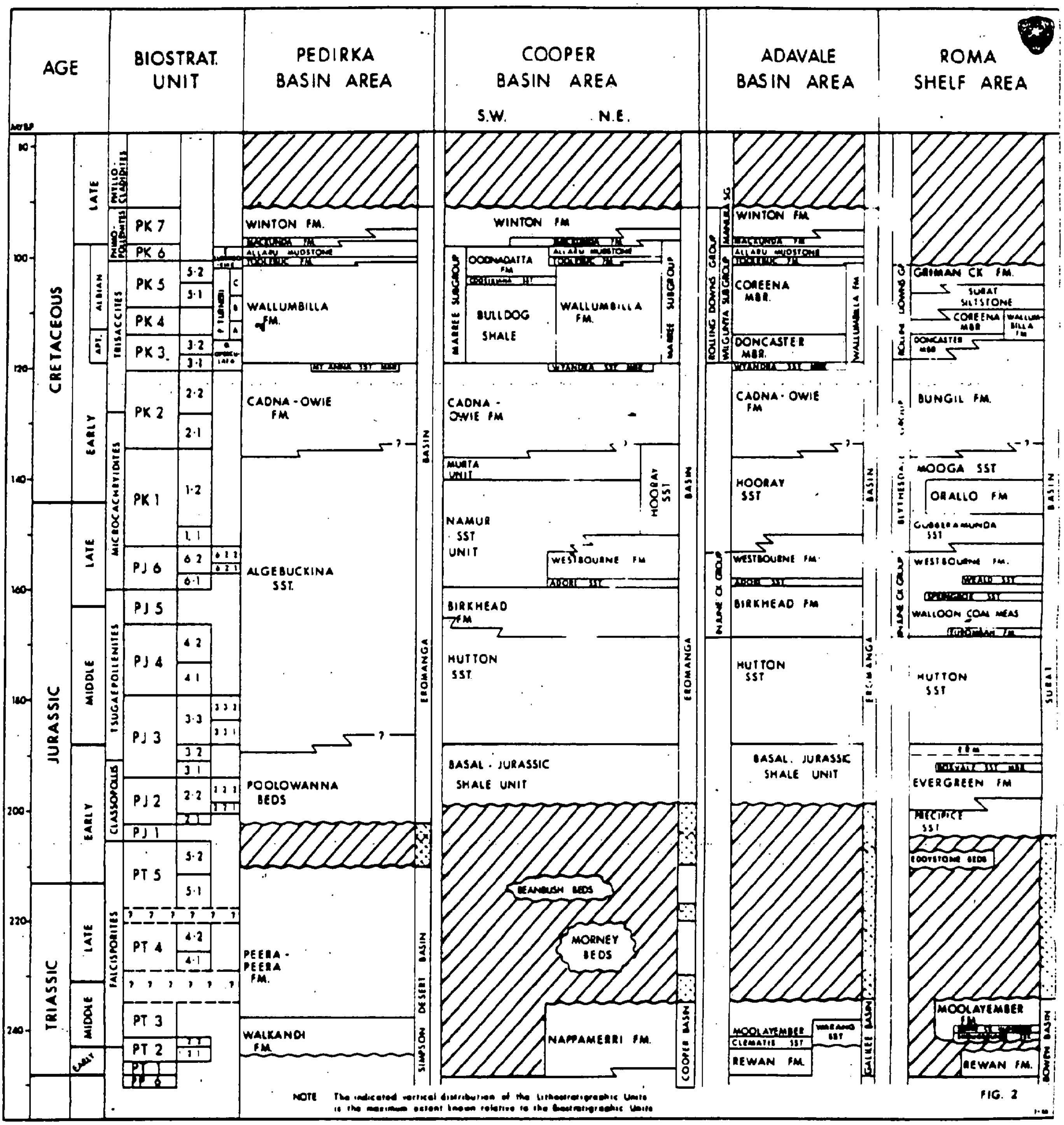


FIG. 2

30960 U32

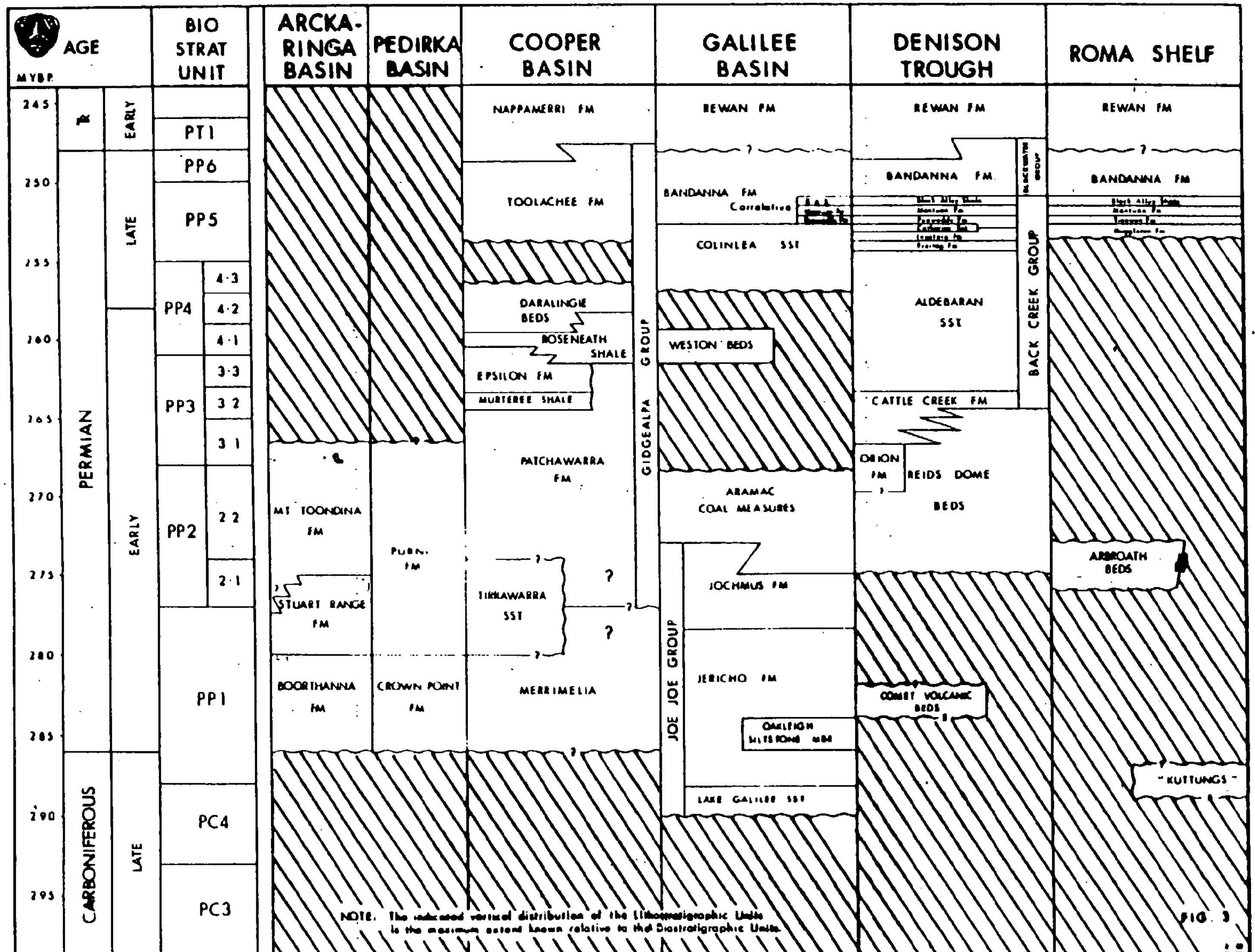


FIG. 3

30961 U32

0070

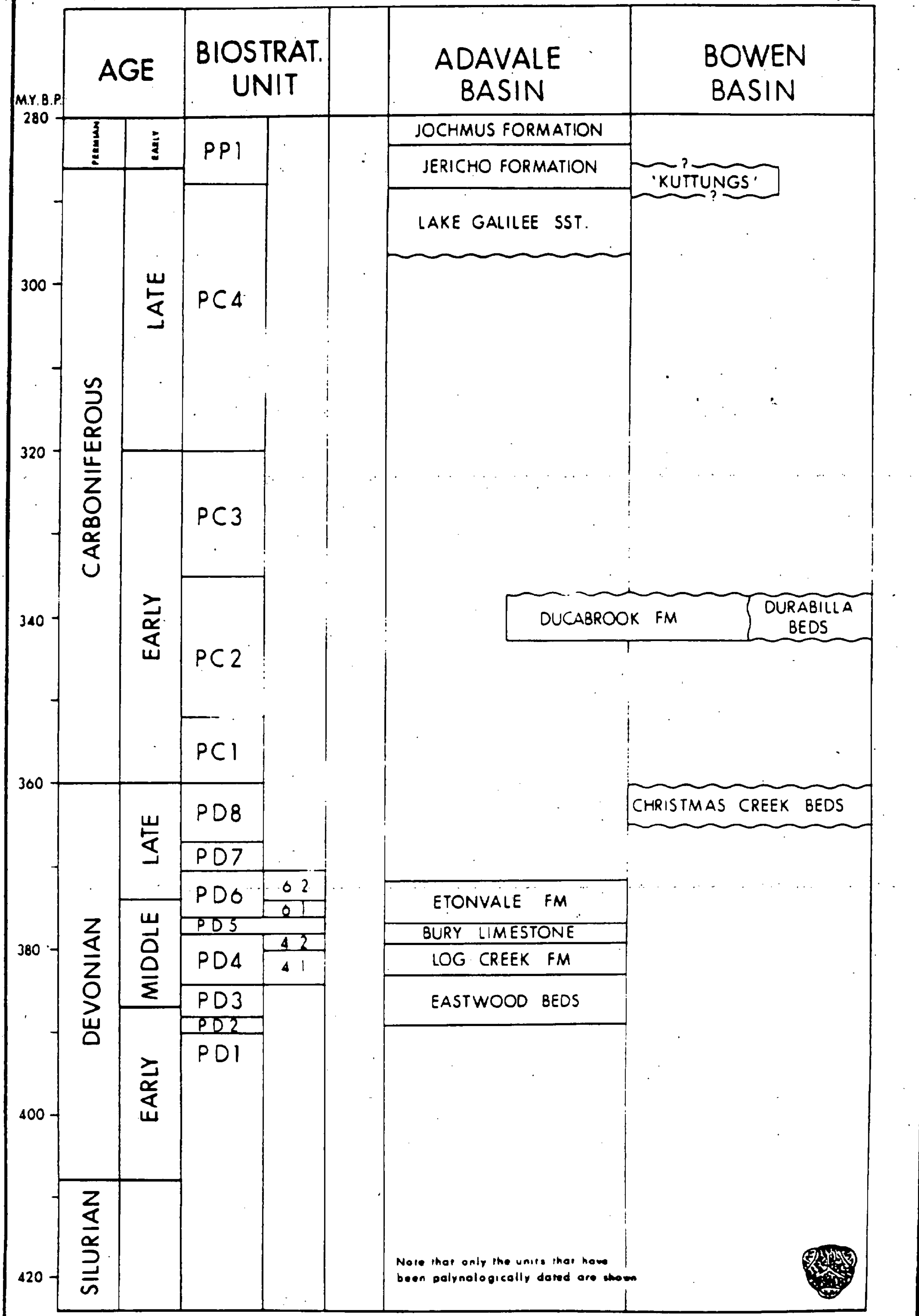

AGE
BIOSTRAT. UNIT
ADAVALE BASIN
BOWEN BASIN
M.Y. B.P.
280
300
320
340
360
380
400
420
PERMIAN
EARLY
CARBONIFEROUS
LATE
EARLY
DEVONIAN
LATE
MIDDLE
EARLY
SILURIAN
PP1
PC4
PC3
PC2
PC1
PD8
PD7
PD6
6 2
6 1
PD5
PD4
4 2
4 1
PD3
PD2
PD1
JOCHMUS FORMATION
JERICHO FORMATION
LAKE GALILEE SST.
'KUTTUNGS'
?
?
DUCABROOK FM
DURABILLA BEDS
CHRISTMAS CREEK BEDS
ETONVALE FM
BURY LIMESTONE
LOG CREEK FM
EASTWOOD BEDS
Note that only the units that have been palynologically dated are shown

FIG. 4

2-85

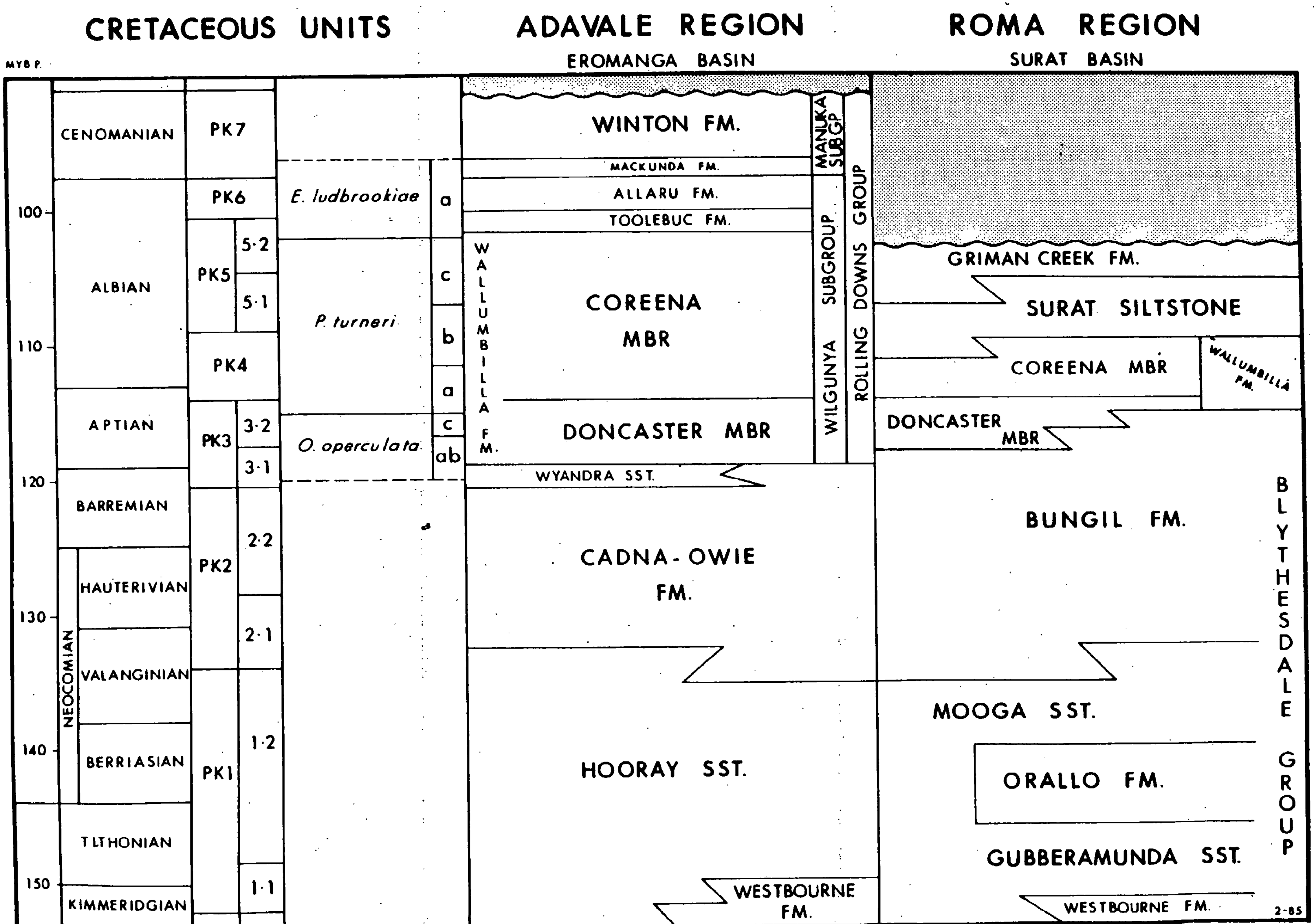
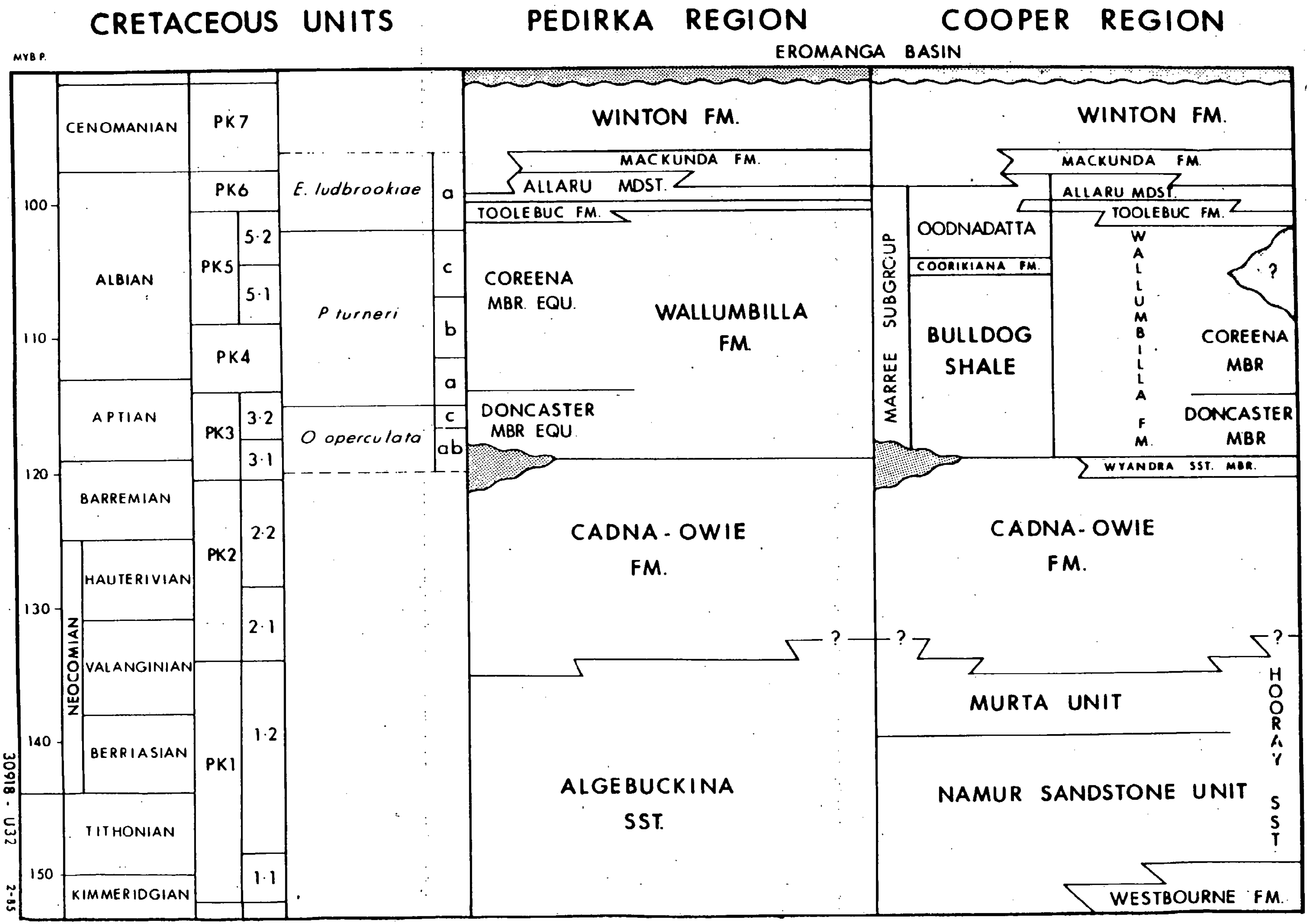

CRETACEOUS UNITS
ADAVALE REGION
EROMANGA BASIN
ROMA REGION
SURAT BASIN
MYB P.
100
110
120
130
140
150
CENOMANIAN
ALBIAN
APTIAN
BARREMIAN
NEOCOMIAN
HAUTERIVIAN
VALANGINIAN
BERRIASIAN
TITHONIAN
KIMMERIDGIAN
PK7
PK6
PK5
5·2
5·1
PK4
PK3
3·2
3·1
PK2
2·2
2·1
PK1
1·2
1·1
E. ludbrookiae
P. turneri
O. operculata
a
c
b
a
c
ab
WINTON FM.
MACKUNDA FM.
ALLARU FM.
TOOLEBUC FM.
WALLUMBILLA FM.
COREENA MBR
DONCASTER MBR
WYANDRA SST.
CADNA-OWIE FM.
HOORAY SST.
WESTBOURNE FM.
MANUKA SUBGP
WILGUNYA SUBGROUP
ROLLING DOWNS GROUP
GRIMAN CREEK FM.
SURAT SILTSTONE
COREENA MBR
WALLUMBILLA FM.
DONCASTER MBR
BUNGIL FM.
MOOGA SST.
ORALLO FM.
GUBBERAMUNDA SST.
WESTBOURNE FM.
BLYTHESDALE GROUP
2-85

FIG. 5

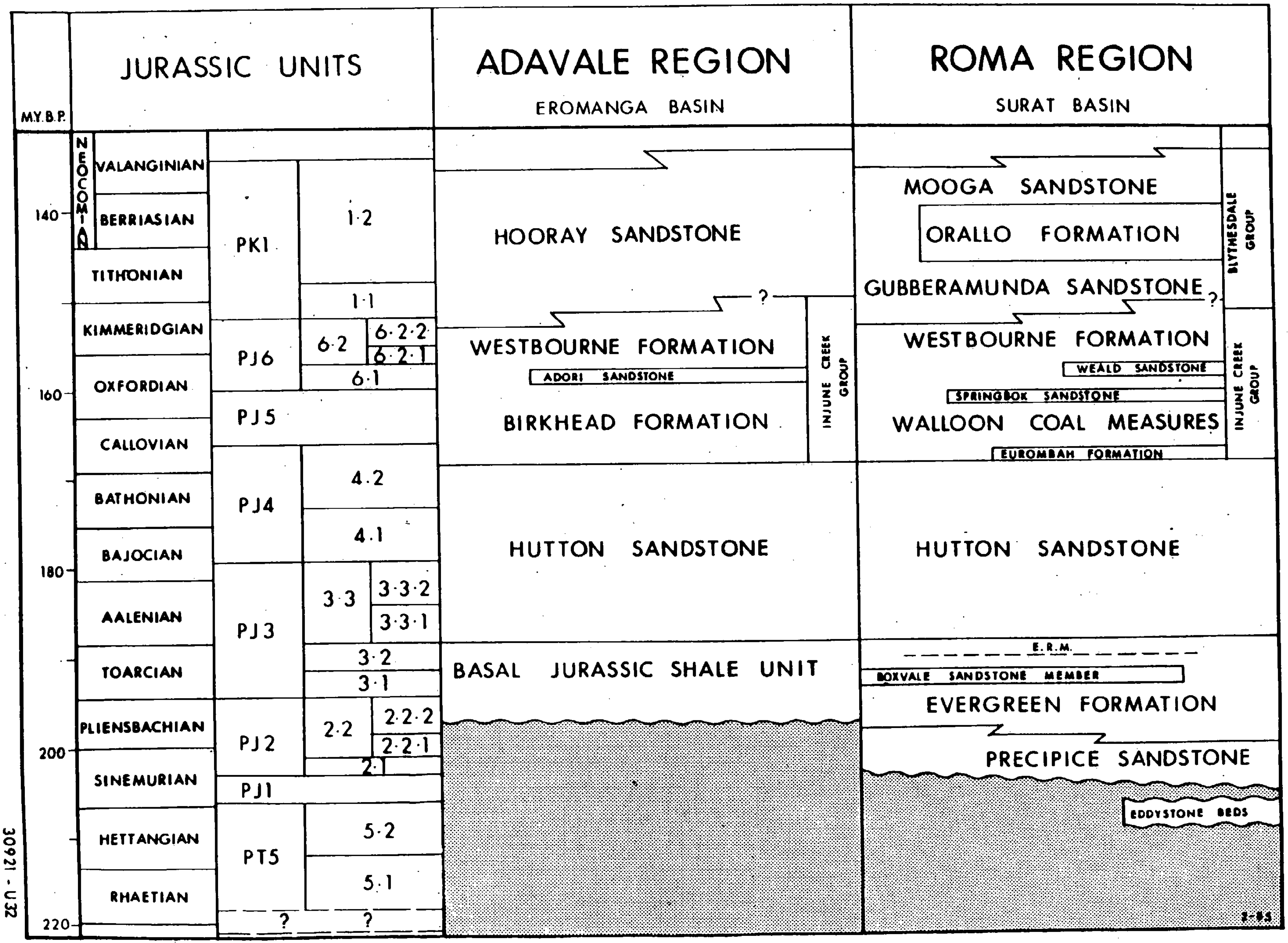
0072



30918-U32 2-85

FIG. 6

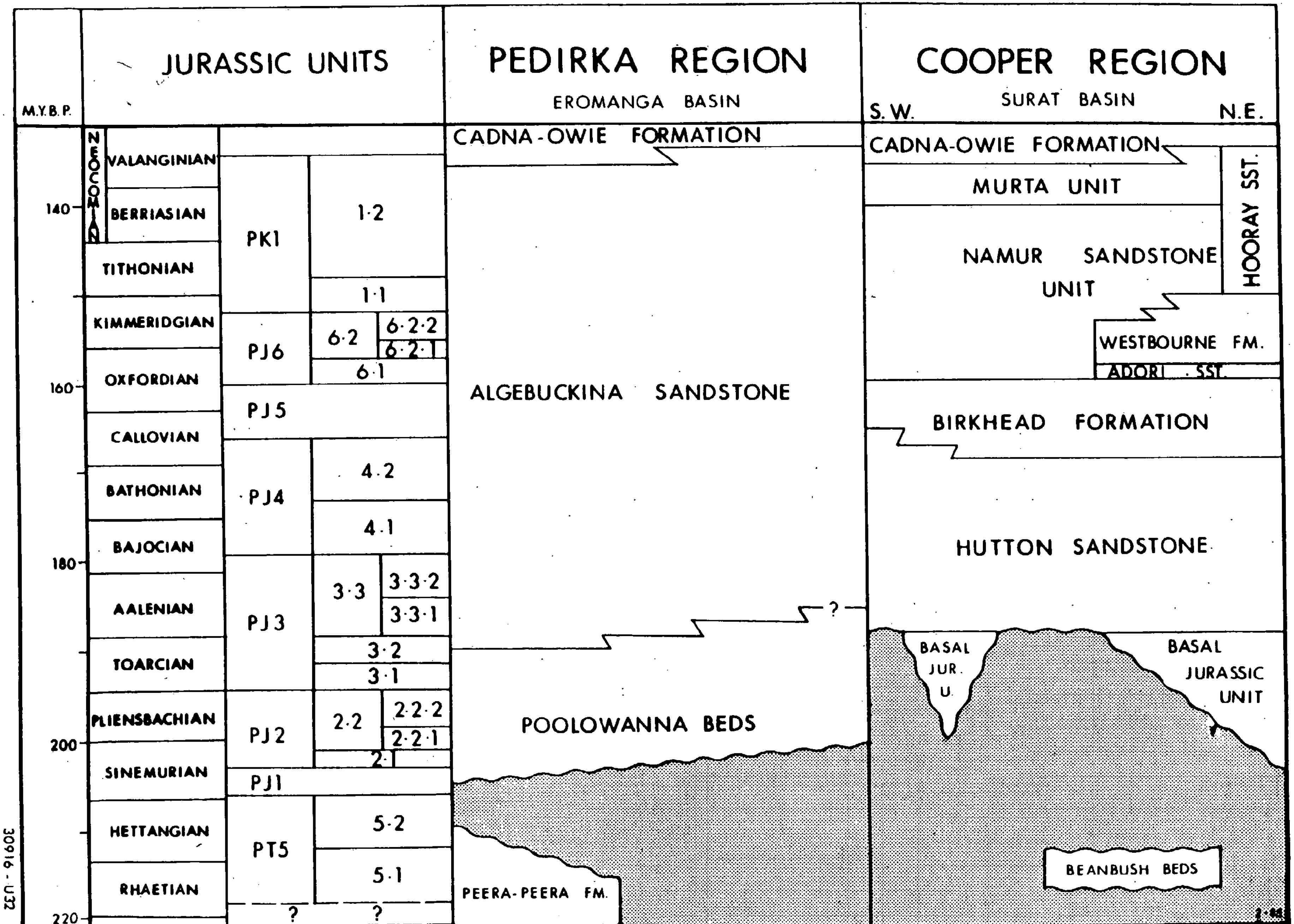
0073



30921 - U32

FIG. 7

0071



30916 - U32

FIG. 8

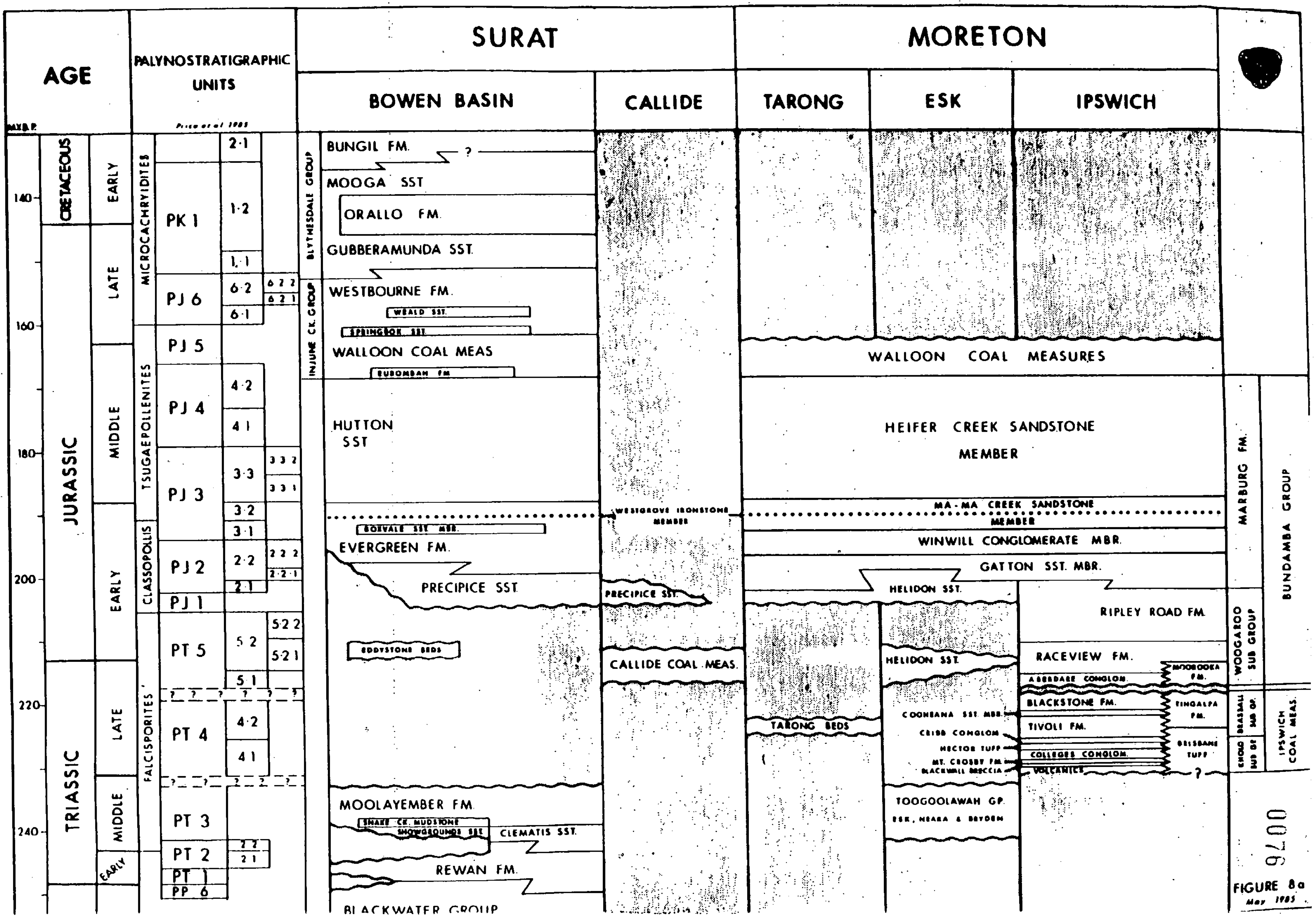
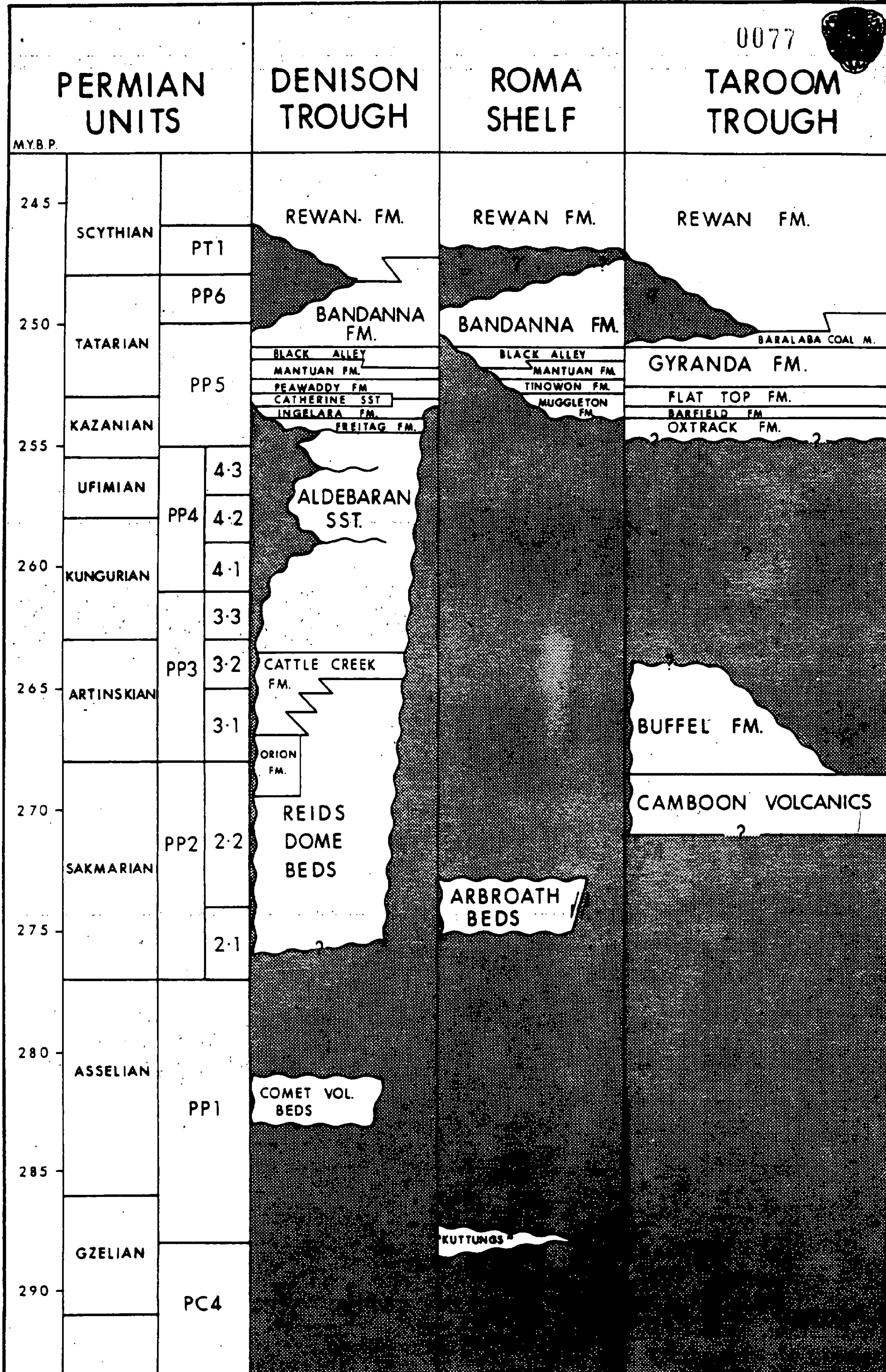


FIGURE 8a
May 1985

0076


PERMIAN UNITS
M.Y.B.P.
DENISON TROUGH
ROMA SHELF
TAROOM TROUGH
245
250
255
260
265
270
275
280
285
290
SCYTHIAN
TATARIAN
KAZANIAN
UFIMIAN
KUNGURIAN
ARTINSKIAN
SAKMARIAN
ASSELIAN
GZELIAN
PT1
PP6
PP5
PP4
PP3
PP2
PP1
PC4
4·3
4·2
4·1
3·3
3·2
3·1
2·2
2·1
REWAN FM.
BANDANNA FM.
BLACK ALLEY
MANTUAN FM.
PEAWADDY FM
CATHERINE SST
INGELARA FM.
FREITAG FM.
ALDEBARAN SST.
CATTLE CREEK FM.
ORION FM.
REIDS DOME BEDS
COMET VOL. BEDS
REWAN FM.
BANDANNA FM.
BLACK ALLEY
MANTUAN FM.
TINOWON FM.
MUGGLETON FM.
ARBROATH BEDS
"KUTTUNGS"
REWAN FM.
BARALABA COAL M.
GYRANDA FM.
FLAT TOP FM.
BARFIELD FM.
OXTRACK FM.
BUFFEL FM.
CAMBOON VOLCANICS
50923-U32

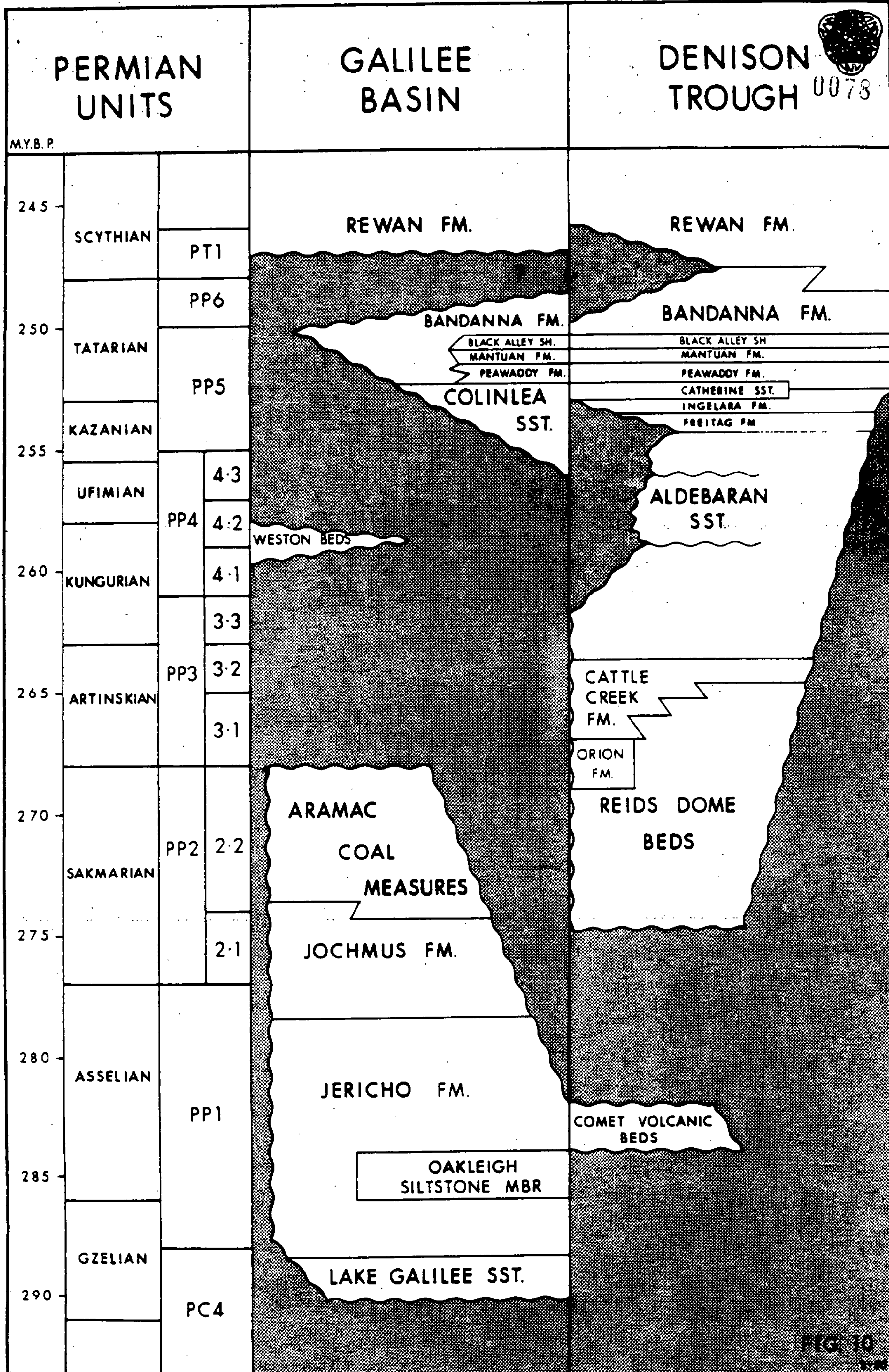
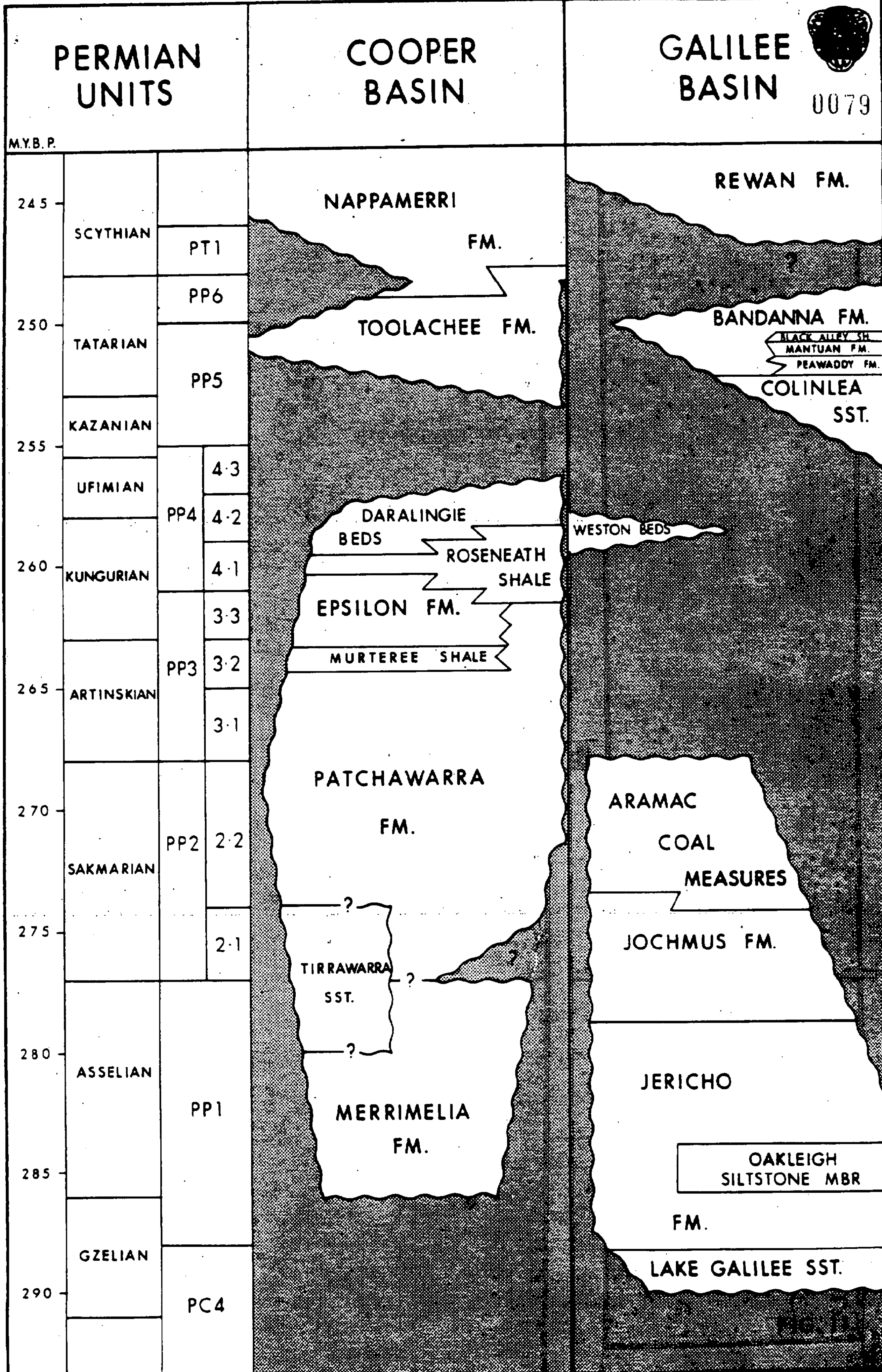

PERMIAN UNITS
M.Y.B.P.
GALILEE BASIN
DENISON TROUGH
0078
245
250
255
260
265
270
275
280
285
290
SCYTHIAN
TATARIAN
KAZANIAN
UFIMIAN
KUNGURIAN
ARTINSKIAN
SAKMARIAN
ASSELIAN
GZELIAN
PT1
PP6
PP5
PP4
PP3
PP2
PP1
PC4
4·3
4·2
4·1
3·3
3·2
3·1
2·2
2·1
REWAN FM.
BANDANNA FM.
BLACK ALLEY SH.
MANTUAN FM.
PEAWADDY FM.
COLINLEA SST.
WESTON BEDS
ARAMAC COAL MEASURES
JOCHMUS FM.
JERICHO FM.
OAKLEIGH SILTSTONE MBR
LAKE GALILEE SST.
REWAN FM.
BANDANNA FM.
BLACK ALLEY SH
MANTUAN FM.
PEAWADDY FM.
CATHERINE SST.
INGELARA FM.
FREITAG FM
ALDEBARAN SST.
CATTLE CREEK FM.
ORION FM.
REIDS DOME BEDS
COMET VOLCANIC BEDS

FIG. 10


PERMIAN UNITS
COOPER BASIN
GALILEE BASIN
0079
M.Y.B.P.
245
250
255
260
265
270
275
280
285
290
SCYTHIAN
TATARIAN
KAZANIAN
UFIMIAN
KUNGURIAN
ARTINSKIAN
SAKMARIAN
ASSELIAN
GZELIAN
PT1
PP6
PP5
PP4
4·3
4·2
4·1
PP3
3·3
3·2
3·1
PP2
2·2
2·1
PP1
PC4
NAPPAMERRI FM.
TOOLACHEE FM.
DARALINGIE BEDS
ROSENEATH SHALE
EPSILON FM.
MURTEREE SHALE
PATCHAWARRA FM.
TIRRAWARRA SST.
MERRIMELIA FM.
REWAN FM.
BANDANNA FM.
BLACK ALLEY SH.
MANTUAN FM.
PEAWADDY FM.
COLINLEA SST.
WESTON BEDS
ARAMAC COAL MEASURES
JOCHMUS FM.
JERICHO FM.
OAKLEIGH SILTSTONE MBR
LAKE GALILEE SST.

30922 - U32

Supplement to:

GEOLOGICAL SOCIETY OF AUSTALIA

ABSTRACTS
NUMBER 17

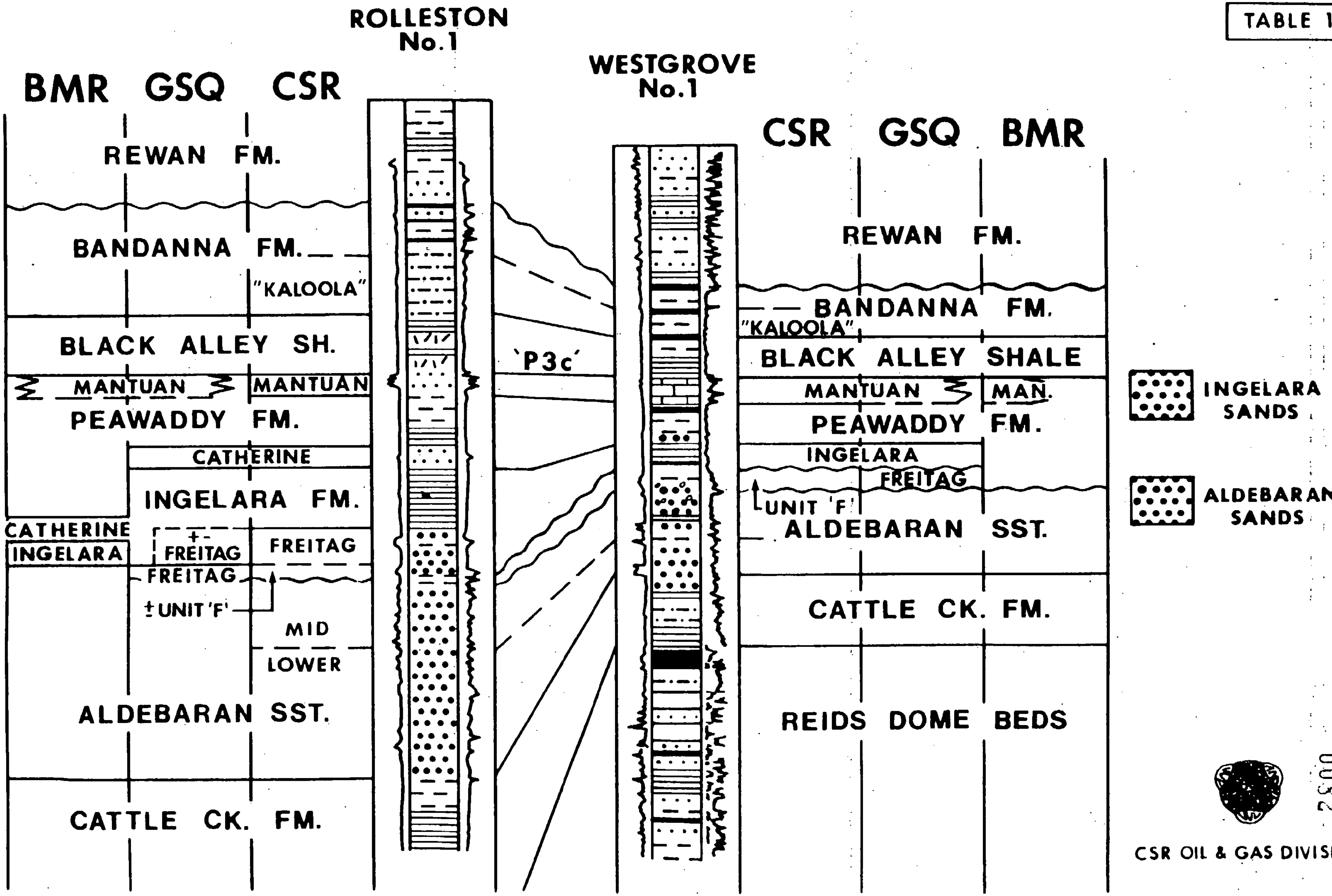
BOWEN BASIN COAL SYMPOSIUM

An Historical Review of the Bowen Basin Stratigraphy

P.L. PRICE
CSR OIL & GAS DIVISION

Since the delineation by Daintree in 1872 of the Permian and Triassic sediments which are now included in the Bowen Basin, it has been the subject of study by Geoscientists from a range of organisations, including Geological Survey of Queensland, University of Queensland, Bureau of Mineral Resources, Oil Exploration Companies and Coal Exploration Companies. As part of their studies, they have subdivided the sections and correlated these stratigraphical units across the Basin. A comprehensive compilation of the Bowen Basin's stratigraphy was presented in 1972 by Dickens and Malone (B.M.R. Bulletin No. 130) but with the change of geological concepts and the acquisition of new subsurface data, it has been modified. A view of the modifications is summarised on the accompanying stratigraphical tables, together with the palynostratigraphical units currently being used by CSR.

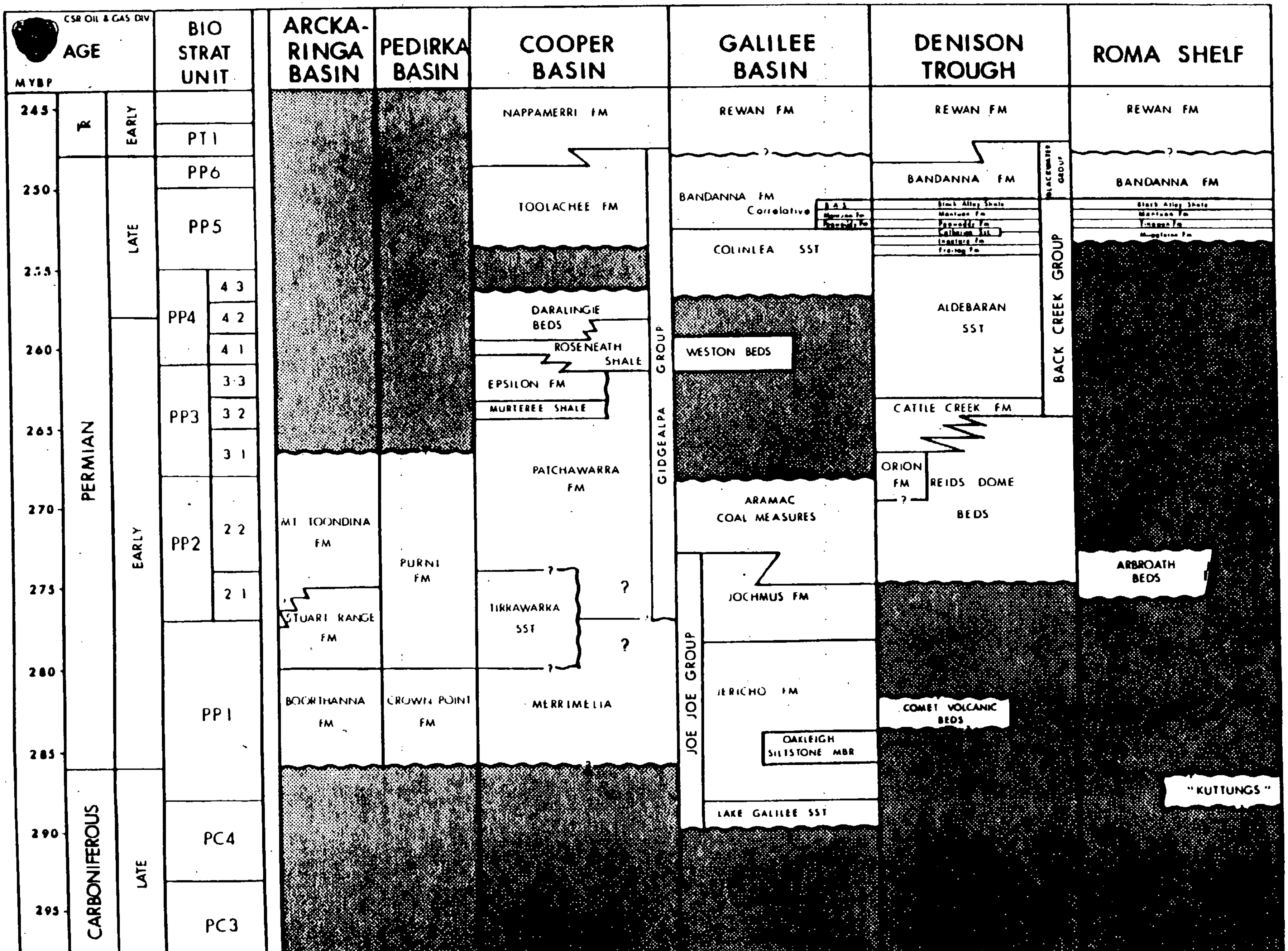
TABLE 1



CSR OIL & GAS DIVISION

00S2

TABLE 2


CSR OIL & GAS DIV
AGE
MYBP
BIO STRAT UNIT
ARCKA-RINGA BASIN
PEDIRKA BASIN
COOPER BASIN
GALILEE BASIN
DENISON TROUGH
ROMA SHELF
245
250
255
260
265
270
275
280
285
290
295
PERMIAN
CARBONIFEROUS
EARLY
LATE
EARLY
LATE
PT1
PP6
PP5
PP4
PP3
PP2
PP1
PC4
PC3
4 3
4 2
4 1
3·3
3 2
3 1
2 2
2 1
NAPPAMERRI FM
TOOLACHEE FM
DARALINGIE BEDS
ROSENEATH SHALE
EPSILON FM
MURTEREE SHALE
PATCHAWARRA FM
TIRRAWARRA SST
MERRIMELIA
GIDGEALPA GROUP
MT TOONDINA FM
STUART RANGE FM
BOORTHANNA FM
PURNI FM
CROWN POINT FM
REWAN FM
BANDANNA FM Correlative
COLINLEA SST
WESTON BEDS
ARAMAC COAL MEASURES
JOCHMUS FM
JERICHO FM
OAKLEIGH SILTSTONE MBR
LAKE GALILEE SST
JOE JOE GROUP
REWAN FM
BANDANNA FM
Black Alley Shale
Mantuan Fm
ALDEBARAN SST
CATTLE CREEK FM
ORION FM
REIDS DOME BEDS
COMET VOLCANIC BEDS
BACK CREEK GROUP
BLACKWATER GROUP
REWAN FM
BANDANNA FM
Black Alley Shale
ARBROATH BEDS
"KUTTUNGS"

0083

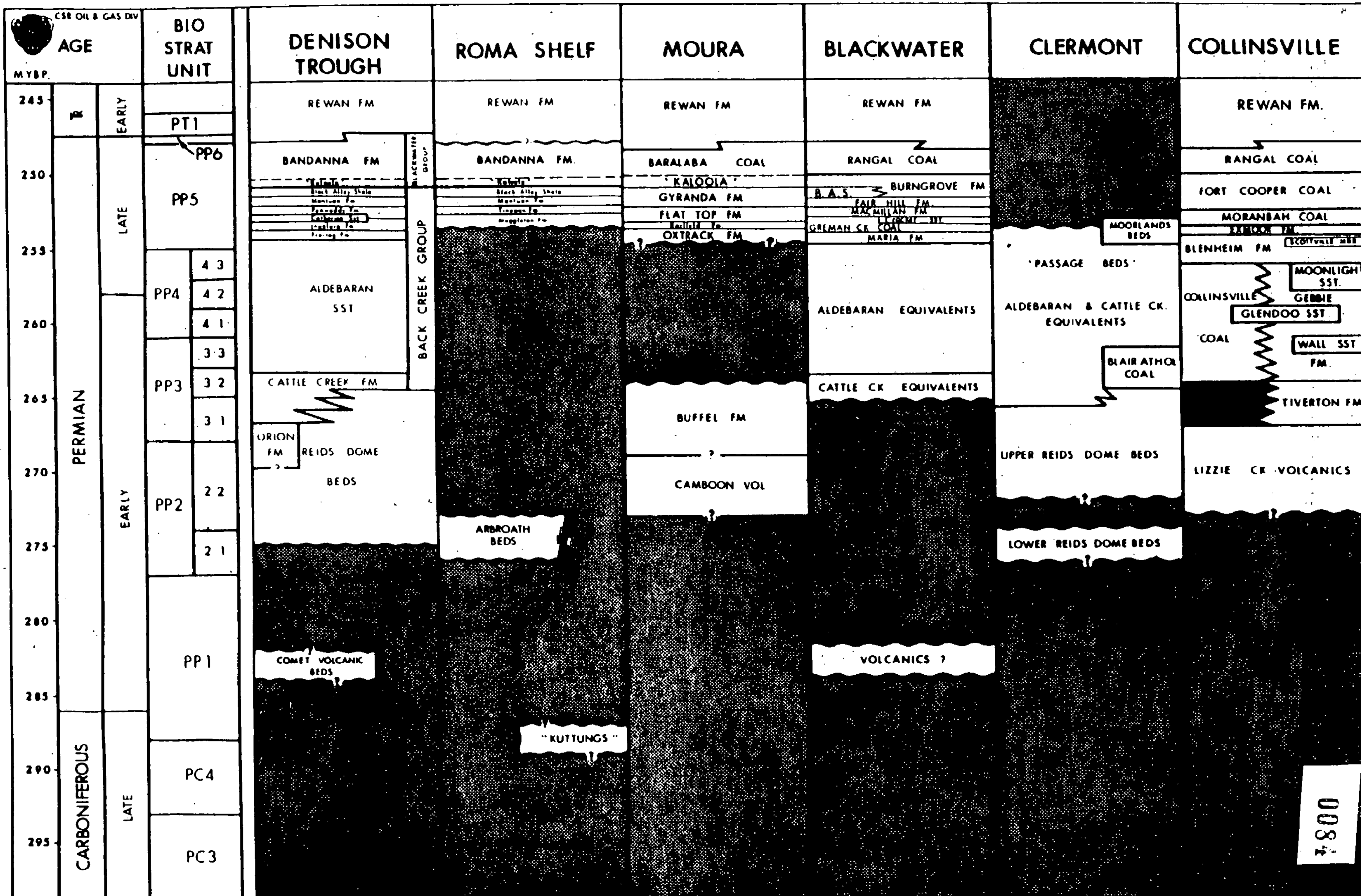

CSR OIL & GAS DIV
AGE
M.Y.B.P.
BIO STRAT UNIT
DENISON TROUGH
ROMA SHELF
MOURA
BLACKWATER
CLERMONT
COLLINSVILLE
245
250
255
260
265
270
275
280
285
290
295
PERMIAN
CARBONIFEROUS
EARLY
LATE
EARLY
LATE
PT1
PP6
PP5
PP4
4 3
4 2
4 1
PP3
3 3
3 2
3 1
PP2
2 2
2 1
PP1
PC4
PC3
REWAN FM
BANDANNA FM
BLACKWATER GROUP
BACK CREEK GROUP
ALDEBARAN SST
CATTLE CREEK FM
ORION FM
REIDS DOME BEDS
COMET VOLCANIC BEDS
REWAN FM
BANDANNA FM.
ARBROATH BEDS
"KUTTUNGS"
REWAN FM
BARALABA COAL
'KALOOLA'
GYRANDA FM
FLAT TOP FM
OXTRACK FM
BUFFEL FM
CAMBOON VOL
REWAN FM
RANGAL COAL
B.A.S.
BURNGROVE FM
FAIR HILL FM.
MACMILLAN FM
GREMAN CK COAL
MARIA FM
ALDEBARAN EQUIVALENTS
CATTLE CK EQUIVALENTS
VOLCANICS ?
MOORLANDS BEDS
'PASSAGE BEDS'
ALDEBARAN & CATTLE CK. EQUIVALENTS
BLAIR ATHOL COAL
UPPER REIDS DOME BEDS
LOWER REIDS DOME BEDS
REWAN FM.
RANGAL COAL
FORT COOPER COAL
MORANBAH COAL
BLENHEIM FM
MOONLIGHT SST.
COLLINSVILLE
GEBBIE
GLENDOO SST
COAL
WALL SST
FM.
TIVERTON FM
LIZZIE CK VOLCANICS

TABLE 4

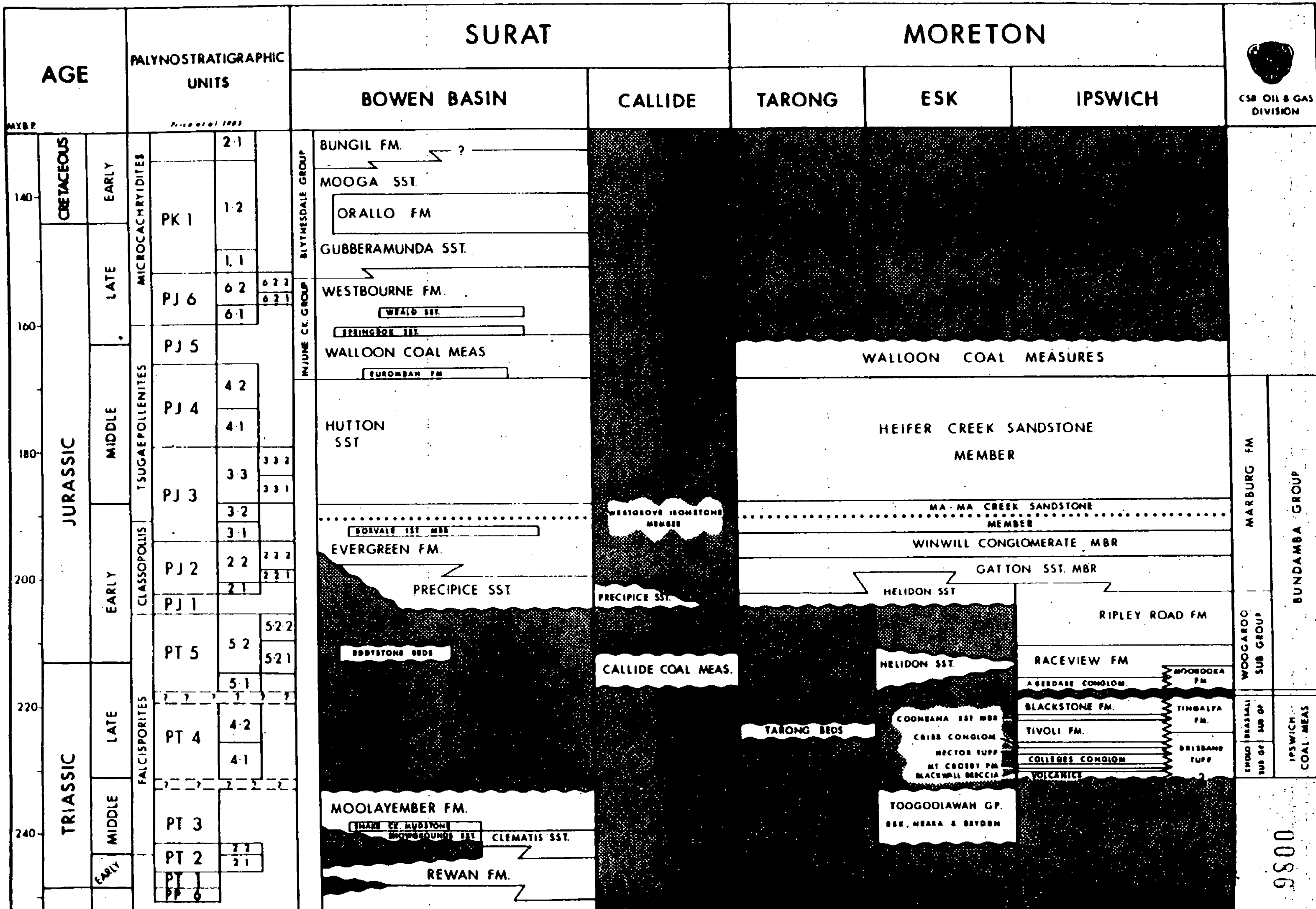
LATE PERMIAN STRATIGRAPHIC UNITS

ROMA SHELF	DENISON TROUGH	COMET BLACKWATER	COLLINSVILLE	CORRELATABLE EVENTS
BANDANNA FM	BANDANNA FM	RANGAL C.M.	RANGAL C.M.	◄ TOP COAL MEASURE DEPOSITION
"KALOOLA"	"KALOOLA"	BURNGROVE FM	FORT COOPER C.M.	◄ TOP ABUNDANT TUFF
BLACK ALLEY SHALE (WINNATHOOLA COAL MBR)	BLACK ALLEY SHALE	BLACK ALLEY SHALE		
MANTUAN FM	MANTUAN FM	FAIR HILL FM		◄ 'P3c' ARCITARCH
TINOWON FM (WALLABELLA COAL MBR)	PEAWADDY FM			◄ BASE ABUNDANT TUFF
		MACMILLAN FM	MORANBAH C.M.	◄ 'P' TUFF
MUGGLETON FM	CATHERINE SST	CROCKER SAND	GOONYELLA SM	
LORELLE SST	INGELARA FM	GERMAN CK FM	EXMOOR FM	
		MARIA FM	BLENHEIM FM (SCOTTVILLE)	
	FREITAG FM			

CSR OIL & GAS DIV.

0085

TABLE 5


AGE
MYBP
PALYNOSTRATIGRAPHIC UNITS
SURAT
MORETON
BOWEN BASIN
CALLIDE
TARONG
ESK
IPSWICH
CSR OIL & GAS DIVISION
140
160
180
200
220
240
CRETACEOUS
JURASSIC
TRIASSIC
EARLY
LATE
MIDDLE
MICROCACHRYIDITES
TSUGAEPOLLENITES
CLASSOPOLLIS
FALCISPORITES
PK 1
PJ 6
PJ 5
PJ 4
PJ 3
PJ 2
PJ 1
PT 5
PT 4
PT 3
PT 2
BLYTHESDALE GROUP
INJUNE CK. GROUP
BUNGIL FM.
MOOGA SST.
ORALLO FM
GUBBERAMUNDA SST.
WESTBOURNE FM.
WALLOON COAL MEAS
HUTTON SST
EVERGREEN FM.
PRECIPICE SST.
MOOLAYEMBER FM.
CLEMATIS SST.
REWAN FM.
PRECIPICE SST.
CALLIDE COAL MEAS.
TARONG BEDS
WALLOON COAL MEASURES
HEIFER CREEK SANDSTONE MEMBER
MA-MA CREEK SANDSTONE MEMBER
WINWILL CONGLOMERATE MBR
GATTON SST. MBR
HELIDON SST
RIPLEY ROAD FM
RACEVIEW FM
HELIDON SST.
BLACKSTONE FM.
TIVOLI FM.
TOOGOOLAWAH GP.
MARBURG FM
BUNDAMBA GROUP
WOOGAROO SUB GROUP
IPSWICH COAL MEAS
9800

CSR OIL AND GAS DIVISION - TRIASSIC NOMENCLATURE

ADOPTED AGES		PRE-1985 USAGE	CURRENT NOMENCLATURE (INTERVAL ZONES)				INDEX FORMS
JURASSIC	EARLY	J1	PJ1				*Classopollis classoides*
JURASSIC / TRIASSIC	EARLY / LATE	BASAL BUNDAMBA ASSEMBLAGE	PT5	PT5.2	PT5.2.2		*Retitriletes austroclavatidites*
			PT5	PT5.2	PT5.2.1		*Retitriletes rosewoodensis*
			PT5	PT5.1			*Polycingulatisporites crenulatus/P. mooniensis*
		H I A T U S					
TRIASSIC	LATE	IPSWICH ASSEMBLAGE	PT4	PT4.2			*Annulispora densata*
			PT4	PT4.1			*Annulispora folliculosa*
		H I A T U S					
	MIDDLE	Tr3c-d	PT3				*Lycopodiacidites kuepperi* (sp. 84)
	MIDDLE	Tr3a-b	PT2	PT2.2			
	EARLY	Tr2b	PT2	PT2.2			*Rugulatisporites trisinus* (sp. 708)
	EARLY	Tr2a	PT2	PT2.1			*Aratrisporites* spp.
	EARLY	Tr1b	PT1				*Lunatisporites pellucidus*
PERMIAN	LATE	Tr1a	PP6				*Triplexisporites playfordii*

TABLE 6

MAY 1985

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CSR OIL AND GAS DIVISION - PERMIAN NOMENCLATURE

ADOPTED AGES		PRE-1985 USAGE		CURRENT NOMENCLATURE (INTERVAL ZONES)			INDEX FORMS
TRI.	EARLY	Trlb		PT1			*Lunatisporites pellucidus*
PERMIAN	LATE	Unit Trla		PP6			*Triplexisporites playfordii*
		upper stage 5	U5b-c	PP5	PP5.2		*Dulhuntyispora stellata*
			U5a		PP5.1		*Dulhuntyispora parvitholus*
		lower stage 5	L5c	PP4	PP4.3		*Dulhuntyispora dulhuntyi*
	EARLY		L5b		PP4.2		*Didecitriletes ericianus* (sp.7)
			L5a		PP4.1		*Dulhuntyispora granulata*
		stage 4	U4b	PP3	PP3.3	PP3.3.2	*Lopadiospora vermithola*
						PP3.3.1	*Acanthotriletes villosus*
			U4a		PP3.2		*Praecolpatites sinuosus* (sp.21)
			L4		PP3.1		*Phaselisporites cicatricosus*
		stage 3	3b	PP2	PP2.2		*Granulatisporites trisinus*
			3a		PP2.1		*Pseudoreticulatispora pseudoreticulata*
		stage 2		PP1			*Protohaploxypinus* spp.
CARB.	LATE	stage 1		PC4			*Potonieisporites* spp.

TABLE 7

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FEBRUARY 1985

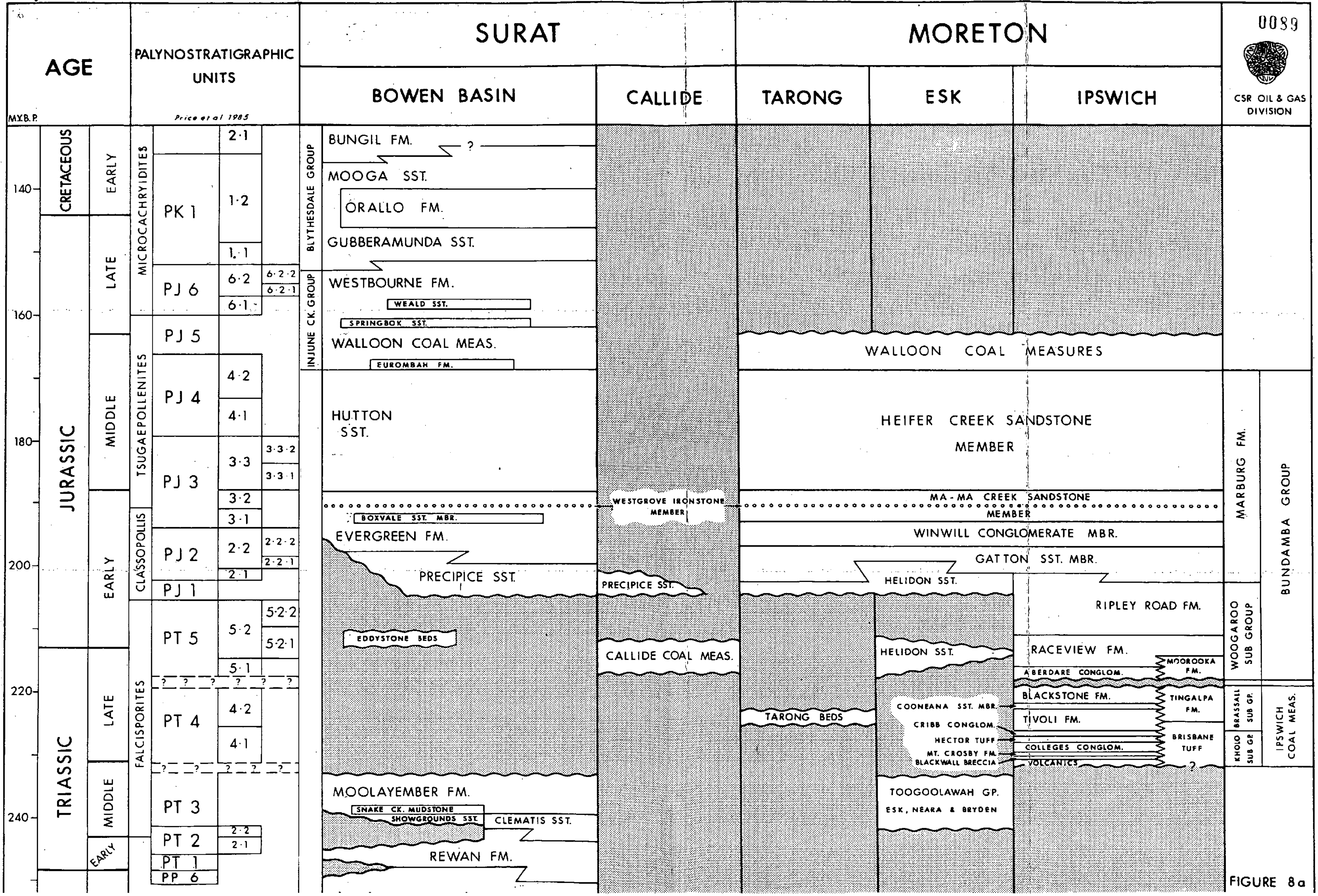
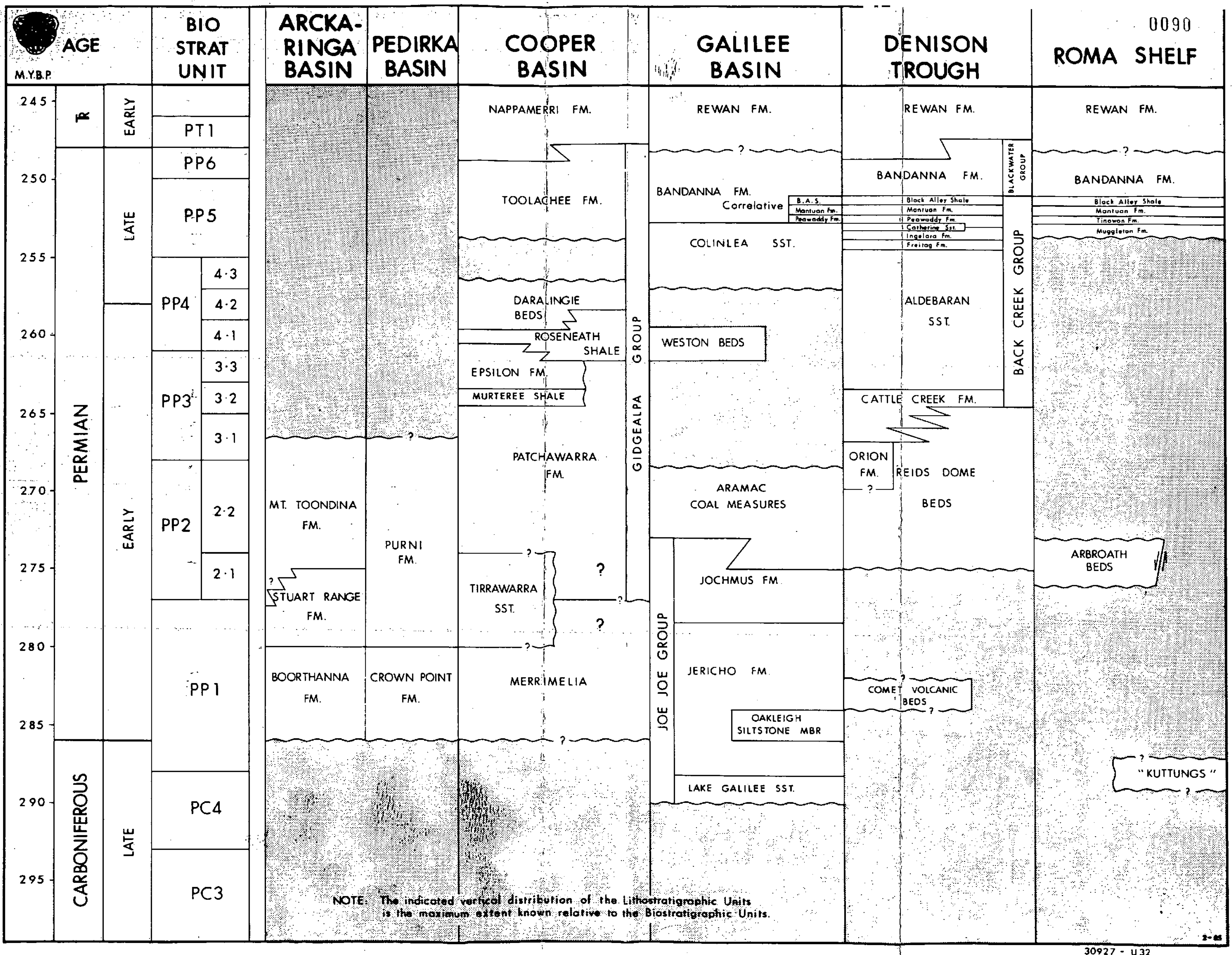

AGE
M.Y.B.P.
PALYNOSTRATIGRAPHIC UNITS
Price et al 1985
SURAT
MORETON
BOWEN BASIN
CALLIDE
TARONG
ESK
IPSWICH
CSR OIL & GAS DIVISION
140
160
180
200
220
240
CRETACEOUS
JURASSIC
TRIASSIC
EARLY
LATE
MIDDLE
EARLY
LATE
MIDDLE
EARLY
MICROCACHRYIDITES
TSUGAEPOLLENITES
CLASSOPOLLIS
FALCISPORITES
PK 1
PJ 6
PJ 5
PJ 4
PJ 3
PJ 2
PJ 1
PT 5
PT 4
PT 3
PT 2
PT 1
PP 6
2·1
1·2
1·1
6·2
6·1
4·2
4·1
3·3
3·2
3·1
2·2
2·1
5·2
5·1
4·2
4·1
2·2
2·1
6·2·2
6·2·1
3·3·2
3·3·1
2·2·2
2·2·1
5·2·2
5·2·1
BLYTHESDALE GROUP
INJUNE CK. GROUP
BUNGIL FM.
MOOGA SST.
ORALLO FM.
GUBBERAMUNDA SST.
WESTBOURNE FM.
WEALD SST.
SPRINGBOK SST.
WALLOON COAL MEAS.
EUROMBAH FM.
HUTTON SST.
BOXVALE SST. MBR.
EVERGREEN FM.
PRECIPICE SST.
EDDYSTONE BEDS
MOOLAYEMBER FM.
SNAKE CK. MUDSTONE
SHOWGROUNDS SST.
CLEMATIS SST.
REWAN FM.
WESTGROVE IRONSTONE MEMBER
PRECIPICE SST.
CALLIDE COAL MEAS.
WALLOON COAL MEASURES
HEIFER CREEK SANDSTONE MEMBER
MA-MA CREEK SANDSTONE MEMBER
WINWILL CONGLOMERATE MBR.
GATTON SST. MBR.
HELIDON SST.
RIPLEY ROAD FM.
HELIDON SST.
RACEVIEW FM.
MOOROOKA FM.
ABERDARE CONGLOM.
BLACKSTONE FM.
TINGALPA FM.
TIVOLI FM.
BRISBANE TUFF
COLLEGES CONGLOM.
VOLCANICS
TARONG BEDS
COONEANA SST. MBR.
CRIBB CONGLOM.
HECTOR TUFF
MT. CROSBY FM.
BLACKWALL BRECCIA
TOOGOOLAWAH GP.
ESK, NEARA & BRYDEN
MARBURG FM.
WOOGAROO SUB GROUP
BUNDAMBA GROUP
BRASSALL SUB GP.
KHOLO SUB GP.
IPSWICH COAL MEAS.

FIGURE 8a


0090
AGE
M.Y.B.P.
BIO STRAT UNIT
ARCKA-RINGA BASIN
PEDIRKA BASIN
COOPER BASIN
GALILEE BASIN
DENISON TROUGH
ROMA SHELF
245
250
255
260
265
270
275
280
285
290
295
EARLY
LATE
PERMIAN
CARBONIFEROUS
PT1
PP6
PP5
PP4
4·3
4·2
4·1
PP3
3·3
3·2
3·1
PP2
2·2
2·1
PP1
PC4
PC3
NAPPAMERRI FM.
TOOLACHEE FM.
DARALINGIE BEDS
ROSENEATH SHALE
EPSILON FM.
MURTEREE SHALE
PATCHAWARRA FM.
TIRRAWARRA SST.
MERRIMELIA
GIDGEALPA GROUP
MT. TOONDINA FM.
STUART RANGE FM.
BOORTHANNA FM.
PURNI FM.
CROWN POINT FM.
REWAN FM.
BANDANNA FM. Correlative
B.A.S.
Mantuan Fm.
Peawaddy Fm.
COLINLEA SST.
WESTON BEDS
ARAMAC COAL MEASURES
JOCHMUS FM.
JERICHO FM.
OAKLEIGH SILTSTONE MBR
LAKE GALILEE SST.
JOE JOE GROUP
BANDANNA FM.
BLACKWATER GROUP
Black Alley Shale
Mantuan Fm.
Peawaddy Fm.
Catherine Sst.
Ingelara Fm.
Freitag Fm.
ALDEBARAN SST.
BACK CREEK GROUP
CATTLE CREEK FM.
ORION FM.
REIDS DOME BEDS
COMET VOLCANIC BEDS
Black Alley Shale
Tinowon Fm.
Muggleton Fm.
ARBROATH BEDS
"KUTTUNGS"
NOTE: The indicated vertical distribution of the Lithostratigraphic Units is the maximum extent known relative to the Biostratigraphic Units.
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