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BONAPARTE GULF BASIN EXPLANATORY NOTES AND STRATIGRAPHIC CORRELATIONS

by

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ABSTRACT

The Bonaparte Gulf Basin is located in northwest Australia and underlies 18 000 km^2 onshore and more than 245 000 km^2 offshore. The basin comprises a total stratigraphic thickness of approximately 17 000 m of Phanerozoic sedimentary rocks. Palaeozoic sediments crop out onshore and have been intersected by petroleum exploration well in the southern offshore part of the basin. Mesozoic and Cainozoic sediments are thin in the southeast and thicken considerably in the northwest. Present-day geophysically defined structural elements are interpreted to represent a complex horst and graben system, which is in turn interpreted to indicate that the Bonaparte Gulf Basin is a composite of an older northwesterly trending, fault-bounded, Early Palaeozoic graben and a younger, superimposed, northeasterly trending, Late Palaeozoic - Cainozoic rift-drift system. Rifting in the Early Palaeozoic provided an intracratonic site for deposition of Cambrian to Lower Carboniferous continental clastics, evaporites and restricted marine sediments. The Late Carboniferous to Cainozoic rift-drift sequence consists of four major strata-tectonic units that can be correlated with continental rifting, breakup and post-breakup restricted marine and open-marine stages. Several gas, condensate and oil shows have been encountered in rocks ranging in age from Carboniferous to Eocene and have encouraged continuing hydrocarbon exploration. However, the potential of an apparently highly prospective basin has been limited by an unfortunate relative timing of periods of hydrocarbon migration, trap formation and erosion.

These explanatory notes accompany correlated stratigraphic columns which were prepared as a contribution for the United Nations ESCAP Atlas of Stratigraphy.

BONAPARTE GULF BASIN

Introduction

The Bonaparte Gulf Basin is a northwesterly trending basin of Phanerozoic sedimentary rocks mainly located beneath the continental shelf of northwestern Australia (Fig. 1). The basin underlies 18 000 km^2 onshore in Western Australia and the Northern Territory, and more than 245 000 km^2 offshore. The basin is fault-bounded to the southwest, southeast and east by Precambrian rocks of the Kimberley, Sturt, and Darwin Blocks respectively (structure and tectonic element diagrams on atlas sheet Au 5a). Farther offshore, Mesozoic-Cainozoic sediments of the basin are partly contiguous with the adjacent Browse Basin to the southwest and the Money Shoal Basin to the northeast. The northwestern boundary of the basin is here taken as the Timor Trough, a partially infilled Plio-Pleistocene downwarp with a bathymetric depth of 2-3,000 m.

The basin comprises a total stratigraphic thickness of approximately 17 000 m of sedimentary rocks. Palaeozoic sediments crop out onshore and have been intersected by petroleum exploration wells in the southeastern offshore part of the basin. Mesozoic and Cainozoic sediments are thin in the southeast, and thicken in the northwest. Deposition of sedimentary sequences within the basin can be correlated with phases of crustal upwarping, rifting and drifting associated with continental margin breakup.

Present-day geophysically defined structural elements are interpreted to represent a complex horst and graben system which reflects the intersection of a northeasterly trending Late Palaeozoic-Cainozoic fault pattern with an older northwesterly trending Palaeozoic fault pattern. This, in turn, is interpreted to indicate that the Bonaparte Gulf Basin is a composite of an older, northwesterly trending, fault-bounded, Early Palaeozoic graben and a younger, superimposed, northeasterly trending, Late Palaeozoic-Cainozoic, rift

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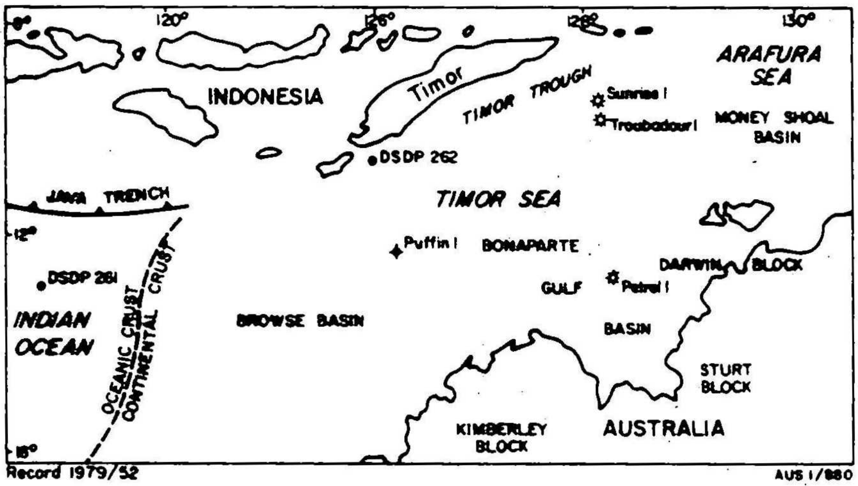
Figures Au 5a, b, c and these explanatory notes were prepared as a contribution for the United Nations ESCAP Atlas of Stratigraphy.



● DSDP - Deep Sea Drilling Project Site

✦ Oil Discovery Well

☼ Gas Discovery Well

Fig. I Locality Diagram.

system. The Petrel Sub-basin and Sahul Syncline are grabens which parallel the northwesterly trend, while the configuration of the Malita Graben, Vulcan Sub-basin Ashmore Block, Londonderry High and Sahul Platform are predominantly influenced by the intersecting northeasterly trend (tectonic element diagram on Au 5a). In the southeastern onshore area, reactivated basement trends are evident where the Precambrian Pincombe Inlier divides the onshore Petrel Sub-basin into the Carlton Sub-basin in the west and the Burt Range Syncline in the east. Northwest of the Timor Trough, folded, faulted and metamorphosed Palaeozoic and Mesozoic sediments, exposed on Timor, are thought to have formerly been part of the northern continental margin of Australia. By contrast sediments in the Bonaparte Gulf Basin, southeast of the Timor Trough have only been deformed by tensional block-faulting and salt piercement diapiric intrusion. Anticlinal structures throughout the basin can be related to sedimentary drape over concealed fault scarps and diapirs (structure diagram on Au 5b).

No economic accumulations of hydrocarbons have as yet been located; however, a number of gas, condensate and oil shows have been encountered in rocks ranging in age from Carboniferous to Eocene and have encouraged continuing exploration.

Data compilation

Onshore, the geology of the basin has been mapped in detail by geologists of the Bureau of Mineral Resources (Veevers and Roberts, 1968; Veevers, 1969; Kaulback and Veevers, 1969; Dickins, Roberts and Veevers, 1972; Roberts and Veevers, 1973; Hughes, 1978) and summarized by the Geological Survey of Western Australia (Playford et al., 1975). Offshore, Arco Australia Limited, Australian Aquitaine Petroleum Pty Ltd (Laws and Kraus, 1974; Laws and Brown, 1976) and the Woodside-Burmah group (Warris, 1973; Powell, 1976) have undertaken extensive marine geophysical surveys and have drilled several wells. The geology and the hydrocarbon exploration activity have been summarized by the Sedimentary Basins Study Section of the Bureau of Mineral Resources (BMR, 1974) and a bibliography of published and unpublished reports compiled by Nicholas (1972).

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The correlated stratigraphic columns shown on the atlas sheets Au5a, b & c are largely based on company interpretations from well completion reports by Arco Australia Ltd, Australian Aquitaine Petroleum, B.O.C. of Australia Ltd, and Alliance Oil Development Australia (listed in Table 1), and on well and geological sections available in the abovementioned publications. The confidential reports are indicated in Table 1; we are indebted to Arco Australia Ltd for permission to use previously confidential information shown on the atlas sheets. Formal definitions of most stratigraphic names have been published by Hughes (1978). Informal stratigraphic names in common usage have been retained and the informal status indicated on the sections. A composite column of onshore stratigraphy is shown on Figure 2, and the stratigraphy of the Bonaparte Gulf Basin is shown on Figure 3.

Regional tectonic evolution

The evolution of the northwest shelf of Australia can be related to two major episodes of rifting and continental margin breakup, firstly in the Early Palaeozoic and secondly in the Late Palaeozoic-Cainozoic. Correlation between rifting and continental margin breakup is more speculative in the Early Palaeozoic but well documented for the Late Palaeozoic-Cainozoic. Early Palaeozoic, northwest-trending rifting, accompanied the development of a postulated Tethyan ocean between Indo-Australian Gondwanaland and an unknown continent to the north. The Petrel Sub-basin is thought to have developed as a rifted aulacogen during this postulated Early Palaeozoic phase of continental margin breakup (Veevers, 1976; Veevers and McElhinny, 1976). Rifting was initially accompanied by volcanism, and subsequently provided an intracratonic site for deposition of Cambrian to Lower Carboniferous continental clastics, evaporites and restricted marine sediments. Development of the basin was probably accommodated by northeast movement of the Darwin Block along the Halls Creek Mobile Zone (Warris, 1973). A major northwesterly trending regional gravity high in the central axis of the Petrel Sub-basin may have resulted from crustal thinning initiated at this time (gravity diagram on Au 5b).

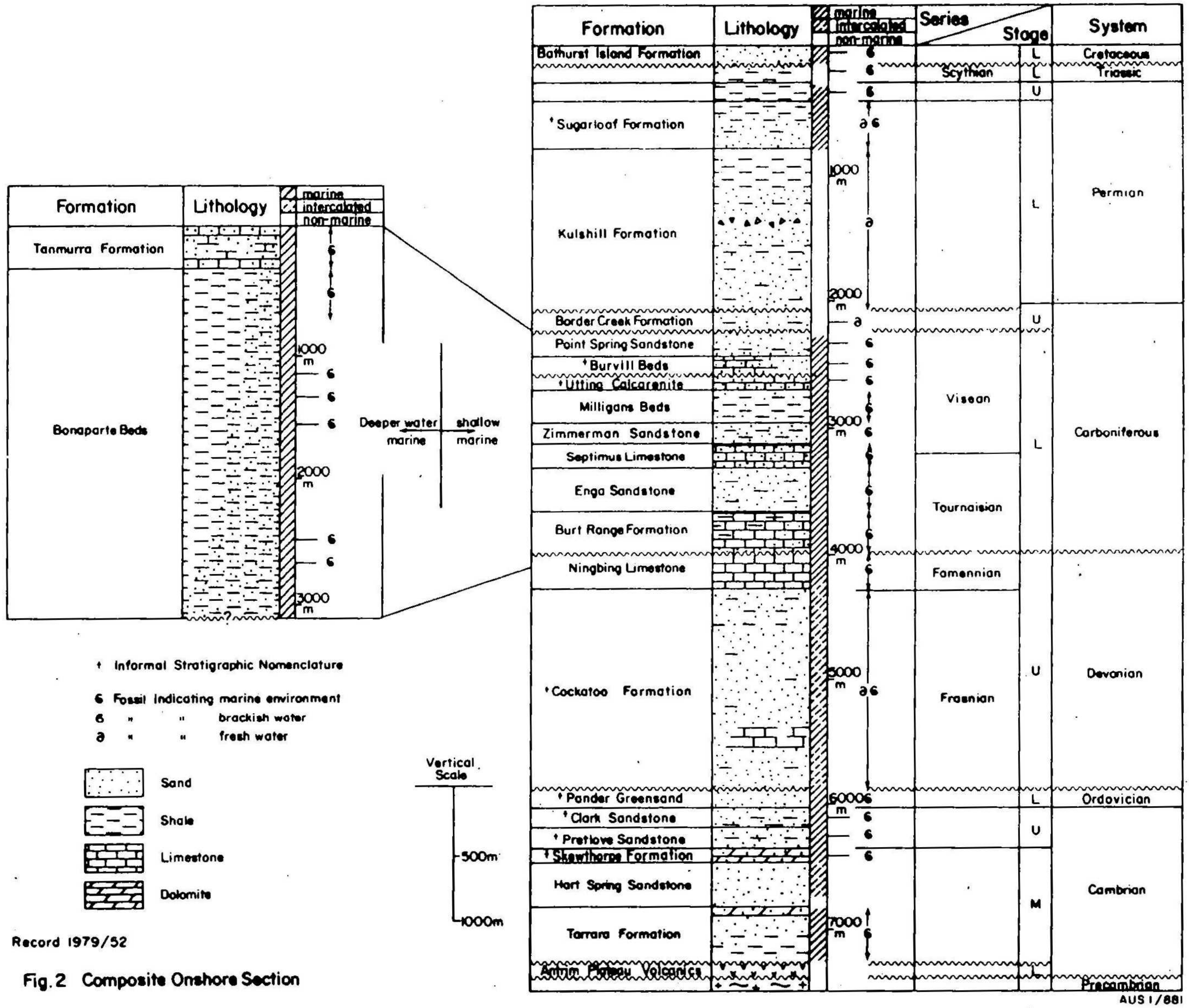

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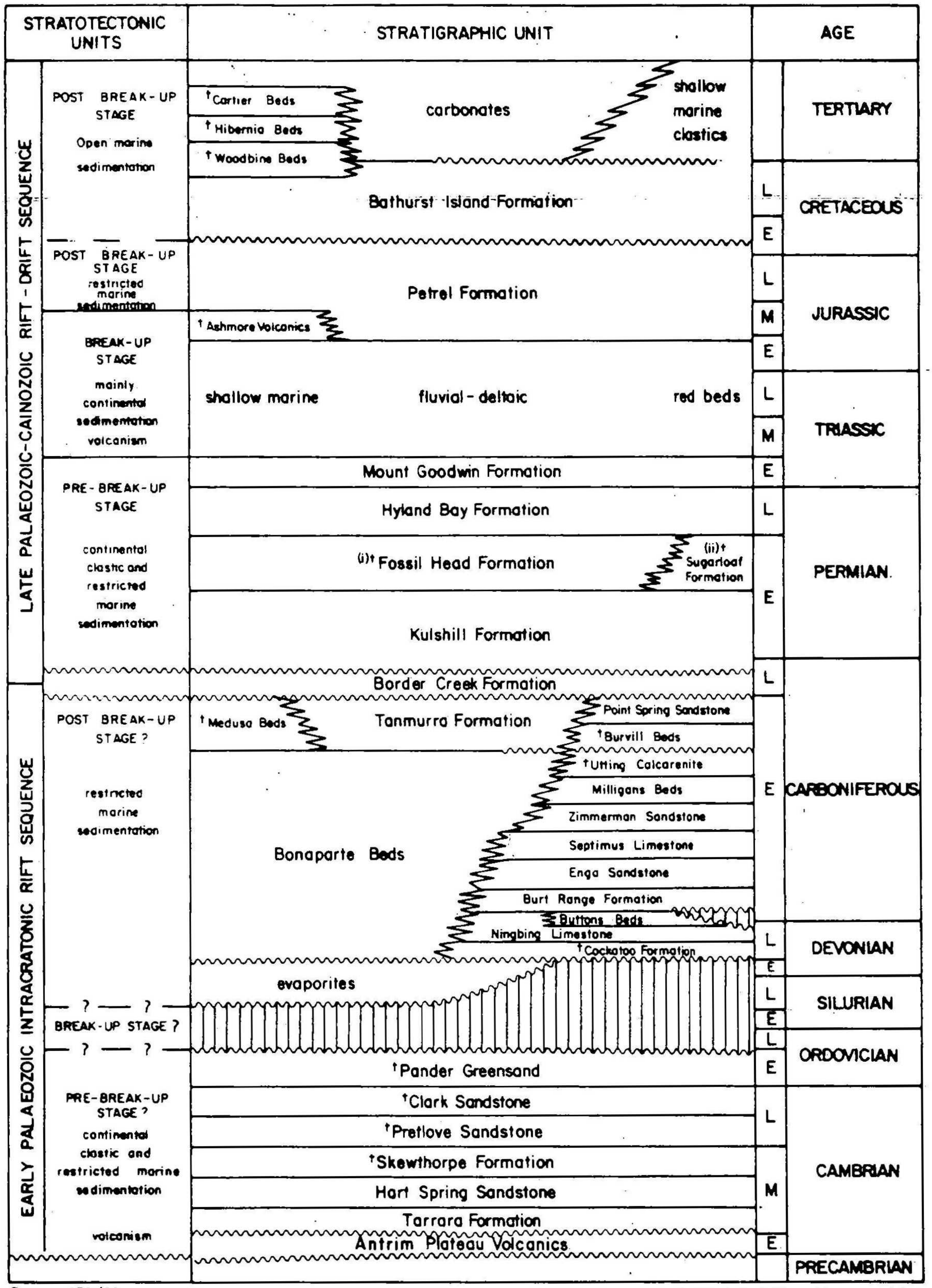
Fig. 2 Composite Onshore Section



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† Informal stratigraphic nomenclature

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Fig. 3 Generalized Stratigraphic Table

The Late Palaeozoic to Cainozoic evolution of the Australian northwest shelf and adjacent Indian Ocean conforms to that of a classical rift-drift sequence (Schneider, 1972; Falvey, 1974). Four major stratotectonic units can be correlated with continental rifting, breakup, and post breakup restricted marine and open-marine stages (Powell, 1976). An early tensional phase in the Late Palaeozoic started development of a northeasterly trending pre-breakup marginal basin which flanks the present-day northwest Australian landmass and which was superimposed on the northwesterly trending Early Palaeozoic sequence (Powell, 1976; Branson, 1978; Doutch and Nicholas, 1978). Deposition of Upper Carboniferous to Middle Triassic fluvio-deltaic and shallow-marine sediments during a continental rifting stage was followed by a mid-Triassic to mid-Jurassic breakup stage accompanied by crustal upwarping, major block-faulting, erosion, and the accumulation of continental red beds and fluvio-deltaic sediments. West, and probably north, of the Bonaparte Gulf Basin this breakup stage ended with the initiation of sea-floor spreading in the Middle to Late Jurassic, as shown by an Oxfordian age of basement at DSDP site 261 (Fig. 1) (Veevers and Heirtzler, 1974) and by magnetic anomalies in the Wharton Basin (Falvey, 1972; Larson, 1975).

Following release of tensional stress in the crust, the Australian shelf began to founder. A restricted marine stage became established in the Middle Jurassic to Early Cretaceous when marginal marine sediments were locally deposited over the block-faulted surface. A post-Neocomian eustatic marine regression was followed in the Aptian-Albian by a rapid transgression of open marine seas over the subsiding shelf. Thick clastics were deposited until the Late Cretaceous and a thick carbonate wedge was deposited in the Tertiary. The relationships between the various stratotectonic units of the Bonaparte Gulf Basin are summarized in a diagrammatic cross-section shown on Figure 4.

Subduction of newly created oceanic crust continued in the north, and the subsequent continent-island arc collision between the Australian and southeast Asian lithospheric plates in the Cainozoic resulted in deformation of the northern margin of the Bonaparte Gulf Basin and the formation of the present-day island of Timor. Preliminary gravity data indicate that Australian continental crust now extends to northern Timor (Chamalauan and others, 1976);

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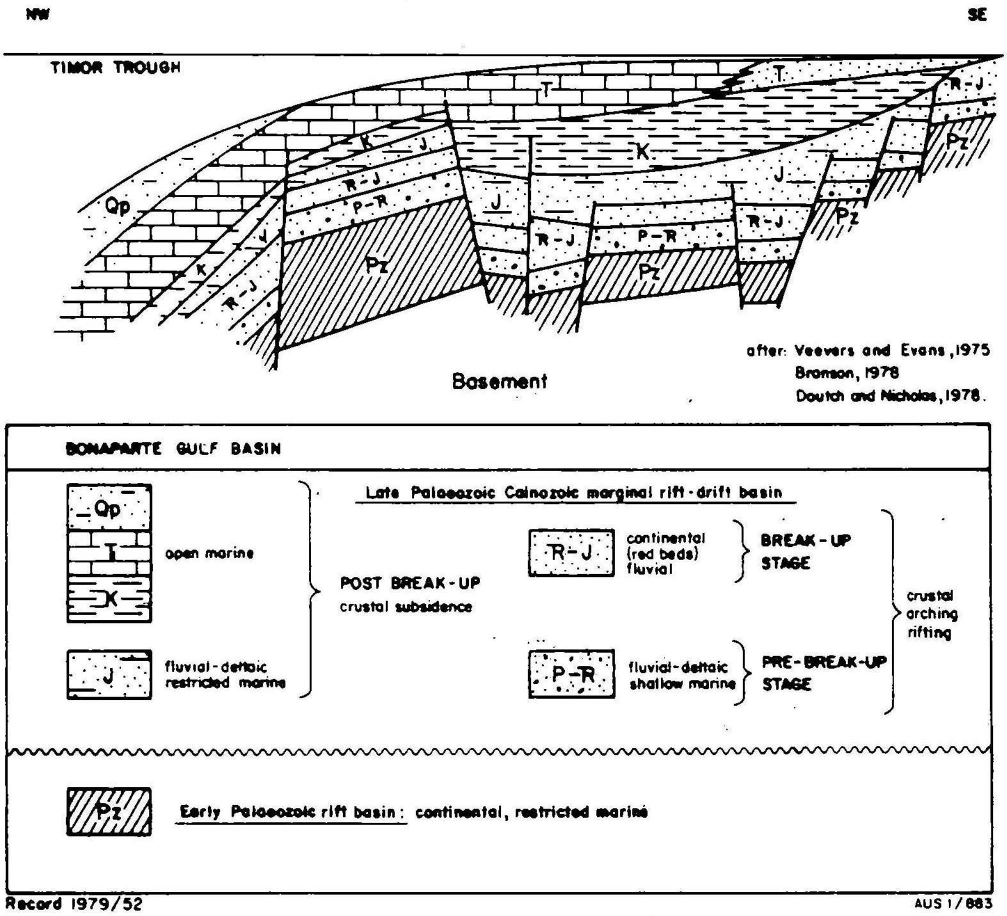

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Fig. 4 Diagrammatic section showing relationship between stratotectonic units in the Bonaparte Gulf Basin

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however, the present-day front of deformation at the Timor Trough is here taken as the present northwestern boundary of the Bonaparte Gulf Basin. The presence of Plio-Pleistocene deep-water sediments over shallow-water late Pliocene sediments in DSDP 262 (Fig. 1) (Veevers and Heirtzler, 1974) is thought to indicate that the present-day Timor Trough formed in the Pliocene. Fitch and Hamilton (1974) consider the Timor Trough to be contiguous with the Java Trench and to represent a former subduction zone. Others (e.g. Audley-Charles and Milsom, 1974; Carter and others, 1976) consider the Trough to be a crustal downwarp, because geological and geophysical data suggest a close affinity between certain rocks of Timor and those of northwest Australia (e.g. Barber and others, 1977; Chamalaun and Grady, 1978). Johnston and Bowin (in prep.) consider that rocks on Timor with Australian affinities were not part of the Australian continental margin in the Cainozoic and reconcile the above views by speculating that they were initially rifted away from the Indo-Australian margin in the Late Jurassic and that their present-day juxtaposition is due to subsequent reconvergence and collision in the Late Cainozoic.

Basin evolution

Early Palaeozoic intracratonic rifting

In the Early Palaeozoic the Bonaparte Gulf Basin developed as an intracratonic northwesterly trending rift basin. The Kimberley, Sturt and Darwin Blocks formed the basin margins and were separated from a central collapsed graben by platform areas which subsided to intermediate depths. In the Early Cambrian, extrusion of the Antrim Plateau Volcanics (Warris, 1973; Laws and Kraus, 1974) was followed by deposition of some 1200 m of shallow and marginal marine, Cambrian to Lower Devonian sediment in a slowly subsiding rift basin (Kaulback and Veevers, 1969). This sequence consists of sandstone and minor sandy dolomite and stromatolitic dolomite (Tarrara Formation to Pander Greensand, Fig. 3).

No sediments of Late Ordovician to Early Silurian age are preserved, and sediments of Late Silurian to Early Devonian age are confined to the central graben and adjacent areas - where precipitation of a thick sequence of evaporites preceded widespread marine sedimentation in the Late Devonian (Veevers, 1969; Edgerly and Crist, 1974). Frasnian gravels and coarse sands were initially deposited around the basin margins (Cockatoo Formation). These graded basinward into shallow marine platform sands, which in turn graded laterally into fine-grained clastics and minor sands (Bonaparte Beds) deposited in the central graben.

In the Famennian widespread deposition of reef, reef-derived, and dolomitic, carbonates (Ningbing Limestone) reflects a reduced supply of terrigenous clastics. Calcareous sands and silty carbonates (Button Beds) accumulated on the landward side of the reef complex, while fine clastics (further Bonaparte Beds) continued to accumulate in the central part of the basin.

In the Early Carboniferous, transgressive-regressive fluctuations resulted in local unconformities around the basin margins and in the rapid migration of facies boundaries. Alternating sand and carbonate-dominated sediments were deposited over platform areas (Burt Range Formation to Utting Calcarenite, Fig. 2), while in the central graben further thick, monotonous sequences of fine-grained sediments continued to accumulate (Bonaparte Beds). A major regression in the late Visean was marked by deposition of a belt of coalesced beach deposits (Burvill Beds) and shallow marine sands (Point Spring Sandstone) around the basin margins, while shallow marine carbonates accumulated in the central part of the basin (Tanmurra Formation, Medusa Beds).

Late Palaeozoic-Cainozoic rift-drift sequence

Following a Late Carboniferous period of erosion, the Late Palaeozoic-Cainozoic rift-drift sequence began to evolve.

Pre-breakup continental rifting stage

In places the eroded basin margins and parts of the adjacent Precambrian basement were unconformably overlain by thin, Upper Carboniferous, fluvial sands and silts (Border Creek Formation), which in turn are unconformably overlain by up to 6000 m of Permo-Triassic sediments. The depositional environment was mainly paralic in the southeast, shallow marine in the northwest. The Lower Permian sequence in the southeast is dominated by coal-bearing fluvio-deltaic sediments, in which sandstones from barrier bar, strandline and channel environments are intercalated with delta plain and pro-delta shales with minor stringers of biomicrite (Kulshill Formation, Sugarloaf Formation, Fossil Head Formation). Poorly sorted pebbles within shales of this Lower Permian sequence are thought to be glacial in origin (Dickins and others, 1972; Laws and Kraus, 1974).

Offshore, the Upper Permian sequence is dominated by marine and marginal marine sandstone, siltstone, shale and bryozoan biomicrite (Hyland Bay Formation). Onshore, the Upper Permian is generally absent, but locally thin marine and non-marine sandstone and siltstone occur.

At the close of the Permian, pre-breakup thermal doming in the mantle resulted in crustal upwarping and initiation of block-faulting accompanied by a major marine regression. Permian sediments are conformably overlain by a Lower Triassic massive siltstone and shale unit (Mount Goodwin Fm) which was deposited mainly in a shallow marine-estuarine environment.

Breakup stage

During the mid-Triassic to mid-Jurassic, continued crustal upwarping resulted in tensional stress accompanied by major block-faulting, and the emergence and erosion of older sediments; the present structural elements of the Bonaparte Gulf Basin became fully established during this phase of deformation. Lower Triassic sediments were in turn locally overlain by Middle Triassic fluvial sands and fine clastics in the southeast, and by Middle to Upper Triassic marginal marine, fine clastics and minor carbonates in the northwest.

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Local deposition of a distinctive red-bed sequence commenced in the Middle Triassic and became more widespread by the Early Jurassic. The sequence partially blanketed the block-faulted palaeotopographic surface and contains many local unconformities. In palaeotopographic depressions the red-bed sequence was in turn overlain by Lower to Middle Jurassic fluvio-deltaic sediments.

Pull-apart tensional stress continued to build up in the crust, until finally relieved in the mid-Jurassic by the initiation of sea-floor spreading farther west and north. Eruption of Middle Jurassic volcanics (Ashmore Volcanics) intersected in Ashmore Reef No. 1 well can be correlated with the commencement of drifting.

Post-breakup restricted-marine stage

As the Australian continent began to drift, thermal cooling of the mantle and crust and the release of tensional stress resulted in rapid regional subsidence in the Middle Jurassic to Early Cretaceous (Neocomian). The subsidence allowed restricted marine seas to transgress progressively over and around the block-faulted palaeotopographic surface. Sedimentation was probably initially local in distribution (Powell, 1976) and conformed closely to a juvenile ocean, 'Red Sea' stage of continental margin development (Schneider, 1972). Shallow-marine conditions were quickly established in the Petrel and Vulcan Sub-basins, Malita Graben and Sahul Syyncline - all of which subsided rapidly, while the basin margins - the Londonderry High, Ashmore Block and Sahul Platform - subsided less rapidly and remained partly emergent throughout this period.

In the southeast, paralic, fine to coarse pebbly sandstones are overlain by transgressive marine shales, which are in turn overlain by a regressive unit of Neocomian paralic sandstone (Petrel Formation). Farther north, the sandstone units grade into marine siltstone and shale which were deposited in the subsiding sub-basins. Minor thinner sequences of sand were deposited over and around the then still partly emergent, eroded, structural highs.

Progression to an open marine, mature stage of continental margin evolution was interrupted by a major post-Neocomian, eustatic marine regression. The entire Bonaparte Gulf Basin became temporarily exposed above sea level - with the possible exception of the Malita Graben, where sedimentation may have continued uninterrupted.

Post-breakup open-marine mature stage

A rapid and widespread transgression of an open marine sea followed the Early Cretaceous period of emergence. The marine transgression was in part caused by a worldwide eustatic event, and partly by continued crustal subsidence. Thick Aptian-Albian marine shales (Bathurst Island Formation) occur over the basin with minor disconformity, except over the Londonderry High, Ashmore Block, and Sahul Platform, where truncated Permian to Jurassic sediments remained partly above sea level until the Late Cretaceous; minor sandstone derived from eroded Triassic and Jurassic sediments occurs over and around the basin margins and structural highs.

By the Late Cretaceous most of the basin was below sea level; deposition of fine-grained marine clastics continued, except in the northwest where argillaceous pelagic carbonates accumulated (Woodbine Beds). The change from terrigenous to carbonate sedimentation has been attributed to development of thermohaline circulation in the expanding Indian Ocean in the Late Cretaceous (Veevers and Johnson, 1974; Exon and Willcox, 1978). An alternative, but less likely, hypothesis attributes the change to a Late Cretaceous increase in carbonate sedimentation on a global scale, while a further hypothesis speculates that northerly drift of the Australian continent into warmer latitudes favoured deposition of carbonate sediments (Veevers and Johnson, 1974).

The Petrel and Vulcan Sub-basins, Malita Graben, and Sahul Syncline were largely infilled by the Early Tertiary when a relatively shallow shelf was established. In the Tertiary, thin terrigenous clastics were deposited over the Petrel Sub-basin, while farther north continued subsidence of the shelf edge allowed accumulation of a prograding northwesterly, thickening wedge of carbonate (further Woodbine Beds, Hibernia, Cartier Beds). A thick sequence of argillaceous micrite and calcisiltite was deposited in the Paleocene and early Eocene, and reef and reef-derived sediments were deposited in the mid-Eocene to Pliocene. Sediments of Oligocene age are generally absent and Neogene carbonates are separated from Palaeogene carbonates by a major regional, pre-Miocene unconformity. Non-deposition, subaerial and submarine erosion, and a lack of diagnostic microfauna are all possible explanations for the occurrence of this stratigraphic break. Branson (1978), and Exon and Willcox (1978), postulate that strong, cold, circumpolar currents swept the Australian continental margin in the Oligocene following Early Tertiary separation of Australia and Antarctica. Carbonate sedimentation may have resumed when Australia migrated into warmer latitudes.

Reef building corals largely became extinct in the late Pliocene to Pleistocene due to accelerated subsidence of the northwest Australian shelf and a thin sequence of Holocene calcareous and terrigenous clastics now veneers the sea floor. Higher than normal present day geothermal gradients (Wise, 1975) indicate that post-breakup mantle cooling and crustal subsidence probably continue to the present day.

Resources

Hydrocarbons

The interpretation of the Bonaparte Gulf Basin as two rift-drift sequences suggests that the basin is favourably located as a site for generation and entrapment of hydrocarbons. The available data indicate that source, reservoir and cap rocks, structural and stratigraphic traps, and an adequate geothermal gradient are all present in the basin. Aeromagnetic, gravity and seismic surveys, supplemented by forty exploration wells have identified and tested several potential plays. Hydrocarbon shows have been reported in Lower Carboniferous, Lower Permian, Upper Permian, late Middle and Upper Jurassic, Upper Cretaceous and Eocene sediments. Petrel No. 1 well (Fig. 1) blew out while drilling Upper Permian carbonates. Currently uneconomic but substantial flows of gas were obtained from the same unit in Petrel No. 2 and Tern No. 1

(Fig. 1). A small oilfield was discovered by Puffin No. 1 well which encountered significant oil shows in Upper Cretaceous sands (Wise, 1975). Gas condensate was discovered in late Middle Jurassic sandstone in Troubadour No. 1 and Sunrise No. 1 wells (Powell, 1976). However, despite the apparently favourable conditions and a continuing relatively high level of exploration activity, no currently economic accumulations of hydrocarbons have as yet been located.

Pre-Carboniferous sediments are considered non-prospective because of silicification (Smith, 1977). Potential Upper Palaeozoic and Mesozoic sandstone and carbonate reservoirs, with good porosity and permeability, occur mainly either in the southeast of the basin or around the basin margins. Porosities and permeabilities decrease towards the northwest, partly because of an increasing argillaceous content in the sandstones, and partly because of secondary silicification with increasing depth of burial. Post-breakup Jurassic and Cretaceous sandstone wedges adjacent to eroded fault scarps are an exception to this trend. These sands were derived from reworked Upper Triassic and Lower Jurassic continental and fluvial sediments with a consequent enhancement of reservoir characteristics.

Potential structural and combination traps are mainly associated with tilted fault blocks and diapiric structures. Several structures in the basin are as yet untested, particularly on the Sahul Platform (structural diagram on Au 5b). However, many traps are likely to have been breached and flushed during subsequent faulting and erosion. Unbreached stratigraphic pinch-out and combination traps may occur around palaeo-shorelines within shallow marine and fluvio-deltaic sequences.

Potential source (and seal) rocks occur throughout the basin. In the southeast these are mainly deltaic, and contain organic matter which is likely to be mainly humic in derivation and, therefore, gas prone. Farther northwest, in the deeper sub-basins, such as the Malita Graben, higher than normal present-day geothermal gradients (Wise, 1975) suggest that pre-Cretaceous shales are likely to be too mature to generate anything but gas. The tectonic history of the basin suggests that much of the oil which may have been previously generated in the basin is likely to have migrated up-dip into traps which were subsequently breached.

In summary, the potential of an apparently highly prospective basin has been limited by an unfortunate relative timing of periods of migration, trap formation and erosion. The best reservoir rocks unfortunately occur in the southeast, where source rocks are likely to generate gas, and major unbreached traps are unlikely to contain oil (Wise, 1975). Potential for oil is thus restricted to smaller unbreached stratigraphic and combination traps around the basin and sub-basin margins, although post-breakup reservoir sands located around the margins of the deeper sub-basins may also be prospective.

Acknowledgement

This contribution is published with the permission of the Director, Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T. (Australia).

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TABLE 1. WELLS USED IN CROSS-SECTIONS

COMPANY

WELL NAME	YEAR	T.D. (m)	SUB-BASIN
ARCO AUSTRALIA LTD			
Lacrosse 1	1969	3054	Petrel
Gull 1	1970/71	3421	Petrel
Petrel 2	1970/71	4725	Petrel
Flamingo 1	1971	3700	Sahul Platform/Sahul Syncline
Sandpiper 1	1971	1692	Petrel
Tern 1	1971	4352	Petrel
Heron 1	1971/72	4209	Malita Graben
Osprey 1	1971/72	3185	Londonderry High
Brown Gannet 1	1972	2743	Ashmore Block
Eider 1	1972	2835	Londonderry High
Pelican Island 1	1972	1981	Petrel
Penguin 1	1972	2757	Petrel
*Puffin 1	1972	2961	Vulcan/Ashmore Block
*Swan 1	1972/73	3284	Vulcan/Ashmore Block
AUSTRALIAN AQUITAINE PETROLEUM			
Keep River 1	1969	4752	Carlton
Flat Top 1	1970	2174	Darwin Block
Newby 1	1969	1149	Darwin Block

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COMPANY

WELL NAME	YEAR	T.D. (m)	SUB-BASIN
B.O.C. of AUSTRALIA LTD			
Ashmore Reef 1	1967/68	3915	Ashmore Block
Sahul Shoals 1	1970	3802	Ashmore Block
ALLIANCE OIL DEVELOPMENT AUSTRALIA			
Bonaparte 1	1963/64	3210	Carlton

*Well completion reports are confidential.

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References

AUDLEY-CHARLES, M.G., and MILSOM, J.S., 1974 - Comment on "Plate Convergence, Transcurrent Faults, and internal deformation adjacent to Southeast Asia and the Western Pacific" by T.J. Fitch. Journal of Geophysical Research, 79, 4980-4981.

BARBER, A.J., AUDLEY-CHARLES, M.G., and CARTER, D.J., 1977 - Thrust tectonics in Timor. Journal of the Geological Society of Australia, 24(1), 51-62.

BRANSON, J.C., 1978 - Evolution of sedimentary basins from Mesozoic times in Australia's continental slope and shelf. Tectonophysics, 48, 389-412.

BMR, 1974 - Summary of the Phanerozoic sedimentary basins of Australia and adjacent regions, 1974. Bureau of Mineral Resources, Australia, Record 1974/178 (unpublished).

BMR, 1976 - 1:5 000 000 gravity map of Australia. Bureau of Mineral Resources, Australia, Canberra.

CARTER, D.J., AUDLEY-CHARLES, M.G., and BARBER, A.J., 1976 - Stratigraphical analysis of island arc-continental margin collision in eastern Indonesia. Journal Geological Society of London, 132, 179-198.

CHAMALAUN, F.H., and GRADY, A.E., 1978 - The tectonic development of Timor: New model and its implications for Petroleum Exploration. APEA Journal, 18, 102-108.

CHAMALAUN, F.H., LOCKWOOD, K., and WHITE, A., 1976 - The bouguer gravity field and crustal structure of eastern Timor. Tectonophysics, 30, 241-259.

23

CRIST, R.P., and HOBDAY, M., 1973 - Diapiric features of the offshore Bonaparte Gulf Basin, northwest Australian shelf. Australian Society Exploration Geophysicists, 4(1), 43-66.

DICKINS, J.M., ROBERTS, J., and VEEVERS, J.J., 1972 - Permian and Mesozoic geology of the northeastern part of the Bonaparte Gulf Basin. Bureau of Mineral Resources, Australia, Bulletin 125, 74-102.

DOUTCH, H.F., and NICHOLAS, E., 1978 - The Phanerozoic sedimentary basins of Australia and their tectonic implications. Tectonophysics, 48, 365-388.

EDGERLY, D.W., and CRIST, R.P., 1974 - Salt and diapiric anomalies in the southeast Bonaparte Gulf Basin. APEA Journal, 14(1), 85-94.

EXON, N.F., and WILLCOX, J.B., 1978 - Geology and Petroleum Potential of Exmouth Plateau area off Western Australia. American Association of Petroleum Geologists Bulletin, 62, 40-72.

FALVEY, D.A., 1972 - Sea-floor spreading in the Wharton Basin (northeast Indian Ocean) and the breakup of eastern Gondwanaland. APEA Journal, 12(2), 86-88.

FALVEY, D.A., 1974 - The development of continental margins in plate tectonic theory. APEA Journal, 14(1), 96-106.

FITCH, T.J., and HAMILTON, W., 1974 - Reply to discussion on a paper by Fitch, T.J. Journal of Geophysical Research, 79(32), 4982-5.

HUGHES, R.J., 1978 - The geology and mineral occurrences of Bathurst Island, Melville Island, and Cobourg Peninsula, Northern Territory. Bureau of Mineral Resources, Australia, Bulletin, 177.

JOHNSTON, C.R., and BOWIN, C.O., in prep - Plio-Pleistocene continental/island arc collision in the Timor region.

KAULBACK, J.A., & VEEVERS, J.J., 1969 - Cambrian and Ordovician geology of the southern part of the Bonaparte Gulf Basin, Western Australia. Bureau of Mineral Resources, Australia, Report, 109.

LARSON, R.L., 1975 - Late Jurassic sea-floor spreading in the eastern Indian Ocean. Geology, 3, 69-71.

LAWS, R.A., and BROWN, R.S., 1976 - Bonaparte Gulf basin - southeastern part; In LESLIE, R.B., EVANS, H.J., & KNIGHT, C.L. (Editors), 1976 - ECONOMIC GEOLOGY OF AUSTRALIA AND PAPUA NEW GUINES, 3, PETROLEUM, Australasian Institute of Mining and Metallurgy, Monograph Series 7, 200-208.

LAWS, R.A., and KRAUS, C.P., 1974 - The regional geology of the Bonaparte Gulf-Timor Sea area. APEA Journal, 14(1), 77-84.

NICHOLAS, E., 1972 - Bibliography of the Bonaparte Gulf Basin, W.A. and N.T. Bureau o. Mineral Resources, Australia, Report, 156.

PLAYFORD, P.E., COPE, R.N., COCKBAIN, A.E., LOW, C.H., and LOWRY, D.C., 1975 - Phanerozoic. In GEOLOGY OF WESTERN AUSTRALIA - Geological Survey of Western Australia, Memoir, 2, 269-318.

POWELL, D.E., 1976 - The geological evolution and hydrocarbon potential of the continental margin off northwest Australia. APEA Journal, 16(1), 12-23.

ROBERTS, J., and VEEVERS, J.J., 1973 - Summary of BMR studies of the onshore Bonaparte Gulf Basin 1963-71. Bureau of Mineral Resources, Australia, Bulletin, 139, 29-58.

25

SCHNEIDER, E.D., 1972 - Sedimentary evolution of rifted continental margins. Geological Society America, Memoir, 132, 109-118.

SMITH, E.R., 1977 - Australia's onshore basins: their petroleum prospects and future exploration program. APEA Journal, 17(2), 17-23.

VEEVERS, J.J., 1969 - Sedimentology of the Upper Devonian and Carboniferous platform sequence of the Bonaparte Gulf Basin. Bureau of Mineral Resources, Australia, Bulletin, 109.

VEEVERS, J.J., 1976 - Early Phanerozoic events on and alongside the Australasian-Antarctic platform. Journal of the Geological Society of Australia, 23, 183-206.

VEEVERS, J.J., and EVANS, P.R., 1975 - Late Palaeozoic and Mesozoic history of Australia. In CAMPBELL, K.S.W. (ed.) GONDWANA GEOLOGY. Third Gondwanaland Symposium, Canberra, 1973.

VEEVERS, J.J., and HEIRTZLER, J.R., 1974 - Tectonic and palaeogeographic synthesis of Leg 27. Initial Reports Deep Sea Drilling Project, 27, 1049-1054.

VEEVERS, J.J., and JOHNSTONE, M.H., 1974 - Comparative stratigraphy and structure of the Western Australian margin and the adjacent deep ocean floor. Initial Reports Deep Sea Drilling Project, 27, 571-585.

VEEVERS, J.J., and McELHINNY, M.W., 1976 - The separation of Australia from other continents. Earth-Science Reviews, 12, 139-159.

VEEVERS, J.J., and ROBERTS, J., 1968 - Upper Palaeozoic rocks, Bonaparte Gulf Basin of northwestern Australia. Bureau of Mineral Resources, Australia, Bulletin, 97.

26

WARRIS, B.J., 1973 - Plate tectonics and the evolution of the **Timor Sea**, northwest Australia. APEA Journal, 13(1), 13-18.

WISE, J.C., 1975 - Petroleum potential of northern Australia. **APEA Journal**, 15(1), 80-85.

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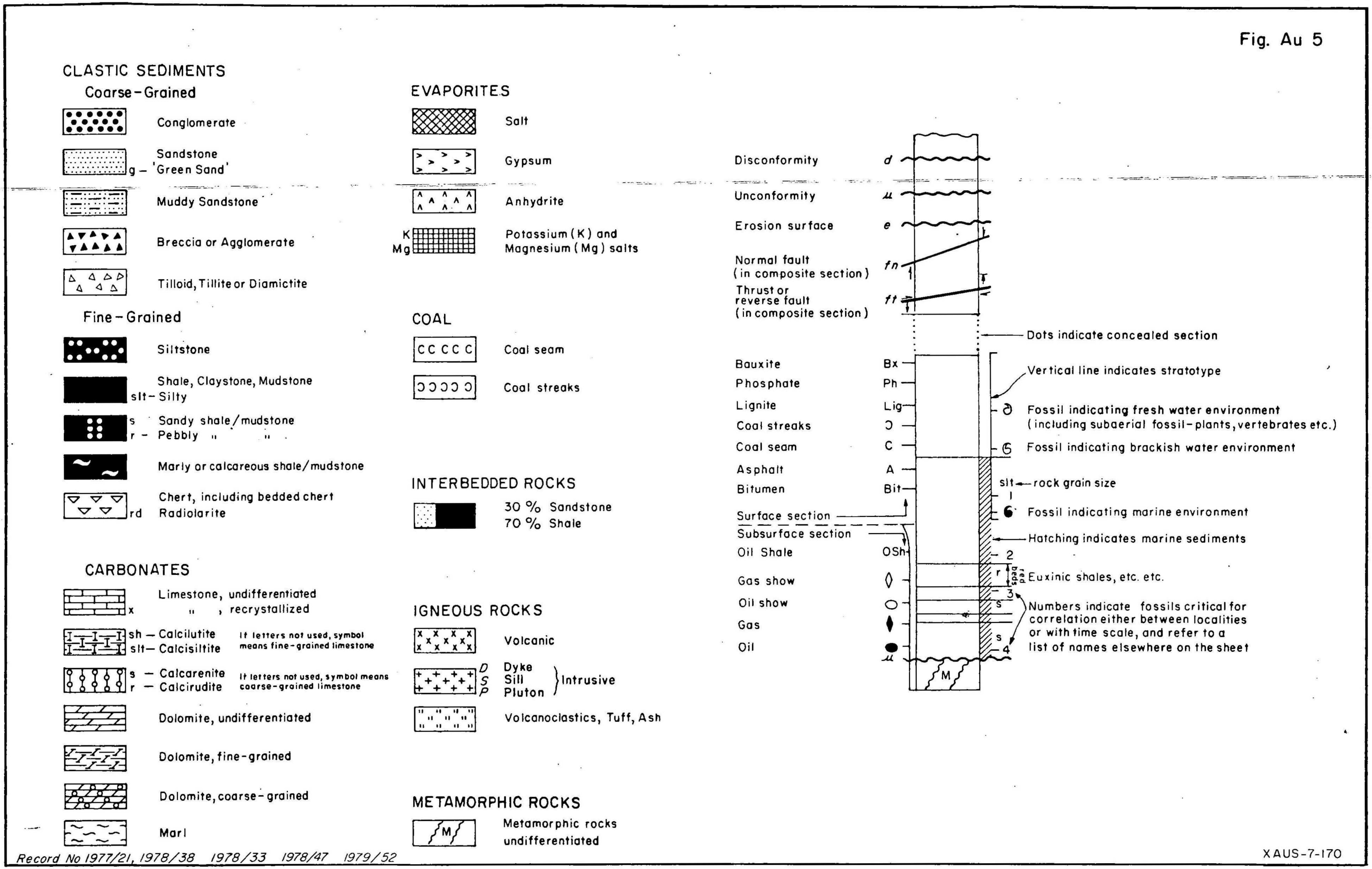


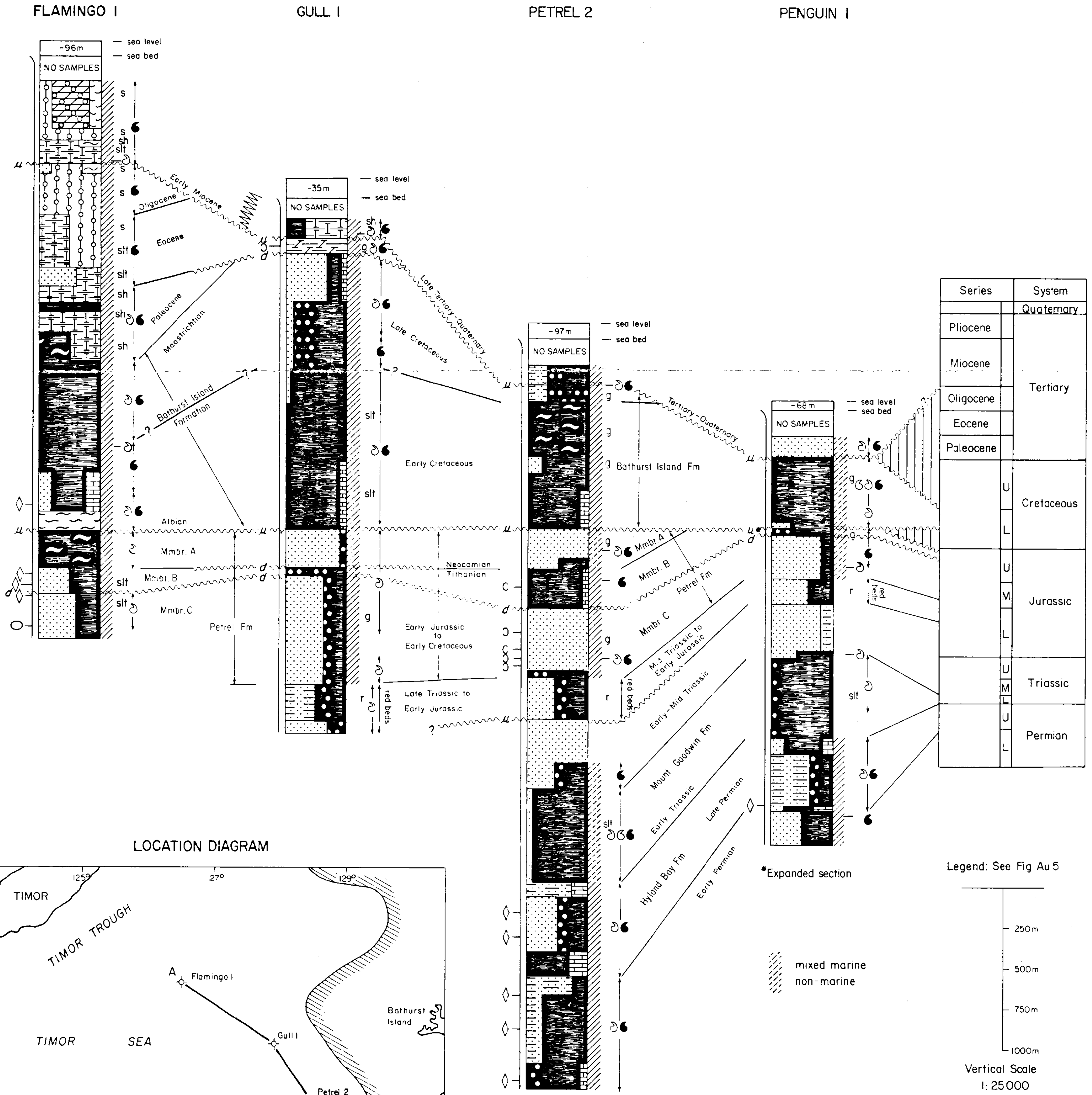
Standard legend for stratigraphic columns

Fig. Au 5a

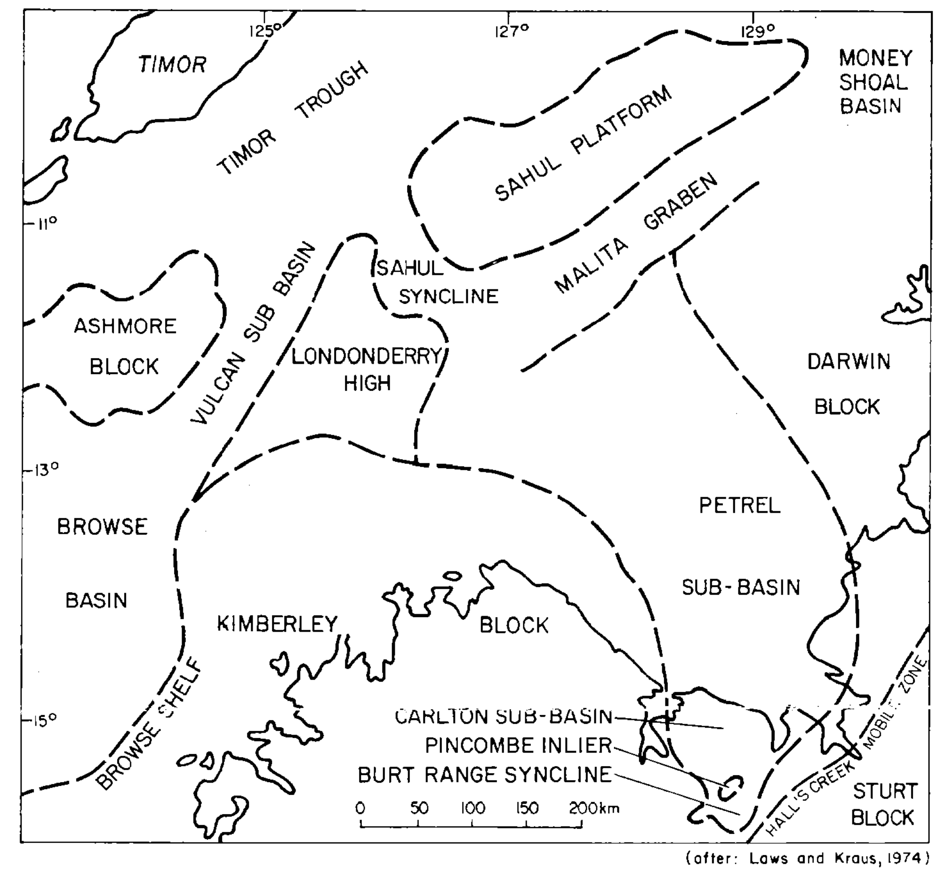
BONAPARTE GULF BASIN: WESTERN AUSTRALIA AND NORTHERN TERRITORY

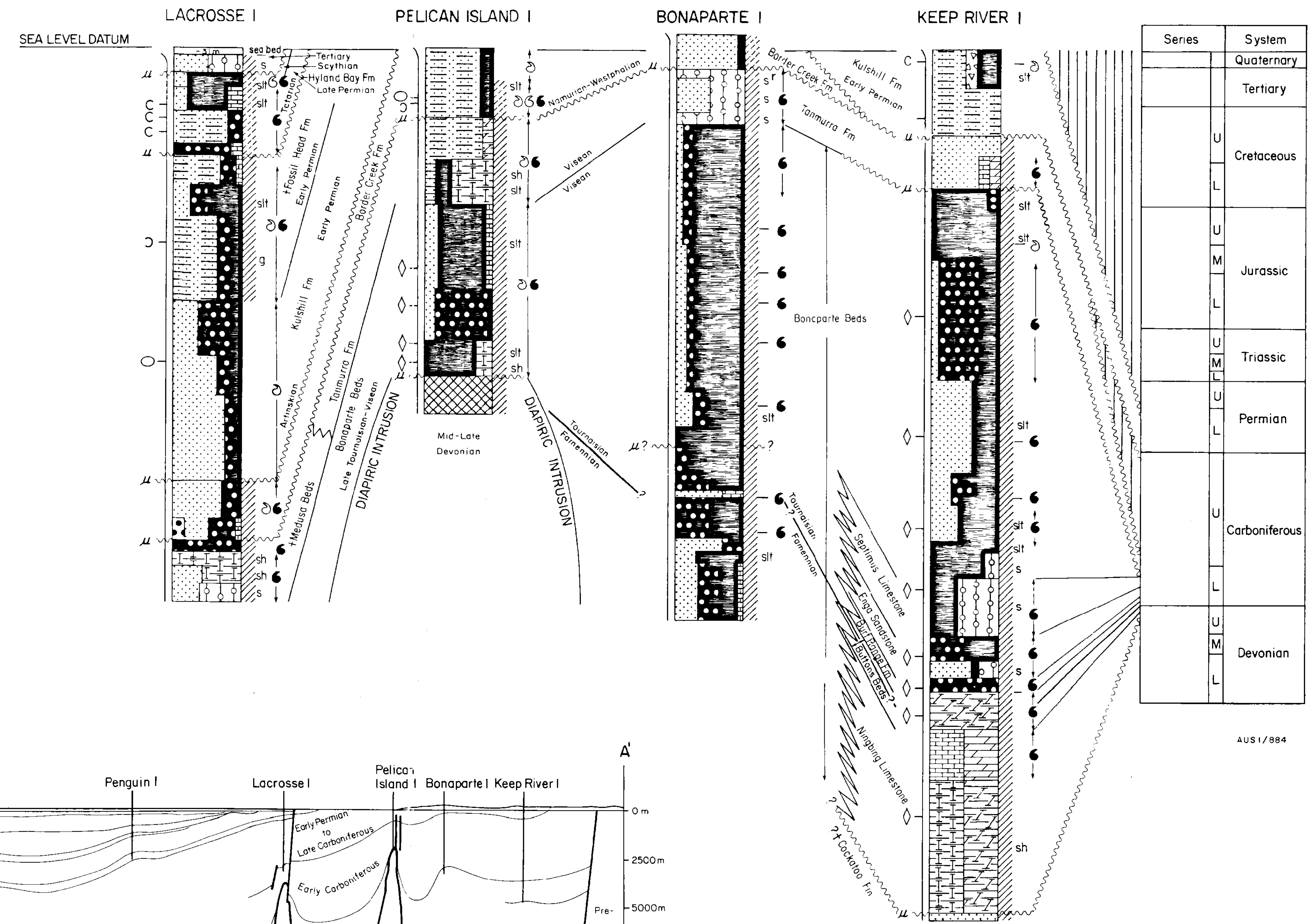
ESCAP ATLAS OF STRATIGRAPHY (IGCP PROJECT No. 32)

SAHUL PLATFORM- PETREL SUB BASIN

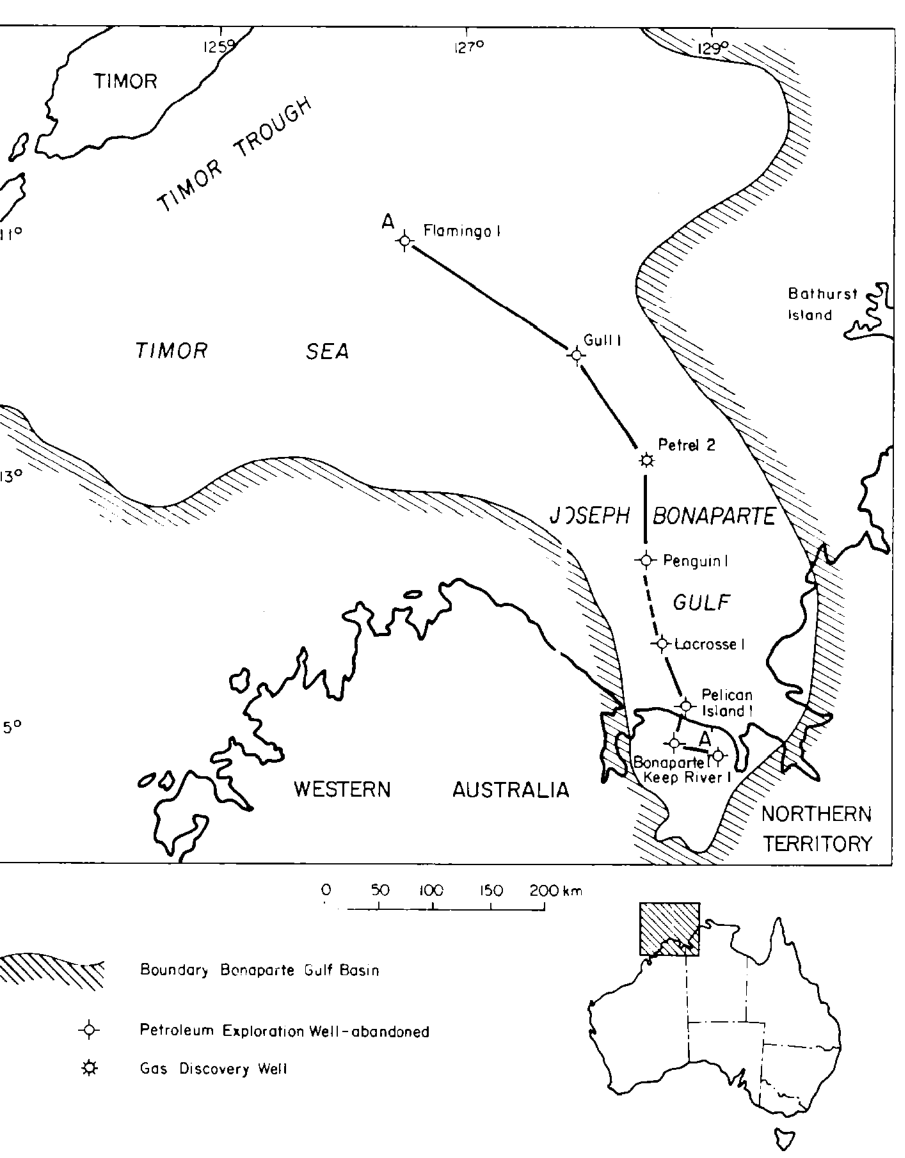


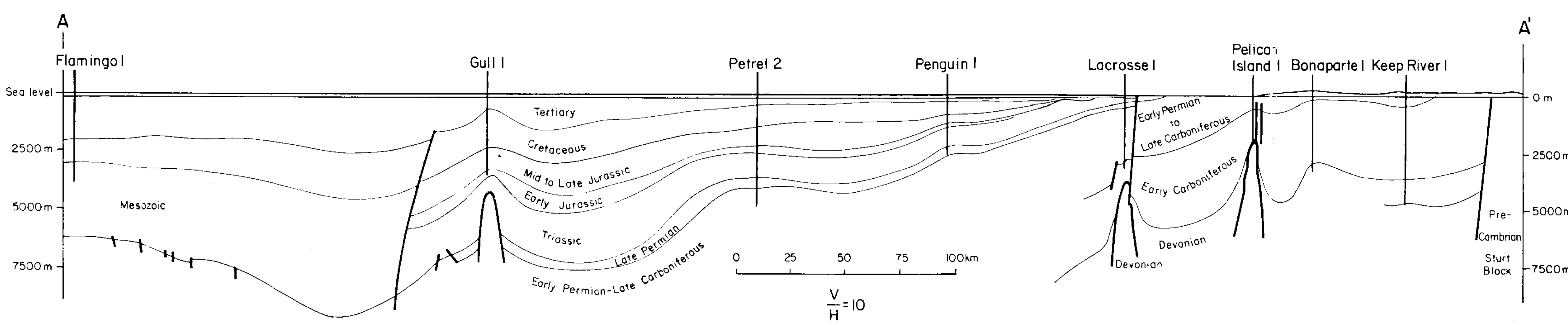
TECTONIC ELEMENTS





LOCATION DIAGRAM





Geological data compiled by C.M. Brown
Drawn by Cangraphics Pty Ltd
Acknowledgment: Geological data from Arco Australia Ltd, Alliance Oil Development Australia, Australian Aquitaine Petroleum

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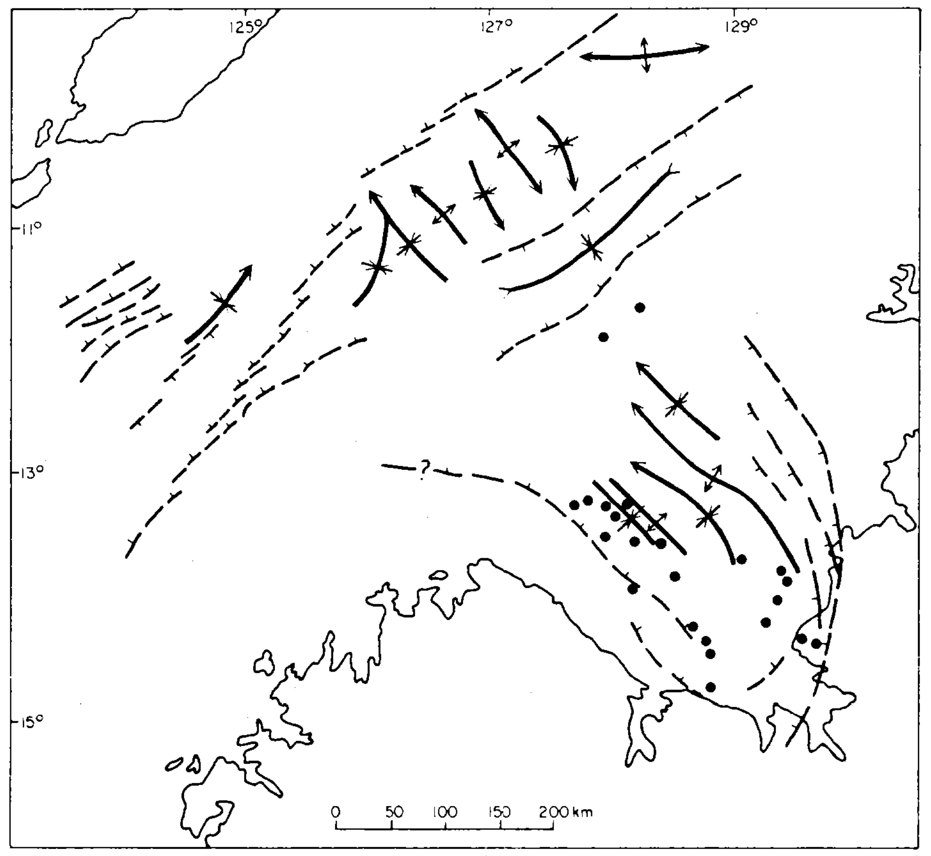
AUSTRALIA

BONAPARTE GULF BASIN: WESTERN AUSTRALIA AND NORTHERN TERRITORY

ESCAP ATLAS OF STRATIGRAPHY (IGCP PROJECT No. 32)

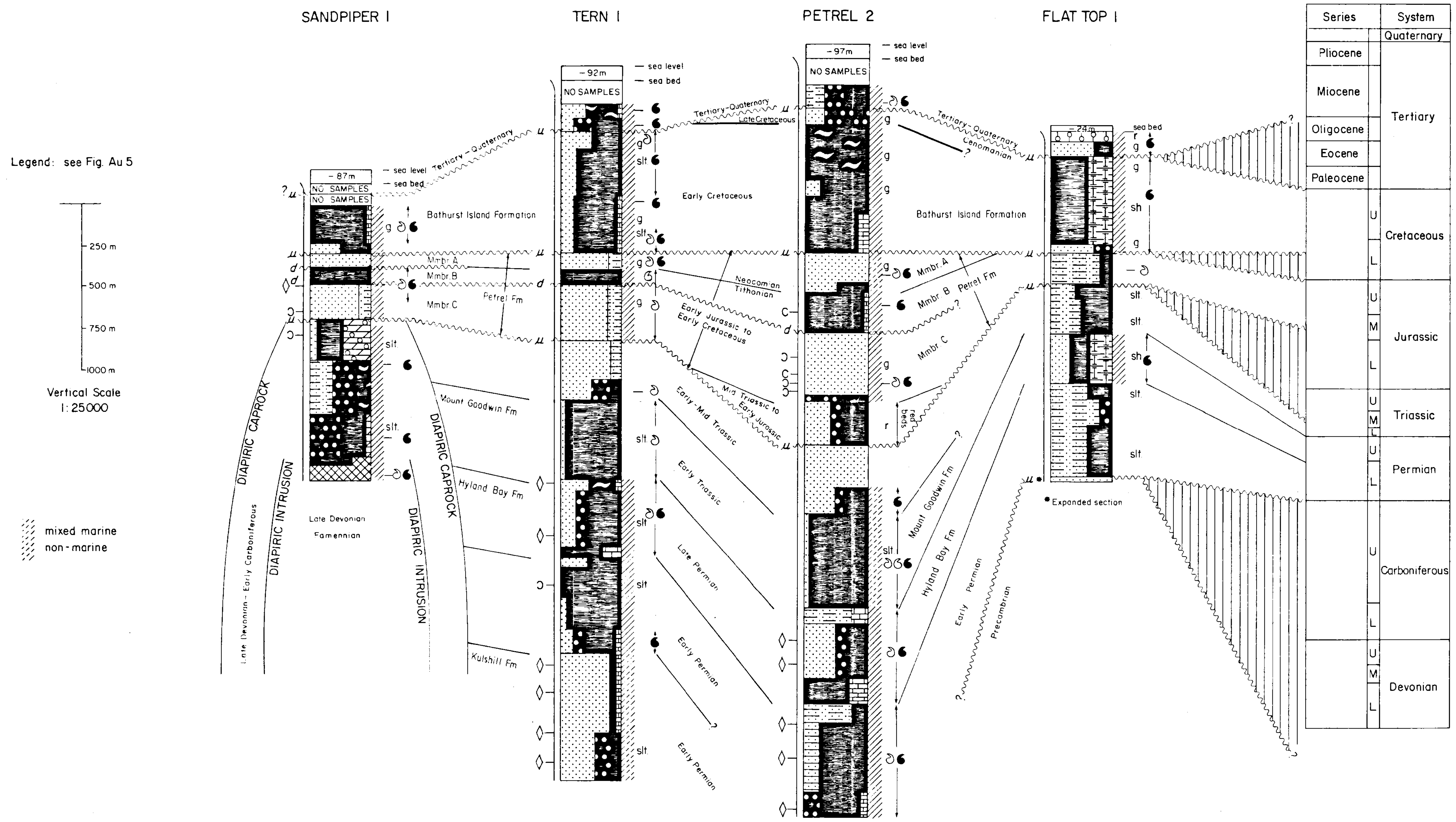
PETREL SUB BASIN

STRUCTURE

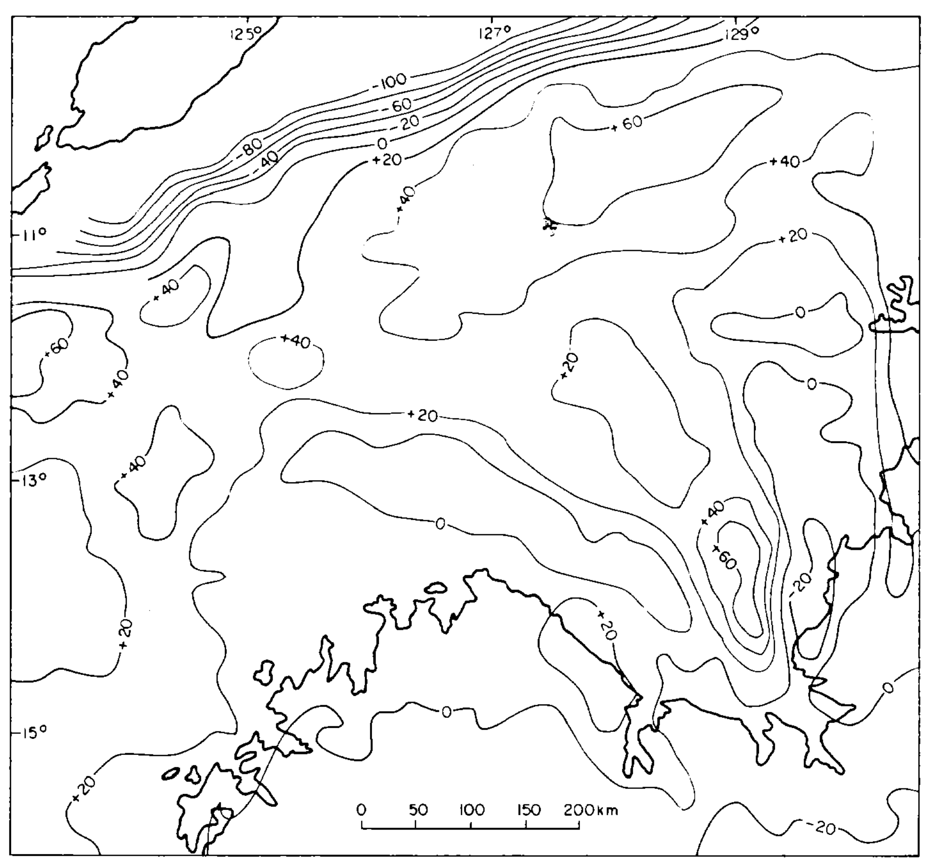


(after: Laws and Kraus, 1974; Edgerley and Crist, 1974)

- Fault
- Anticline
- Syncline
- Salt diapirs



GRAVITY

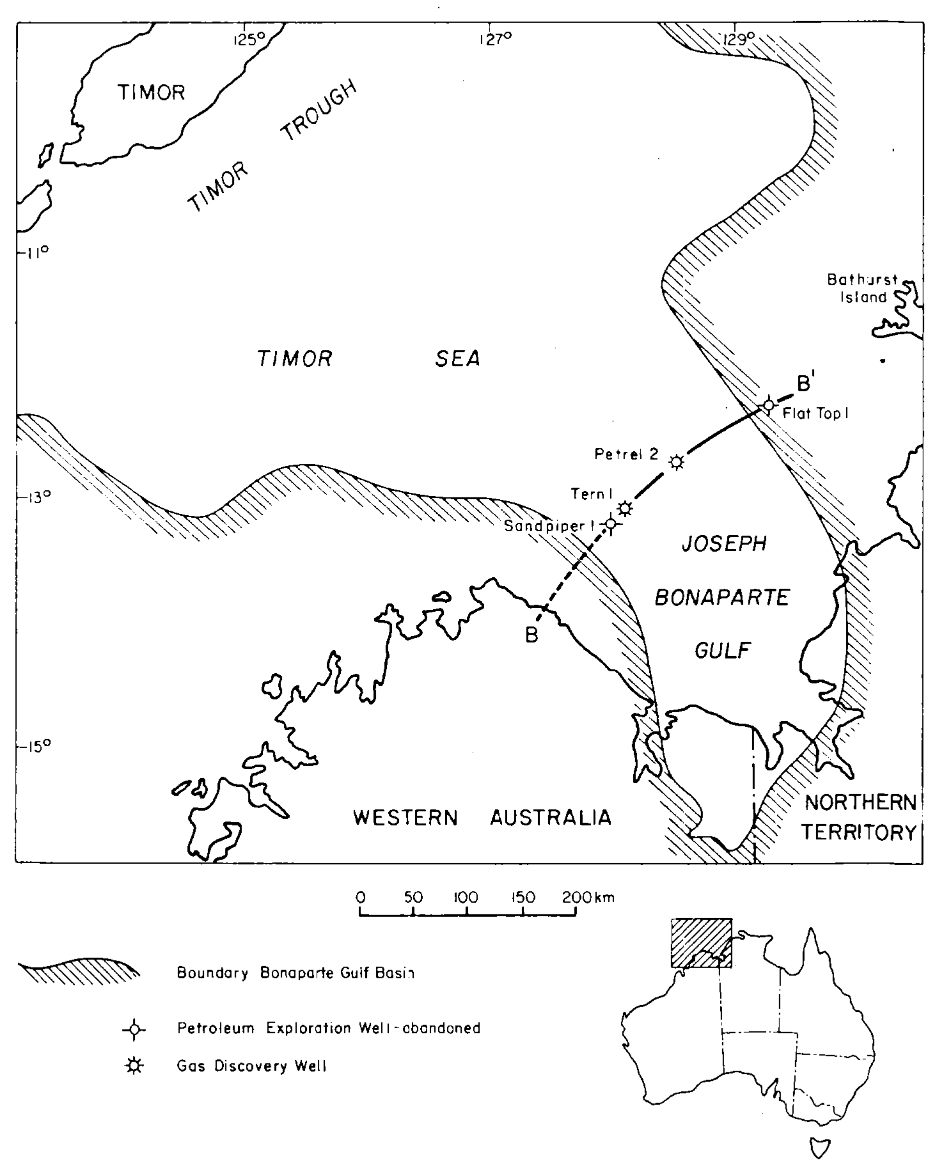


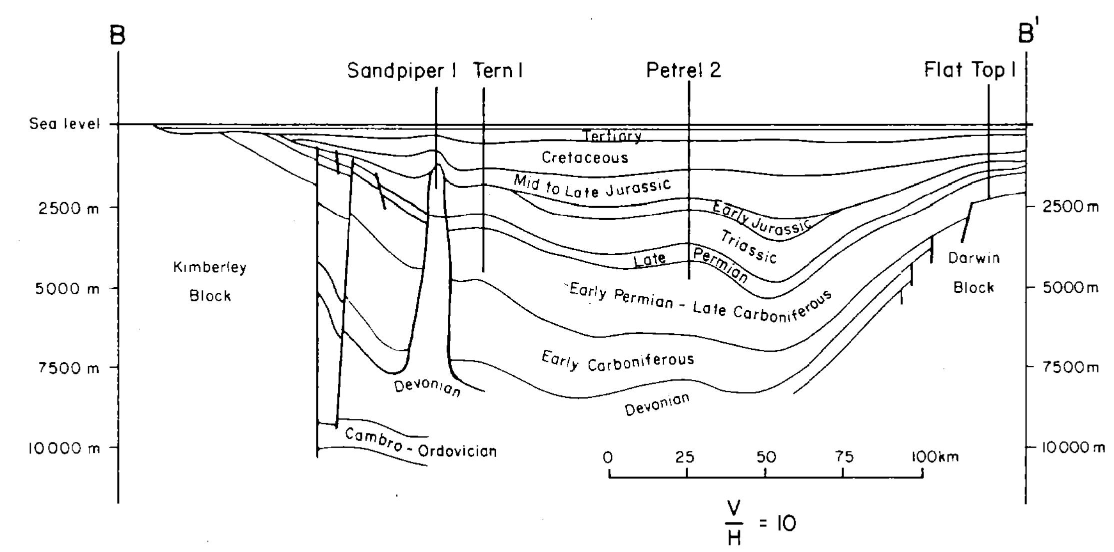
Contour interval 20 milligals

Bouguer Anomalies shown onshore and Free-Air Anomalies offshore

Gravity data from Geophysical Branch Bureau of Mineral Resources Australia (BMR, 1976)

LOCATION DIAGRAM





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Acknowledgment: Geological data from Arco Australia Ltd, Australian Aquitaine Petroleum

AUSTRALIA

BONAPARTE GULF BASIN: WESTERN AUSTRALIA AND NORTHERN TERRITORY

ESCAP ATLAS OF STRATIGRAPHY (IGCP PROJECT No. 32)

Fig. Au 5c