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ABSTRACTS

CONTENTS

GEOLOGICAL AND GEOPHYSICAL REVIEW OF THE CARPENTARIA, OLIVE RIVER AND LAURA BASINS, QUEENSLAND, AND THEIR ECONOMIC POTENTIAL

H.F. Doutch and J. Pinchin

GEOLOGY (H.F. Doutch)

A combined Bureau of Mineral Resources and Geological Survey of Queensland party began regionally mapping the Carpentaria Basin area in 1969. It has now virtually completed all field work. The Olive River Basin (see Structure Map, figure 1), was included in this survey, and the party remapped the western margin of the Laura Basin.

The stratigraphy of the three basins is similar to that of the Eromanga Basin. The basins contain -

1. Upper Jurassic to lowest Cretaceous quartzose sandstone and siltstone, mainly continental. These rocks are overlain conformably by early Cretaceous marine mudstone, siltstone, and labile sandstone. Onshore in the Carpentaria Basin the continental succession is up to 175 m thick, and the marine succession up to 475 m thick.

2. Upper Cretaceous or Lower Tertiary continental clayey quartzose sandstone and siltstone, up to 100 m thick, unconformably overlying the older rocks.

Before Late Cainozoic sedimentation began, a deep weathering event resulted in laterite, ferricrete and other duricrusts developing on Lower Tertiary and older rocks. This event was followed by tectonism which both initiated, and later modified, the late Cainozoic interplay between erosion and sedimentation which started the growth of the fans and fluvial plains which are still developing. They consist of up to 100 m of sand and clay.

Pleistocene sea level changes affected this interplay, and were also important for the control they had on water table fluctuations which resulted in bauxite being formed from laterite in the Weipa area.

The continental Mesozoic beds contain suitable reservoirs for hydrocarbons, and the overlying marine succession could possibly be source rocks. Reservoir conditions in the Upper Cretaceous or Lower Tertiary rocks appear possible, albeit poor. However, only minor oil shows have been found in the eight petroleum exploration wells drilled in the Carpentaria Basin. Most of these have come from the thin calcareous Toolebuc Formation; this unit is part of the Lower Cretaceous marine beds and includes oil shale in the southern part of the Carpentaria Basin and the northern part of the Eromanga Basin. No gas has been found.

In all these basins both the Jurassic and the Lower Tertiary sandstones contain useful aquifers. The water passing through them has probably flushed out hydrocarbons or prevented their accumulation, except, possibly, offshore in the Carpentaria Basin.

Close to provenance both the Mesozoic and Cainozoic successions could contain placers. Gold has been mined from one at the base of the Mesozoic sandstone at Wenlock. Tin and uranium may yet be found elsewhere.

GEOPHYSICS (J. Pinchin)

A review and reinterpretation of geophysical surveys has provided new information on the Carpentaria, Olive River, and Laura Basins and areas which require further geophysical exploration have been indicated. The petroleum potential of the region is generally poor; however, the assessment of the Laura Basin has been upgraded.

Seismic results in the Carpentaria Basin indicate that the basement underlying Mesozoic sediments dips gently to a maximum depth of 1500 m in the centre of the Gulf of Carpentaria. They also show that the Cainozoic sediments thicken gradually to a maximum of 300 m at a point 120 km farther west. There are numerous small basement faults, which have a northerly trend, but no faults or folds within the sediments other than slight draping over basement structures.

"The Palaeozoic igneous and Proterozoic metamorphic rocks which form the basement in the east, and the Proterozoic McArthur Basin sediments which form the basement in the west all have seismic velocities of around 5500 to 6000 m/s; thus their relative extents below the Carpentaria Basin have not been determined from the seismic data."

A chain of positive Bouguer anomalies running from Cloncurry to Arnhem Bay may be caused by Lower Proterozoic basement highs which may form the northeastern limit of the McArthur Basin. On the other hand the smooth Bouguer anomaly contours over the Gulf of Carpentaria show a pattern which is more similar to that over the McArthur Basin than that over the eastern land area of the Carpentaria Basin, which may mean that the Middle Proterozoic sediments continue under the Mesozoic sediments across most of the Gulf. A northerly-trending gravity high which lies along the east coast of the Gulf south of Weipa may be caused by a subsurface ridge of metamorphic rocks which may lie at the eastern limit of the McArthur Basin sediments.

Interpretation of the magnetic results gives generally greater basement depths than those found by seismic surveying or drilling, though the shape of the magnetic and seismic basements in the Gulf are roughly similar.

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The Olive River Basin was first discovered by an aeromagnetic survey; it has no surface expression. Later seismic work confirmed the estimate of just over 900 m depth to basement made from the magnetic interpretation.

Seismic and drilling results in the Laura Basin place the probable Mesozoic basement at a maximum depth of about 1000 m. However, steeply dipping reflectors below this may indicate a 7000 m Permo-Carboniferous section here. Further seismic work in this basin is needed to support this interpretation.

Other areas where further seismic work is recommended are the boundaries of the Carpentaria Basin with the Money Shoal and Morehead Basins.

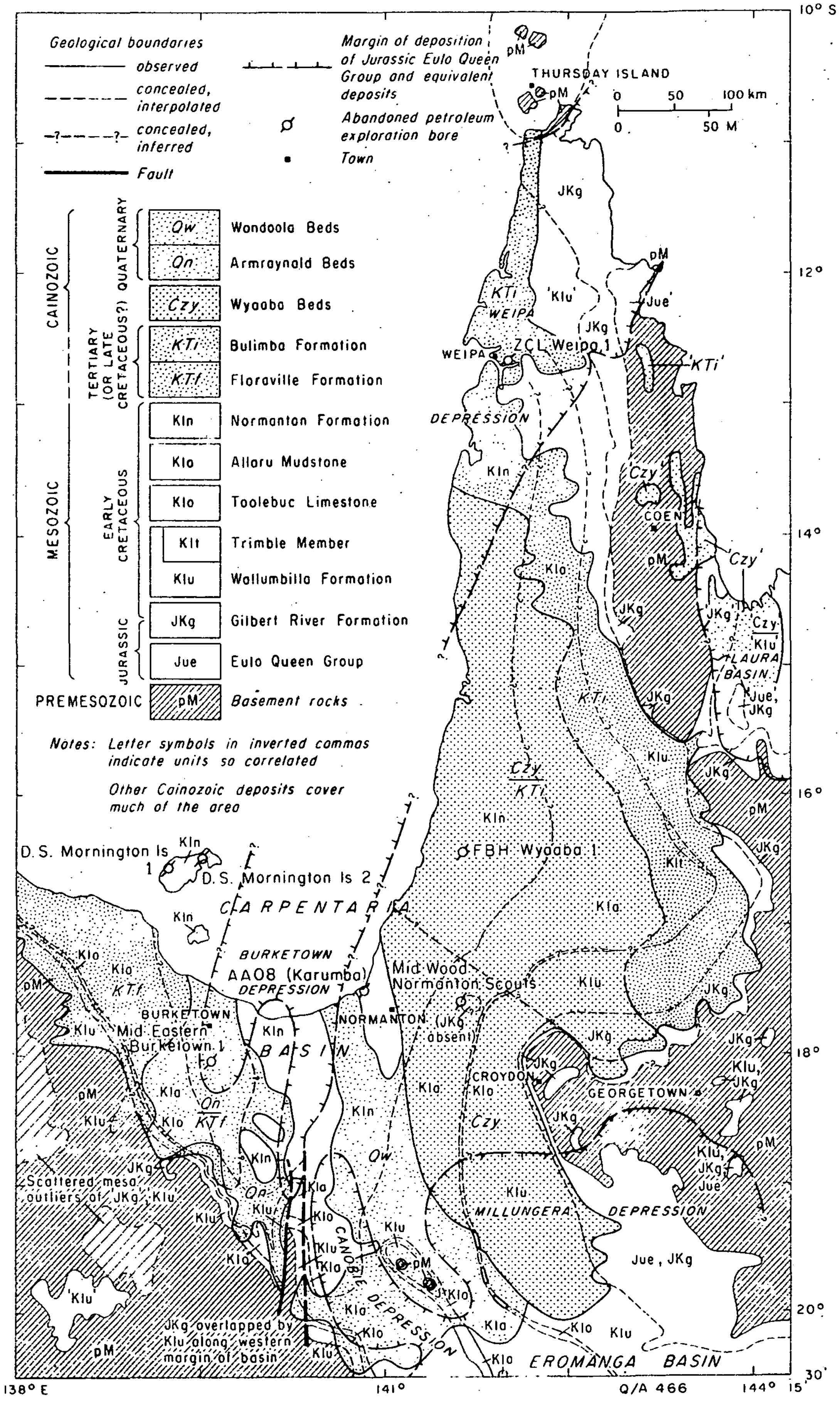

Figure 1 Geological map – Carpentaria Basin

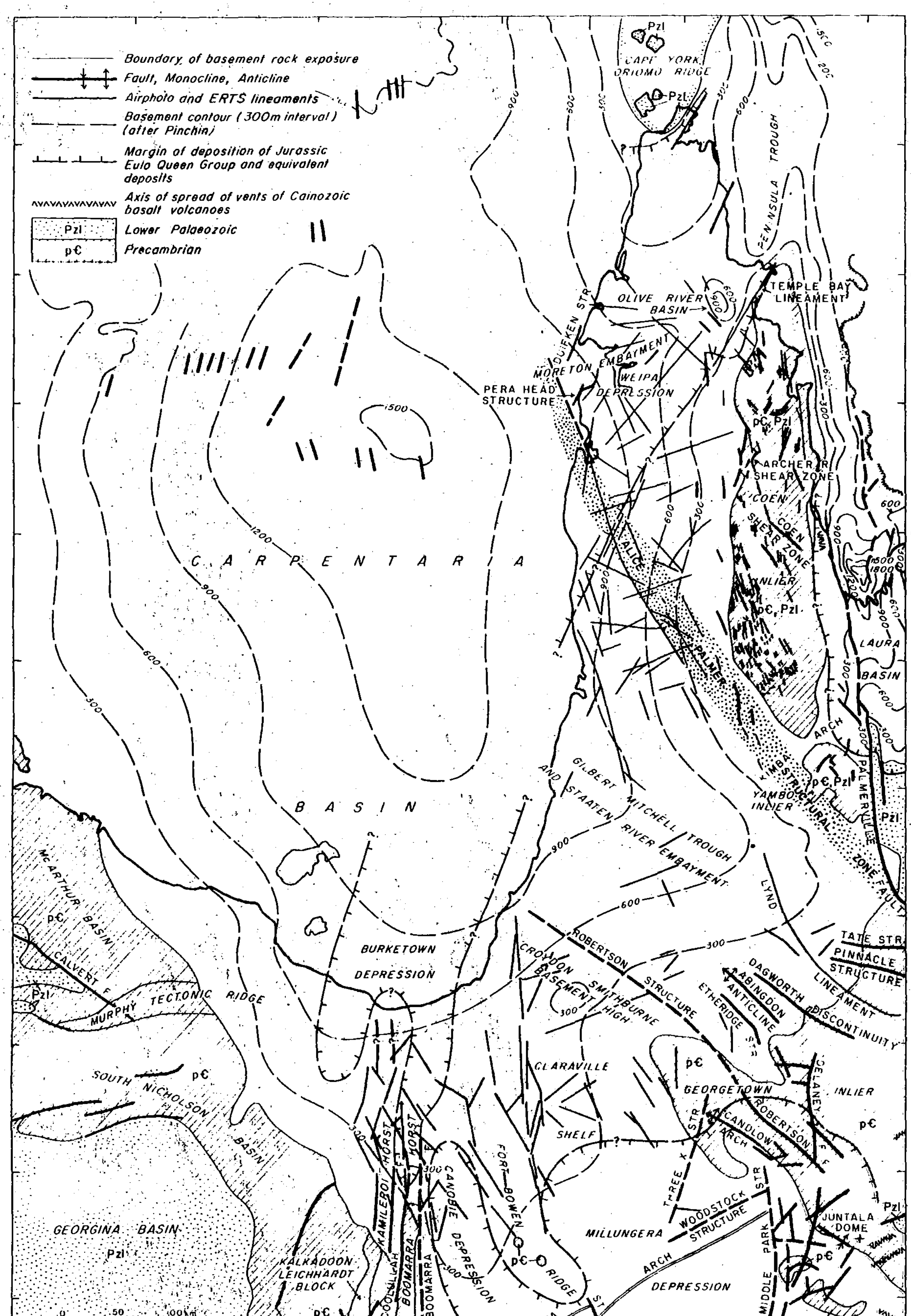

Figure 2 Structural elements - Carpentaria Basin.

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PRECIOUS OPAL IN QUEENSLAND

B.R. Senior

Precious opal deposits in Queensland are present within a chemically weathered profile developed in the Cretaceous Winton Formation. The quartz-deficient labile sandstones, siltstones, and mudstones of the Winton Formation were weathered in the Late Cretaceous down to depths of 130 m. The parent rock fabric was only slightly altered, although some thin carbonate lenses and concretions were replaced by dense iron-oxides. These 'ironstone' bodies commonly exhibit a mixture of concentric layering and septaria with numerous cracks and syneresis voids.

The redistribution of iron oxides, silica, and alumina in the profile led to volume changes, causing minor movements along joints, compaction faults, and cross-bedding interfaces. The opening of such structures gave secondary permeability in the weathered rocks.

The breakdown of feldspar into kaolin provided abundant amorphous silica, some of which became remobilized in Tertiary time, following partial truncation of the weathering profile. Erosion brough the basal third of the profile, which is rich in 'ironstone', closer to the groundsurface and within the zone of fluctuating groundwater. Common opal was precipitated extensively in such situations, toughening the weathered rocks. Precious opal was only precipitated under very special conditions, in situations controlled by the structure and bedding geometry of the host sediments. Ironstone concretions along the base of palaeochannels, on the downthrown side of differential compaction faults, or along basal undulations of bedding interfaces were favourably situated to contain the horizontal movement of silica-laden groundwater. Voids in 'ironstone' formed the prerequisite traps for precipitation of precious opal. Furthermore, these environments were protected from groundwater movement and desiccation, so that the colloidal silica could form a gel, which eventually hydrated and hardened into opal.

In these circumstances the hardening process was slow and uninterrupted and formed opal with a microstructure of regularly arranged and similar sized silica spheres: it is the size, shape, and arrangement of spheres that causes diffraction of light and interplay of flashing colour in precious opal.

The potential host rock extends over many hundred kilometres in southwestern Queensland. Prospecting is mainly carried out by a search of 'ironstone' lag gravel for traces of opal. Open-cut mining has largely replaced hand-dug shaft-sinking.

Outcropping weathered rocks are seldom sufficiently well exposed to recognize the geometric conditions which will lead to a precious opal discovery. Recognition of the partially exhumed weathering profile may aid in selecting suitable areas to prospect. In the open-cut mines examined it is the palaeochannel deposits which give the most bountiful precious opal accumulations. Once a channel is located it might be possible to trace its lateral extent by geophysical methods. Exploration targets for core-hole drilling would lie at low points along the channel.

THREE-DIMENSIONAL MISE-À-LA-MASSE SURVEY : EXPLORATION FOR EXTENSION OF MINERALIZATION BY DOWN-HOLE SURVEY

R. Ogilvy

In March 1973, BMR carried out a Mise-à-la Masse test survey in the Basin Creek area, near Tumut in N.S.W. The work was primarily of an experimental nature aimed at tracing the extent of massive chalcopyrite mineralization intersected by early drilling.

Although the application of the technique using surface potential measurements was restricted by the unfavourable terrain, by extending the measurements into three dimensions, it was possible to obtain valuable information on the extent and structure of the mineralized zones investigated. The method demonstrated that it was possible to isolate different mineralized zones and to correlate, between drillholes, different parts of the same conducting formation. In addition, it was shown that in areas of rugged relief, simple theoretical models can greatly assist the interpretation of surface potential maps.

The rugged terrain and experimental nature of the Mise-à-la Masse measurements did not permit more than qualitative source considerations to be attempted. Despite these limitations, quite definite results were obtained and further development and application of the method is recommended.

FEATURES OF THE AUSTRALIAN CONTINENTAL SLOPE

J.C. Branson

Tectonic structures on land and beneath oceans can be deduced from their topographic expressions. On land topographic forms are generally produced by erosion but in the marine environment tectonic structures are modified by sedimentation and only in a minor way formed by erosion.

Seismic sections and gravity and magnetic anomaly maps produced from the results of the Continental Margin Survey provided a broad picture of the topographic features and the underlying geological structures. The northern Australian region is a shelf sea and is not considered in this paper.

Slope features are broadly classified into major groupings designated by the terms: simple slopes, terraced slopes and marginal plateaus. The simple slope is equated with the classical continental margin consisting of a shelf break, a single slope to abyssal depths and a continental rise forming an apron of sediment at the foot of the slope. This simple slope form makes up only 40% of the margin, while seven marginal plateaus and five terraced slopes occupy the remainder of the eastern, southern, western, and northwestern margin.

Two forms of simple slope are recognized; one is a scarp feature along the rifted margins of the Tasman Sea and Southern Ocean, the other is a convex slope where the margin is overthrust by the Indonesian Archipelago.

Terraced slopes occur along partly subsided slope regions and are often associated with faulting in the margin. In the southern Coral Sea the Marion Terrace would probably be a marginal plateau like the Coreal Sea Plateau if the northern extension of the Dampier Ridge were not close to the continental margin. On the southern margin a basement rise dams back a region of prograded sediment in the Ceduna Terrace, and on the western margin the Wallaby and Scott Plateaus retain the collapsing inner slope to create the Carnarvon and Ashmore Terraces.

Marginal plateaus generally appear to represent foundered pieces of continent and their form depends on the rate of subsidence and on the time of opening of the adjacent ocean basin. The Coral Sea, Cascade, and Tasmania Ridge Plateaux were probably retained as continent until early Tertiary, whereas the Naturaliste, Wallaby, Exmouth and Scott Plateaus appear to have foundered since the late Jurassic.

Deposition on the slope is greatest in the saddle regions between the shelf and the marginal plateaus. The irregular shape of the continental rise appears to be related to water bottom topography and the effects of these features in modifying the water bottom current. The narrow continental shelf regions and abundant sediment supply can be correlated with continental rise accumulations, but often this material is laterally transported before it reaches the base of the slope.

RESULTS FROM THE CONTINENTAL MARGIN GEOPHYSICAL SURVEY

THE NATURALISTE PLATEAU, OFFSHORE WESTERN AUSTRALIA

P. Petkovic

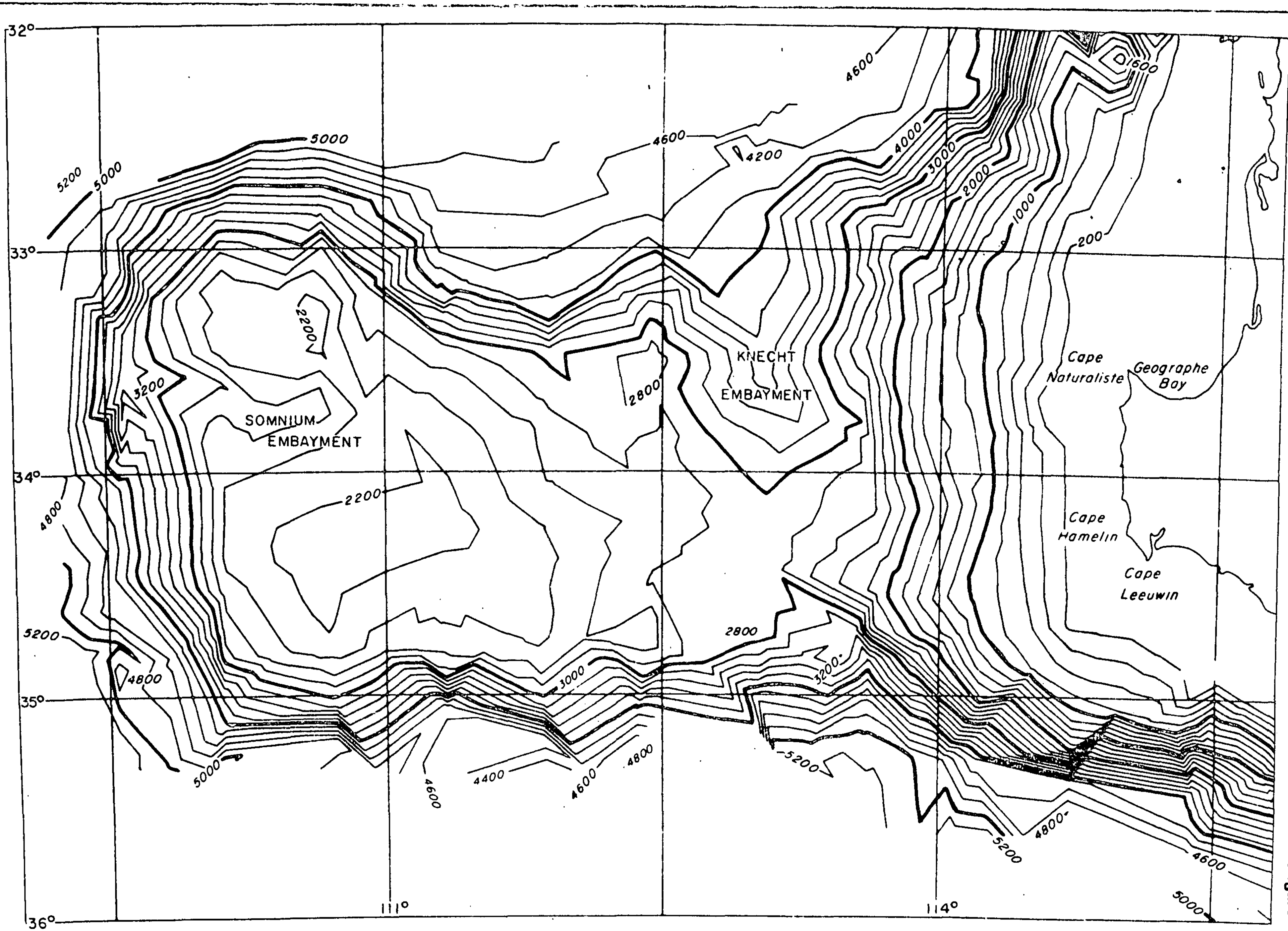
One of the largest of the marginal plateaus bordering the Australian continent is the Naturaliste Plateau. It is roughly rectangular, and most of its surface lies at a depth of about 2500 m, half way between that of the continental shelf and the abyssal plain. The Plateau has an area of 46 000 km^2 and extends 500 km west of the shelf break. Traverses totalling 4500 nautical miles were surveyed across the Plateau by BMR during December 1972, and these, together with the two holes drilled by JOIDES, have allowed the stratigraphy and structural history to be interpreted.

The Plateau surface is smooth and slopes gently to the east into a broad shallow saddle at about 2800 m depth which separates the triangular western half of the Plateau from the continent (see Figure 1). The southern and western margins are steep and straight and are probably fault-controlled.

The average sedimentary cover is less than 1 km thick but increases to more than 2 km on the eastern part of the Plateau close to the mainland. The seismic profiles reveal two major unconformities in the sequence overlying acoustic basement. The younger extends over the entire Plateau, whereas the older is restricted to the area of thick sedimentation to the east. The sediments are flat-lying and tectonically undisturbed everywhere except along the faulted southern and western margins. Results from the hole at Deep Sea Drilling Project site 258 on the Plateau indicate that the sediments above the younger unconformity are predominantly Cretaceous marine beds. Except for some evidence for subsidence in the east there is no indication that these beds have been disturbed by relative horizontal crustal motion between the Plateau and the Australian continent: it seems likely that the Naturaliste Plateau has not changed its position relative to Australia since the onset of sea-floor spreading between Australia and Antarctica in the Cretaceous.

Seismic and magnetic data suggest that the basement, which is shallower in the triangular western part of the Plateau than in the east, is composed of metamorphic rock.

It appears that the Naturaliste Plateau is a portion of continental Australia which has subsided since Cretaceous time.



BATHYMETRY

contour interval 200 metres

50 0 100 Kilometres

Figure 1

RESULTS FROM THE CONTINENTAL MARGIN GEOPHYSICAL SURVEY: THE EXMOUTH PLATEAU, OFFSHORE WESTERN AUSTRALIA

A. Hogan

The Exmouth Plateau lies 500 km west of Port Hedland and is the largest marginal plateau along Australia's western coastline. It is elongated northeast and covers an area of at least 281 000 km^2. The plateau can be divided along latitude 18° South into two distinct geophysical provinces.

The Southern Province: This part of the plateau has a central topographic high 840 m below sea level. It is deeper and more eroded in the west, giving an overall seaward slope. Topographic features generally strike northeast except for a west-northwest striking ridge which coincides with the southern structural boundary of the plateau. The slope associated with the southern margin is notably linear and steep.

The most prominent feature within the sediments of the southern province is a marked angular unconformity of very wide extent. Sediments below this are block-faulted and more folded than the upper strata. Comparison with geophysical and drilling results on the Northwest Shelf suggests that this unconformity may represent an hiatus in the Jurassic. Down-grading of seismic record quality in shallow water precludes any definitive correlation. Gravity trends along the margins of the plateau can be related to the unconformity surface. Broad gravity anomalies elongated northeast and north in the central plateau region are related to folding evident in the upper strata.

Seismic penetration through a sediment thickness of 3 km was attained on some seismic records; however, depths to magnetic basement of at least 9 km below sea level have been calculated over the central plateau region.

The Northern Province: The eastern half of this province consists of a number of horst blocks which form irregular plateaus with an average surface depth of 2000 m below sea level. They are separated from each other and from the southern province by water depths up to 3000 m.

The fault boundaries of the easternmost horst trend northeast, that is, parallel to both the shelf break and the strike of a large gravity low over the southern province. An angular unconformity occurs within the sediments in the northeastern region. The upper sediment layer is flat-lying, eroded, and not more than 1000 m thick. Below the unconformity the strata are broadly folded. There is no evidence of block-faulting similar to that observed in the deeper sediments of the southern province. Over the larger horsts seismic data indicate sediments to a depth of 3 km. Magnetic basement is shallower than in the south and has been displaced by the faulting.

The northwest part of the plateau is a topographic extension of the southern province, with relatively undisturbed sediments resting on a surface interpreted as metamorphic/igneous basement. A higher frequency magnetic pattern over this area is due to intrabasement changes not apparent on the seismic record.

PATTERNS OF MINERALIZATION IN NORTHERN AUSTRALIA, WITH EMPHASIS ON LEAD AND ZINC

K.A. Plumb

The Precambrian geology of the Kimberley to Mount Isa region has recently been synthesized, and the regional distribution of mineralization briefly commented on, by Plumb & Derrick (in press). This lecture will develop ideas on the patterns of mineralization in more depth.

Fundamentally, the region is underlaid by Lower Proterozoic basement rocks (e.g. Pine Creek Geosyncline), together with some Archaean inliers. After these were folded and metamorphosed post-tectonic (or transitional) granites and acid volcanics were emplaced during the late Lower Proterozoic and early Carpentarian. The rocks deposited in the various sedimentary basins which developed on this basement during the late Lower Proterozoic (e.g. Kimberley Basin), Carpentarian (e.g. McArthur Basin), Adelaidean (e.g. Victoria River, Arafura Basins), and Palaeozoic (e.g. Ord, Daly River, Georgina Basins) are only slightly deformed. Rocks equivalent to those of the McArthur Basin were intensely deformed and metamorphosed in the adjacent Mount Isa Orogenic Domain during the Carpentarian. Throughout its history the tectonic evolution of northern Australia has been controlled by a regionally uniform pattern of ancient lineaments, trending roughly northwest and north-northwest to north-northeast.

Mineralization

Copper: Small deposits occur in a variety of rock-types and at many stratigraphic levels, especially in the Northwest Queensland Province and the Kimberley region. Two environments are significant - basic igneous rocks and sedimentary associations (particularly near-shore facies in carbonate associations). Volcanics and granites are of lesser importance. Stratigraphic controls are of local significance. Economic deposits occur only in structurally suitable situations. Particularly favourable situations are structurally conditioned host rocks of favourable lithology (e.g. black shale, dolomite) adjacent to basic igneous rocks; Mount Isa may be an example of this type, although some authors favour syngenesis.

Iron: Iron deposits are of several ages: only the Roper River and Constance Range deposits show a regional stratigraphic control. All deposits are found in shallow-water, commonly near-shore facies, except Frances Creek which was formed by supergene enrichment of iron-rich sediments.

Lead - Zinc: The lead-zinc mineralization is an outstanding example of stratigraphic distribution; all the major deposits, such as Mount Isa, Hilton, H.Y.C., Lady Loretta, and numerous minor deposits, occur in the carbonate-rich Carpentarian McArthur Group and its equivalents throughout the McArthur Basin and the Northwest Queensland Province. The major deposits all show remarkable analogies. They occur about the middle of the McArthur or Mount Isa Group sequences. The ores are finely laminated and the host rocks are laminated carbonaceous, pyritic, dolomitic shales containing abundant tuffaceous material. They were deposited in restricted depressions within linear troughs flanked by shallow shelves on which sections are incomplete and equivalents of the ore-beds are missing. The orebodies are adjacent to major faults, at least some of which were active during sedimentation. Evaporites occur lower in the sequences. Analogies can be drawn with modern Red Sea brines.

Minor deposits (e.g. Woodcutters) are also found in carbonate rocks of other ages.

Uranium: The main exploration target is the Lower Proterozoic Pine Creek Geosyncline. The principal feature which the major deposits (e.g. Ranger, Nabarlek, El Sherana, Rum Jungle) have in common is their stratigraphic control; they all occur in carbonaceous shale or chlorite schist of the stratigraphically equivalent Koolpin and Golden Dyke Formations. They are situated adjacent to basement ridges and localized into structures such as folds, fractures, crush zones, or shears. Proximity to the margins of large migmatite complexes may have contributed to formation of the major deposits of the Alligator Rivers area.

The Carpentarian Mary Kathleen deposit shows some analogy to the Alligator Rivers deposits; it is situated above a basement ridge, and is adjacent to the Burstall Granite. Small amounts of ore and numerous radiometric anomalies have been found in several other Lower Proterozoic and Carpentarian sedimentary and volcanic rocks.

Gold: Primary deposits are generally quartz reefs in favourable structural situations; associated sulphides are common. All are found in orogenic domains, and most show local stratigraphic control although the ultimate source of the gold is obscure.

Tin - Wolfram: These deposits are all associated with post-tectonic granites of the transitional domains.

REFERENCE

PLUMB, K.A., & DERRICK, G.M., in press - Geology of the Proterozoic rocks of northern Australia, in ECONOMIC GEOLOGY OF AUSTRALIA AND PAPUA NEW GUINEA (Ed. C.L. Knight). Aust. Inst. Min. Met., Melb.

RECENT GEOLOGICAL WORK IN THE RUM JUNGLE-ALLIGATOR RIVERS URANIUM PROVINCE, N.T.

R.S. Needham

INTRODUCTION

Semi-detailed mapping in the Rum Jungle and Alligator Rivers areas has been in progress since 1971. In the Alligator Rivers area outcrop is extremely sparse (except of the Kombolgie Formation) and usually deeply weathered; field relationships between units are generally not apparent. Results from a concurrent program of isotopic dating have enabled a tentative geological history to be built up.

The various modes of ore genesis proposed for the uranium deposits of the Alligator Rivers area have been tested by the mapping program, and a syngenetic origin (with subsequent relocation and concentration) is favoured.

In the Alligator Rivers area the 'Koolpin equivalent' has been correlated with the Koolpin Formation in the South Alligator River valley and the Golden Dyke Formation in the Rum Jungle area. These rock units, which are commonly carbonaceous and calcareous, are closely associated with all uranium mineralization in the Pine Creek Geosyncline. The suggested correlations are to be checked by drilling in the vicinity of the Mount Partridge Range in 1974, and by further semi-detailed mapping starting in 1975 between the areas mapped in the Rum Jungle and Alligator Rivers areas.

GEOLOGICAL HISTORY

Stages in the geological evolution of the Alligator Rivers area are shown diagrammatically in Figure 1, and brief lithological descriptions of units are given in Table 1.

An Archaean basement high (the 'Nanambu High') situated between the South and East Alligator Rivers was flanked and progressively covered by Lower Proterozoic sediments, first the Goodparla (Masson and Mount Partridge Formations), and after these were folded, by the South Alligator Group (Koolpin Formation and equivalents, and Fisher Creek Siltstone). Differentiated dolerite of the Zamu Complex was then intruded as numerous sills, mostly in the South Alligator Group. About 1800 m.y. ago the thick pile of sediment accumulated in the northeast of the area was extensively migmatized to form the Nimbuwah Complex. During this process strata, probably including Archaean basement material, were uplifted and overthrust. Rocks were metamorphosed as far southwest as Jim Jim Creek. At the same time the Nanambu High was reactivated and partly migmatized, along with the flanking Lower Proterozoic sediments, to form the Nanambu Complex.

The Oenpelli Dolerite was intruded as a series of ellipsoidal basin-shaped bodies, or lopoliths, at approximately the same level in the rock pile. Hybridization of the dolerite and country rock in the centre of the Nimbuwah Complex suggests that the dolerite was emplaced while the core of the complex was still hot. Melts formed in the root-zone of the Nimbuwah Complex became mobilized, and were intruded as anatectic granites at various levels within and outside the migmatite complexes. The Edith River Volcanics are about the same age, and are possibly comagmatic with the granites.

During the long period of erosion that followed, the area was levelled except for isolated ridges and hills of Oenpelli Dolerite and Mount Partridge Formation. These hills and ridges outlined wide shallow basins during the deposition of the Kombolgie Formation, and the formation was subsequently preferentially eroded along them, where the Kombolgie Formation was thinner.

The Kombolgie Formation was eroded to its present-day outline, mostly before Mesozoic time, predominantly by scarp retreat. Mesozoic terrestrial and littoral sediments covered all the Alligator Rivers area, but have subsequently been almost entirely removed, their breakdown products, along with colluvial material derived from the Kombolgie Formation, contributing to the extensive accumulation of Cainozoic sand over all low-lying areas. Extensive cappings of laterite developed over the low-lying areas mostly before deposition of Cainozoic sand. A Quaternary submergence resulted in extensive deposition of silt and clay in the major estuaries. A recent minor emergence is marked by incised channels in flood-plain deposits and incision of most creek courses.

ORIGIN OF URANIUM DEPOSITS

All the uranium occurrences of the Pine Creek Geosyncline lie within or adjacent to Koolpin Formation (South Alligator River valley occurrences), 'Koolpin equivalent' (Alligator Rivers area occurrences) or Golden Dyke Formation (Rum Jungle occurrences). These three rock units are time and facies equivalents, and were probably deposited in separate sub-basins developed by folding after deposition of the Masson and Mount Partridge Formations. They are all partly carbonaceous and calcareous and were deposited in similar environments. Semi-detailed mapping at Rum Jungle has shown that the carbonaceous sediments of the Golden Dyke Formation were deposited in basins within or at the edge of the Batchelor Shelf. It is most likely that the pattern of sedimentation was the same in the Alligator River and South Alligator River valley areas.

The 'Koolpin equivalent' is more heterogeneous and thicker than the Koolpin Formation, and has been metamorphosed to varying degrees (lower greenschist near the Mount Partridge Range to lower amphibolite where it has been incorporated into the Nanambu Complex). Results of further work, especially drilling, will probably warrant a formational status distinct from Koolpin Formation.

STRATIGRAPHIC TABLE OF PROTEROZOIC ROCK UNITS

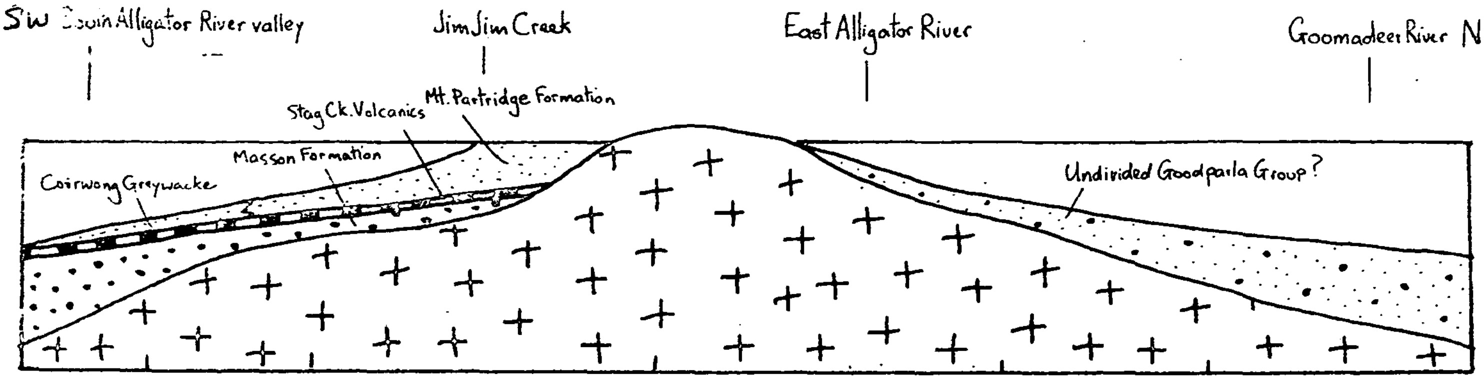
ALLIGATOR RIVERS AREA N.T.

Age	Group	ROCK UNIT.	m. THICKNESS	LITHOLOGY	REMARKS
ADELAIDEAN ?		* MUDGINBERRI & * MANINGKORRIRR PHONOLITES.	<1·5	Phonolites and trachytic differentiates.	Randomly oriented dyke swarms.
CARPENTARIAN		KOMBOLGIE FM.	500	Mod. to poorly sorted coarse quartz sandstone, clayey sandstone, conglomerate, thin siltstone bands.	Forms Arnhem Land Escarpment. Marked regional unconformity at base.
		NUNGBALGARRI VOLCANIC MEMBER.	<60	One or several basalt flows, amygdaloidal, minor interbedded sediments.	Nungbalgarri Volcanic Member divides the formation into lower and upper sandstone units
		* GILRUTH VOLCANIC MEMBER.	< 3	Amygdaloidal basalt, tuff, tuffaceous siltstone, jasper.	
		EDITH RIVER VOLCANICS	<1200	Rhyolite, dacite, tuff.	Valley infill deposits.
LOWER PROTEROZOIC		*NABARLEK & *TIN CAMP GRANITES.		Altered medium to coarse grained biotite granite, commonly cut by north trending quartz breccia zones.	Anatectic granites. Anomalously radioactive < X10 background.
		*OENPELLI DOLERITE	<300	Differentiated dolerite sill; ophitic, porphyritic, granophyric phases; minor ophitic gabbro, gabbro pegmatite, and chilled margin.	Forms a series of ellipsoidal lopoliths? Total extent > 50,000 sq km.
		NIMBUWAH COMPLEX		Granitoid and gneissic migmatite of granitic to granodioritic composition; lit-par-lit gneiss, amphibolite, minor schist and quartzite.	Predominantly migmatized Lower Proterozoic sediments.
		NANAMBU COMPLEX		Leucocratic granite and gneiss with minor schist, mantled by biotite, muscovite, and chlorite quartz schist and gneiss, and quartzite.	Large core of partially migmatized Archaean crystalline rock surrounded by migmatized Lower Proterozoic sediments, predominantly Koolpin equivalent.
		ZAMU COMPLEX		Dolerite and gabbro with diorite and syenite differentiates. Metamorphosed to metadolerite and amphibolite north of Graveside Gorge.	Numerous sills, folded to give appearance of NW trending dyke swarm.
	SOUTH ALLIGATOR GROUP	FISHER CREEK SILTSTONE	>7000	Siltstone, minor arenaceous siltstone. Metamorphosed to phyllite north of Graveside Gorge, and schist north of Jim Jim Creek.	Transitionally overlies Koolpin Formation and Koolpin equivalent. Eastern extent not known.
		*KOOLPIN EQUIVALENT	<6000	Quartz mica schist, chlorite schist, carbonaceous schist, amphibolite; lenses and bands of quartzite and carbonate rock.	Uranium mineralization assoc. with this unit. Lateral equivalent of Koolpin Formation.
		KOOLPIN FORMATION	1500	Chert-banded pyritic carbonaceous siltstone, lenses of algal carbonate rock.	Uranium mineralization assoc. with this unit. Unconformably overlies Goodparla Group. Lateral equivalent of Golden Dyke formation.
	GOODPARLA GROUP	COIRWONG GREYWACKE	300	Sandstone, quartz greywacke, conglomerate.	Lateral equivalent of Mount Partridge Fm.
		MT. PARTRIDGE FM.	6000	Coarse quartz sandstone, clayey sandstone, siltstone, arkose, conglomerate; ripple marked and cross-bedded in places.	Wedge-shaped deposit, thins westwards and is continuous with Coirwong Greywacke
		STAG CREEK VOLCS.	<300	Altered basalt and agglomerate.	Interbedded with top of Masson Formation.
		MASSON FORMATION	>3000	Quartz greywacke, siltstone, minor conglomerate, sandstone, carbonaceous siltstone and carbonate rock.	Oldest known unit in Pine Creek Geosyncline.

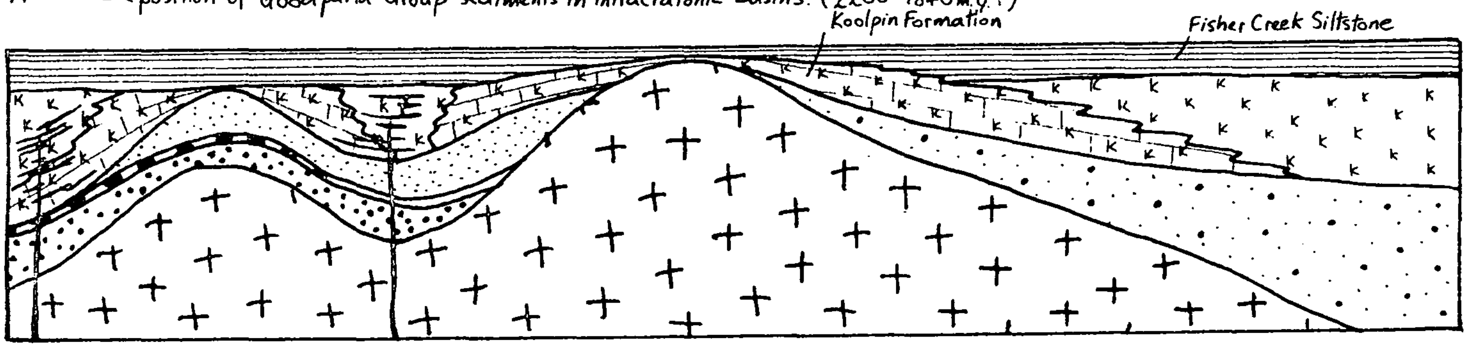
* Informal name

Table 1

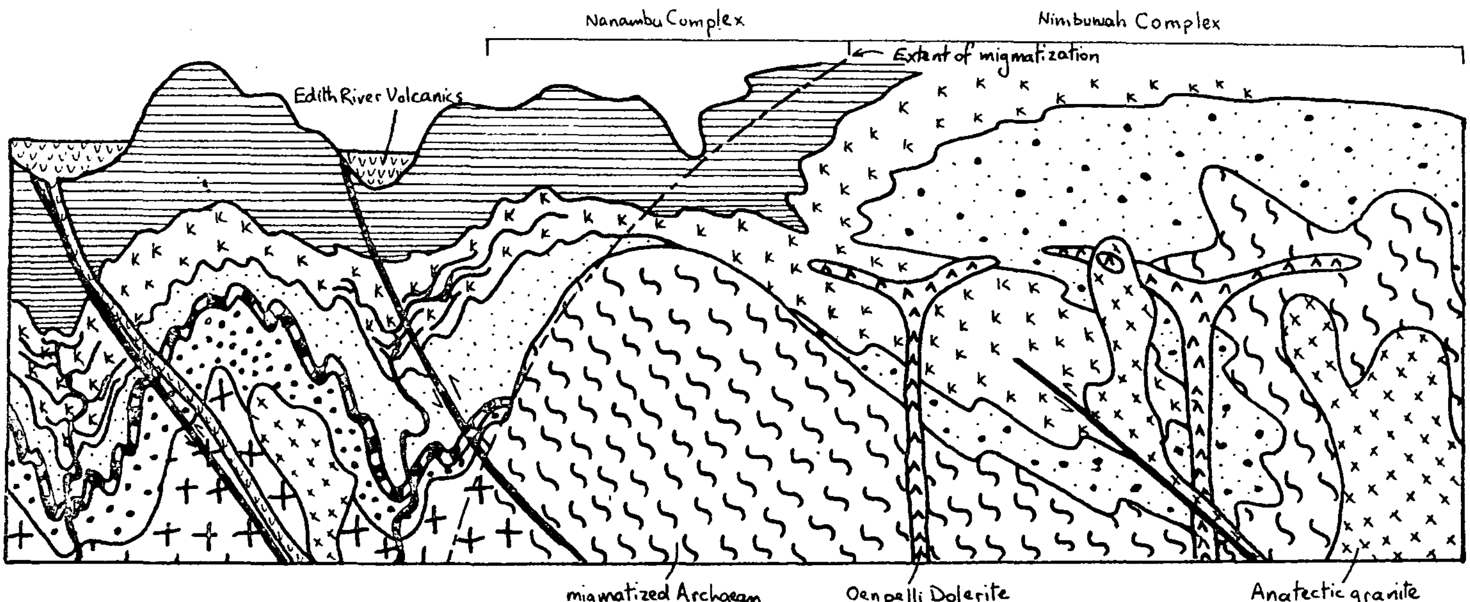
GEOLOGICAL HISTORY OF THE ALLIGATOR RIVERS AREA N.T.



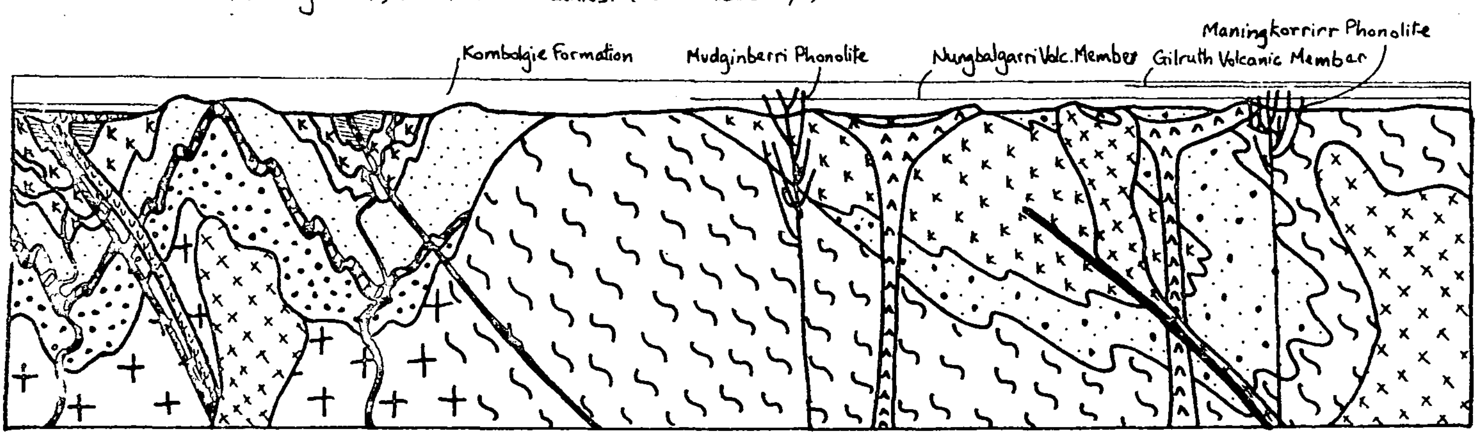
A Deposition of Goodparla Group sediments in intracratonic basins. (2200-1840 m.y.?)



B Open folding in southwest; deposition of South Alligator Group sediments. Intrusion of Zamu Complex dolerites as sills. (2200-1840 m.y.?)



C Formation of Nimbuwah Complex by extensive migmatization; reactivation of Archaean basement to form Nanambu Complex mantled gneiss dome; associated overthrusting, folding and regional metamorphism. Intrusion of Oenpelli Dolerite. Formation and mobilization of anatectic granites and extrusion of (comagmatic?) Edith River Volcanics. (1840-1600 m.y.?)



D Period of erosion. Deposition of Kombolgie Formation plateau sandstone and extrusion of basaltic volcanic members. Intrusion of phonolites. (1600-1320 m.y.?) 19

Figure 1

IMPLICATIONS OF NEW GEOCHRONOLOGICAL DATA IN THE ALLIGATOR RIVERS AREA, NORTHERN TERRITORY

R.W. Page

The ages of several Precambrian rock suites in the Alligator River area have been measured on total rocks and minerals by both the Rb-Sr and K-Ar dating techniques. The resultant geochronological framework yields a clearer understanding of the Precambrian history of this area.

Leucocratic granite gneisses of the Nanambu Complex have an age of approximately 2500 m.y., and represent the oldest known parts of the basement complexes. This Archaean age for the Nanambu Complex suggests a link between the basement of this area and the basement complex at Rum Jungle (also 2500 m.y. old). Some parts of the Nanambu Complex have been remobilized and converted to migmatites and highly foliated micaceous gneisses; at least two such events, at 2000 m.y. and 1800 m.y., are recognized.

The migmatites and granite gneisses of the Nimbuwah Complex were also formed in the Lower Proterozoic, but on present knowledge show no sign of an Archaean pre-history, and may thus be quite different from the rocks of the Nanambu Complex. The Rb-Sr and K-Ar mineral ages determined on all of these rock units invariably reflect an event at 1840-1800 m.y. This is interpreted as the main regional metamorphism affecting the basement complexes and overlying Goodparla and South Alligator River Groups. The combined data allow us to place firm age limits on the time of deposition of the Goodparla and South Alligator Groups of between 2200 and 1840 m.y.

A number of basic intrusive bodies have their primary igneous mineralogy preserved, and were emplaced subsequent to the 1800 m.y. regional metamorphic episode. One of these masses, the Oenpelli Dolerite, yields a well-fitted total rock Rb-Sr isochron of 1718 ± 65 m.y. This age is consistent with the field evidence and the previously mentioned results, and probably registers the time of differentiation and cooling of the dolerite. Phonolitic dykes which intrude the regionally metamorphosed rock units, give an unrealistic spread of K-Ar ages between 2100 and 600 m.y. The Rb-Sr data on the phonolites are more readily interpretable, and yield an age of emplacement of around 1350 m.y. Further minor dolerite bodies intruding the Kombolgie Formation sandstone have been dated at about 1200 m.y. We can thus infer that deposition of the Kombolgie Formation took place between 1720 m.y. and 1200 m.y. ago.

The chronology of recognizable geological events recorded by the Rb-Sr and K-Ar isotopic clocks shows little correlation with the generally younger U-Pb ages on pitchblende, determined by Cooper (1973) and Hills and Richards (1972). Although the uranium mineralization is considered to have originally developed in the Lower Proterozoic, we can infer from the comparisons given above that the final remobilization of uranium took place at temperatures below the threshold of retention of radiogenic argon and strontium, i.e. below 200°C.

ASPECTS OF REGIONAL GEOLOGY AND GEOPHYSICS IN THE MOUNT ISA - CLONCURRY AREA

D. Tucker and R. Hill

The BMR in co-operation with the Geological Survey of Queensland is continuing an integrated program of detailed geological mapping, geophysics, age determination, and geochemistry in the Precambrian belt of northwestern Queensland. During 1973 the Prospector and Quamby 1:100 000 Sheet areas were mapped and an aeromagnetic and radiometric survey was flown over the whole of the Cloncurry 1:250 000 Sheet area.

New data obtained from the 1973 mapping have confirmed conclusions based on previous detailed mapping to the south. However, the Myally Beds and Surprise Creek Beds, which are poorly represented to the south, greatly thicken to the north in the Prospector Sheet area and increasingly onlap the Kalkadoon-Leichhardt Basement block to the east. The geological history of the area will be reviewed taking these factors into account.

The aeromagnetic survey of Cloncurry showed that the outcropping Precambrian rocks commonly have strong magnetic response, typical of Precambrian metamorphic belts. Anomalies of amplitude 500-2000 gammas due to linear sources dominate the magnetic pattern. These anomalies are typical of those produced by steeply dipping tabular bodies and appear to be caused by metavolcanics and magnetic beds parallel to the sedimentary layering, cross-cutting basic dykes, and possibly magnetic material in faults. It is believed that the main magnetic mineral is magnetite.

There appears to be a relationship between the amplitude of magnetic anomalies and the metamorphic grade of the Precambrian rocks. The amplitudes of anomalies over the Corella Formation are generally high close to the contact with younger granites; they form haloes around the granites. There is support for a suggested anatectic origin of the Naraku Granite. South of Naraku, magnetic anomalies over the granite have similar trend directions to the enclosing Corella Formation.

The pattern of magnetic anomalies over the plain of Cainozoic sediments in the east of Cloncurry is similar to that over the adjacent Precambrian outcrop. It is likely that much of this area is underlain by steeply dipping Precambrian rocks, possibly Corella Formation, at a depth of 100-500 m.

The radiometric data recorded over Precambrian outcrop revealed large anomalies associated with granites, the Corella Formation, Marimo Slate, Argylla Formation, and Leichhardt Metamorphics. Anomalies were detected over various known uranium occurrences. The radiometric anomalies have been classified to indicate principal source elements (K, U & Th). Most sources fall in the high potassium classification, good examples being the Argylla Formation and Leichhardt Metamorphics. Broadly speaking, the Corella Formation falls into the high potassium classification; however, potassium response decreases and thorium response increases progressively northwards. High uranium/thorium ratios are associated with anomalies over the Marimo Slate, in addition to a high potassium response.

Uranium anomalies were recorded over the Lower Cretaceous Toolebuc Limestone, a known radiometric marker in the Great Artesian Basin as recorded by logging.

SEVENTEEN YEARS GEOLOGICAL EXPLORATION OF PAPUA NEW GUINEA - A CONSTRAINT ON TECTONIC MODELLING

D.B. Dow

Since the Mesozoic, Papua New Guinea has been a buffer zone between the northward-drifting Australian continent and fragments of oceanic crust that acted as rigid plates to the north and east. The result has been an intensely folded and faulted geologically complex zone, called the New Guinea Mobile Belt, which forms the spine of mainland Papua New Guinea. Thus the geology, from south to north, falls into three broad divisions: the Australian Platform, the New Guinea Mobile Belt, and the Melanesian Oceanic Province (Fig. 1).

AUSTRALIAN PLATFORM

The Australian Platform was the site of almost continuous shallow marine or lacustrine sedimentation from early Jurassic to Holocene. The sedimentary environment was stable for long periods, and as a consequence the sediments are uniform over large areas: the Mesozoic sequence consists mainly of shale and siltstone with prominent interbeds of quartz sandstone, and the Tertiary rocks are notable for shelf limestone up to 3000 m thick which extends over most of the Platform. The sediment was derived almost entirely from the Australian continent, which was low-lying for most of the time.

The sediments over all the Platform except the peripheral 50 km, having been protected by the underlying competent continental block, are almost completely undeformed. Minor faults have been detected by oil exploration surveys, but the sediments have essentially the same attitude as when they were laid down.

NEW GUINEA MOBILE BELT

The New Guinea Mobile Belt is defined as the tectonically unstable zone between the Australian continental block to the southwest and the oceanic crustal plates of the Melanesian Oceanic Province to the north and northeast.

The geology of the New Guinea Mobile Belt offers a complete contrast to that of the Australian Platform, and three main features stand out. Firstly, throughout its history the Mobile Belt has been an unsettled sedimentary environment, and was the repository of a great variety of sediments several times as thick as those of the Platform; most of the sediments were deposited in geosynclines, and the great majority are composed of volcanic detritus.

The prevalence of igneous activity provides the second main contrast with the Australian Platform. Major volcanic units occur throughout the stratigraphic column and most are associated with acid to basic plutonic rocks.

The third and most obvious difference between the two geological provinces is the intense deformation of the rocks in the Mobile Belt. Faulting over most of the Belt is extraordinarily intense - so much so that the whole Belt could be described as a fault zone. In some areas folding is dominant, particularly on the periphery of the Belt, where the rocks have been metamorphosed.

MELANESIAN OCEANIC PROVINCE

The rocks of the Melanesian Oceanic Province are quite different from those of the Australian Platform or the New Guinea Mobile Belt, and consist entirely of the products of oceanic and island arc volcanism. They comprise lavas extruded on the deep ocean floor, and island arc submarine lavas and agglomerates, tuffs, volcanolithic sediments, and some reef limestones.

PLIOCENE METALLOGENIC EPOCH

The beginning of the Pliocene saw a great upsurge of volcanic and intrusive activity throughout the three provinces, which continues to the present day. By far the greatest proportion of metals mined in Papua New Guinea, both from primary lodes and alluvial deposits, was introduced by this igneous activity.

All the primary gold mined, with the possible exception of the lodes on Woodlark Island, owes its origin to these young intrusives. The principal deposits of alluvial gold, which constitute most of the mineral wealth so far won in Papua New Guinea, also derive from this epoch.

The reason for this concentration of metallic mineralization is not known, but part of the answer probably lies in the fact that in such a tectonically active region the upper, more mineralized, parts of younger intrusions are much more likely to be preserved.

PLATE TECTONICS

Despite its long history of interaction between crustal plates, there is little evidence that large crustal shortening has taken place along the New Guinea Mobile Belt.

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Blueschist metamorphics of probable early Oligocene age are associated with ultramafic rocks in a complexly deformed zone south of the Sepik River, and could possibly mark the site of a north-dipping subduction zone which was active in the Late Cretaceous and Eocene. Palaeogeographic reconstruction of Eocene sedimentation and volcanism shows that such a subduction zone could have extended southeastwards to the Owen Stanley Metamorphics, where blueschist rocks are also known.

Island arc volcanics which could be the products of such a subduction zone are preserved only north of the Sepik River - to the southeast their absence could be explained by overthrusting and erosion.

Since the early Oligocene the rocks of the Mobile Belt have adjusted to stress by large-scale faulting which appears to have been dominantly transcurrent, a tectonic regime which continues to the present day. Any significant crustal shortening since the early Oligocene must have taken place to the north and northeast, beyond the Mobile Belt.

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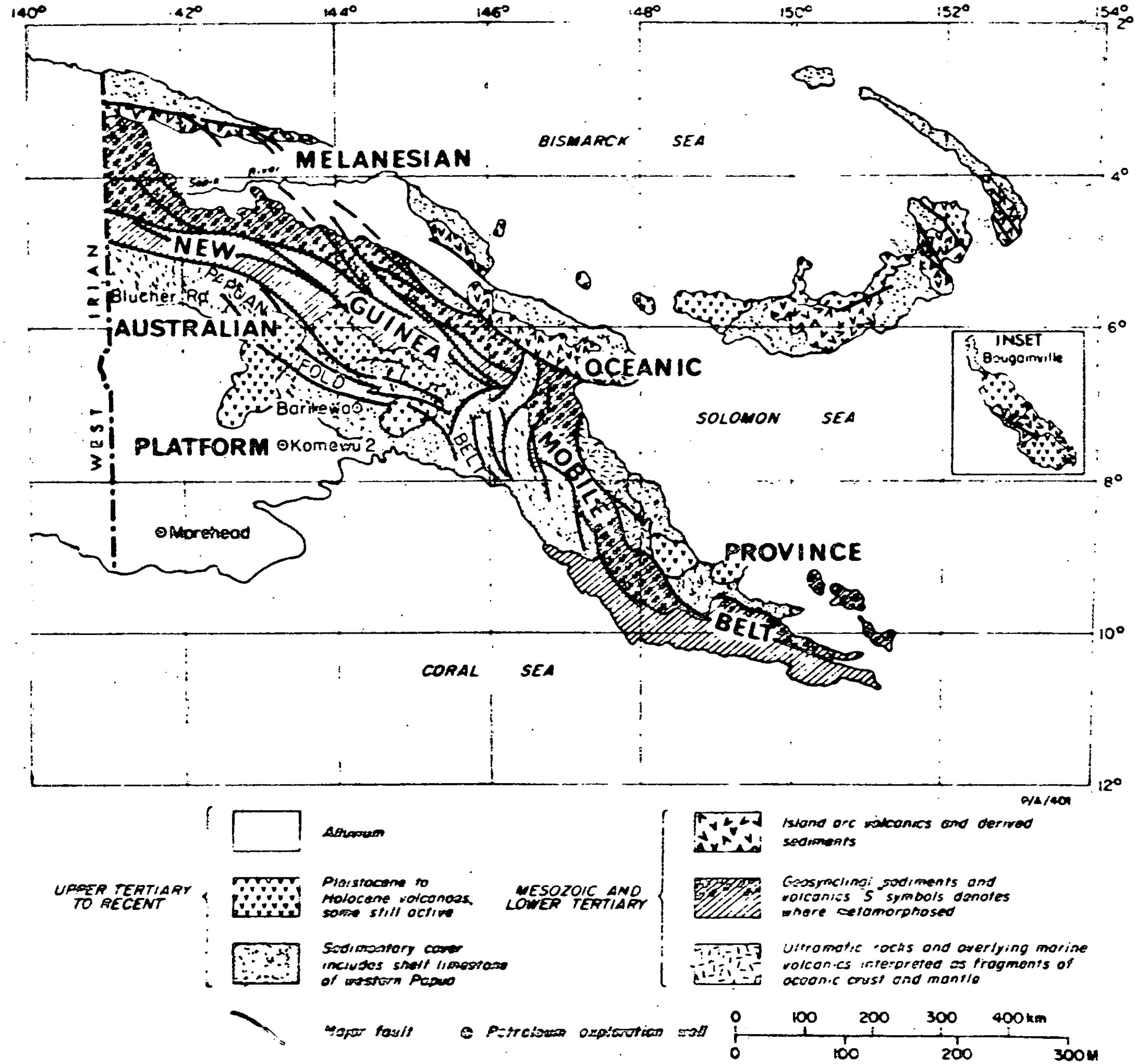


FIG 1 GEOLOGICAL PROVINCES OF PAPUA NEW GUINEA

VOLCANIC AND TECTONIC HISTORY OF THE NORTH SEPIK REGION, PAPUA NEW GUINEA

D.S. Hutchison

The North Sepik Region covers the northwestern extremity of Papua New Guinea between the Sepik River and the north coast. It consists of a narrow east-west trending mountain chain (Bewani, Torricelli, and Prince Alexander mountains) composed of Cretaceous and Lower Tertiary basement rocks, flanked by unconformably overlying Neogene sediments which form areas of low relief (Fig. 1).

GEOLOGY

The Bewani and Torricelli mountains form the North Sepik Volcanic Arc, and comprise island-arc volcanics and associated comagmatic intrusives ranging in age from Late Cretaceous to earliest Miocene. The volcanics consist of lavas and pyroclastics of basaltic and andesitic compositions, volcanically derived sediments, and limestone. Pillow basalts are abundant throughout the sequence. The intrusives are mostly fine to medium-grained gabbro and diorite.

Both the volcanics and the intrusives are typically highly sheared and faulted, and relationships are generally obscured, but shallow-water bioclastic limestone lenses are common throughout the volcanic sequence, and larger foraminifera have provided good age control. Thus the volcanics appear to fall into two groups: an older one of Late Cretaceous to Eocene age, and a younger one of late Oligocene to earliest Miocene age. No early or middle Oligocene fossils have been identified, and an hiatus is assumed between the two volcanic episodes. K-Ar dating of the intrusive rocks confirms this apparent age grouping.

Volcanism in the North Sepik Arc ceased completely in the earliest Miocene, and, apart from those in the Quaternary Bismarck Volcanic Arc, offshore to the north, no younger volcanics occur in the region.

In the east, the Prince Alexander Mountains are the topographic expression of a large, complex fault zone, containing crushed intrusives, high-grade metamorphics of early Cretaceous age, and ultrabasic to acid intrusives of early Miocene age.

The central basement ridges of the Bewani, Torricelli, and Prince Alexander Mountains form part of the province boundary between the New Guinea Mobile Belt to the south and the oceanic province to the north.

South of the mountains metamorphic rocks crop out as scattered inliers over a wide area. These are mostly of low to medium grade (locally of higher grade) and have a general east-southeast foliation, reflecting the regional structural trend. Most are pelitic, and they probably represent metamorphosed fine-grained marine sediments with minor limestone and volcanic intercalations. Near Amanab, limestone lenses in the metamorphics have yielded Cretaceous and Eocene fossils.

In the southwest boulders of diorite and granodiorite have been dated by K-Ar methods as Middle Permian. We interpret these rocks as being a fault-rafted fragment of Australian continental crust.

STRUCTURE

Both the basement and the Neogene cover rocks in the mountains have been intensely faulted. The faults are invariably nearly vertical; subhorizontal slickensides show that they were probably predominantly transcurrent. Apparent offsetting of intrusive bodies suggests left lateral movement. A considerable compressive component to the faulting is indicated by tight folding and overturning along the north side of the Bewani and Torricelli Mountains.

Since the beginning of the Miocene the region has been subjected to rapid uplift, and the region is still seismically active today.

ECONOMIC GEOLOGY

Alluvial gold is the only mineral of economic interest known in the region. It occurs in the Border Mountains around Amanab, and in the Prince Alexander Mountains north of Maprik. At Amanab the gold is probably derived from quartz veins associated with intrusions invading the metamorphics. Around Maprik the gold is derived from the basal conglomerate overlying the basement rocks, although rocks in the Prince Alexander Mountains are undoubtedly the ultimate source. Alluvial platinum associated with gold occurs at Kilifas in the Bewani Mountains, and here the immediate source is a Pliocene conglomerate. Minor lateritic nickel occurrences have been reported from the Oenake Mountains, and larger occurrences are known from adjacent parts of Irian Jaya. However, the absence of any large ultramafic bodies east of the border considerably downgrades the nickel potential of this area.

The North Sepik Arc is considered to be a good environment for porphyry-type copper deposits, but no extensive hydrothermal alteration or mineralization was found during the survey.

vx

TECTONIC INTERPRETATION

The island-arc nature of the North Sepik volcanics implies that the source magma was derived by melting of a down-going crustal slab in a subduction zone. If so, the two distinct volcanic episodes suggest that the North Sepik arc is a remnant of an arc-trench system that was active during the Late Cretaceous-Eocene period, and again during the late Oligocene and early Miocene. It is suggested that the arc developed in the Late Cretaceous by subduction due to interaction of the northward-moving Australian continental plate and the westward-moving Pacific oceanic plate. The initial phase of volcanism ceased in the late Eocene. During the late Cretaceous to Eocene the region between the arc and the Australian continent was possibly a marginal sea receiving sediment from both southern and northern sources. These sediments were metamorphosed at some time in the early Oligocene, and form the metamorphics cropping out in the North Sepik region. This metamorphic event may have been related to stabilization of the subduction zone in the late Eocene.

The early and middle Oligocene was a period of non-deposition, and no volcanism is recorded in the region.

Volcanism began again in the late Oligocene, and once more was probably related to subduction. This second volcanic episode ceased abruptly in the earliest Miocene, and was immediately followed by uplift and rapid erosion. Uplift was accompanied by intense faulting; possibly both the North Sepik Arc and the Prince Alexander fault zone were active transcurrent plate boundaries in the Miocene and Pliocene. Uplift and faulting have continued until the present day.

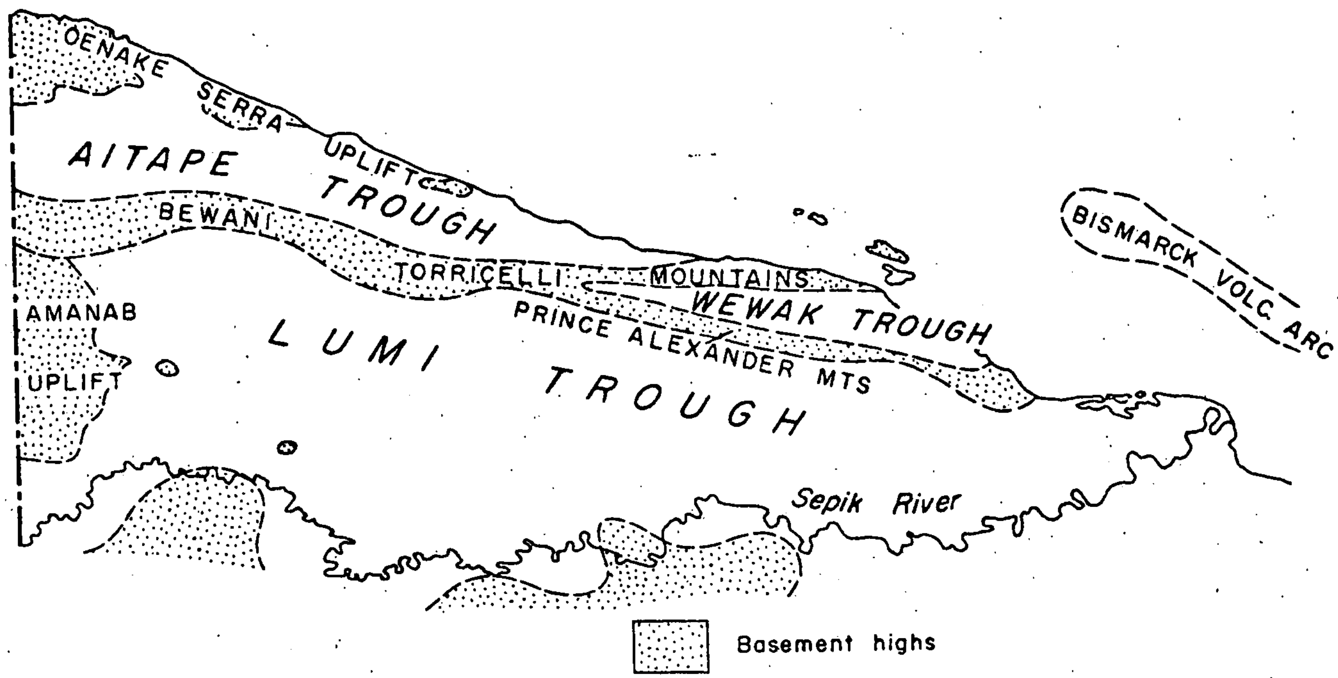
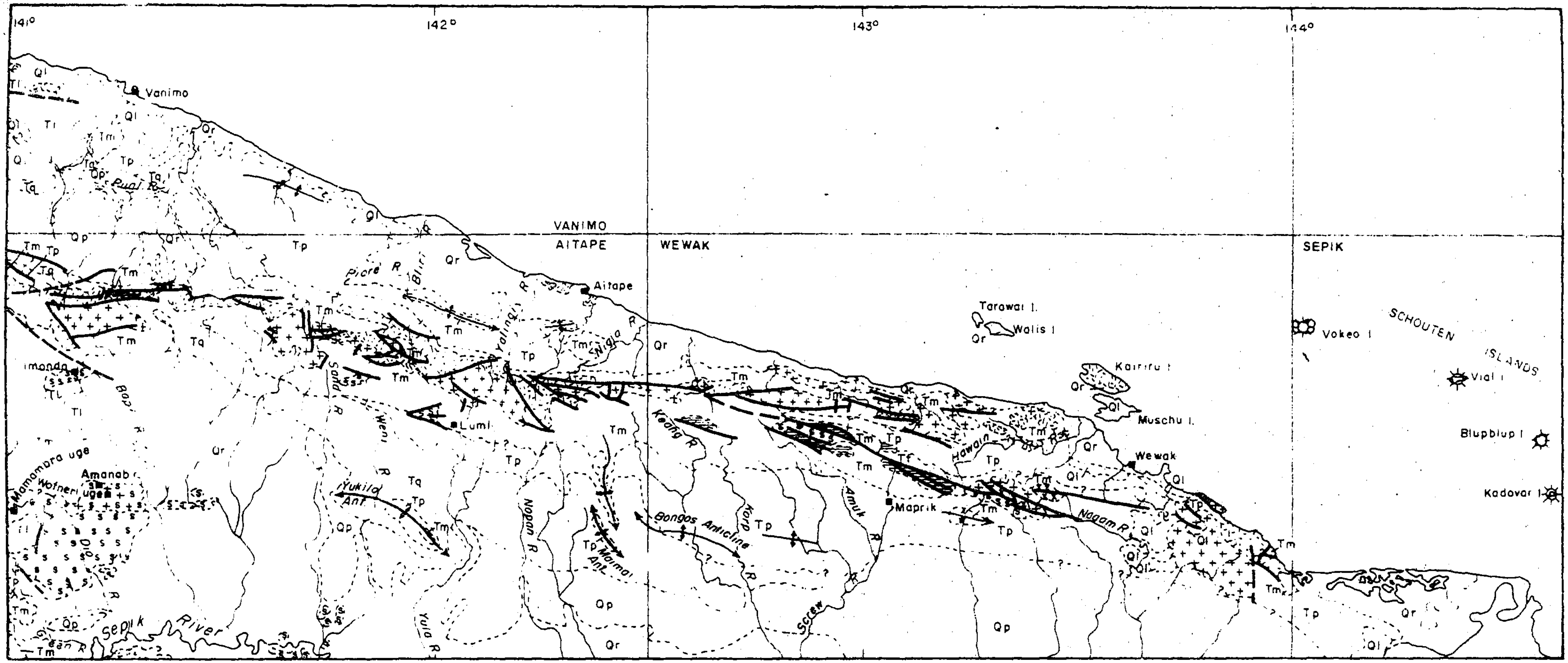


Fig.1 Principal structural features of the North Sepik Region



BASEMENT

? L. MIOCENE	x x x x	*Gabbro, pyroxenite, peridotite*
U. CRETACEOUS – L. OLIGOCENE	+ + +	*Granodiorite, diorite gabbro, dolerite*
? U. CRETACEOUS – L. MIOCENE		*Basic to intermed. volcanics and derived sediments, limestone*
? L. CRETACEOUS – L. MIOCENE		*Crush zone, mixture of intrusives and metamorphics*
U. CRETACEOUS to EOCENE	s + s +	*Altered diorite, granodiorite, gabbro, minor serpentinite*
	s s s s	*Slate, phyllite, quartz-mica-schist, garnet schist, minor metavolcanics and marble*
? PERMIAN	P	*Granodiorite, diorite*

COVER

QUATERNARY	☼	*Active basaltic volcanoes*
HOLOCENE	Qr	*Alluvium, reef limestone*
PLEISTOCENE - HOLOCENE	Ql	*Raised reef limestone*
PLEISTOCENE - EARLY HOLOCENE	Qp	*Older alluvium, terrace gravels*
PLIO-PLEISTOCENE	Tq	*Estuarine sandstone, siltstone minor coal*
?	Tf	*Intermontane fanglomerate*
PLIOCENE	Tp	*Siltstone, sandstone, conglomerate minor limestone*
PARTLY MIOCENE	Tl	*Limestone, marl, minor siltstone*
MIOCENE	Tm	*Siltstone, sandstone, conglomerate, limestone lenses, flysch*

0 20 40 60 80 100 km

Major faults

Anticlines

Fig. 2 Geology of North Sepik Region

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SYNOROGENIC SEDIMENTATION, NORTH SEPIK REGION

M.S. Norvick

Sedimentation in the coeval Lumi, Aitape, and Wewak troughs (Fig. 1) is characterized by very thick sequences of poorly consolidated, dominantly immature clastic rocks, which range in age from early Miocene to Recent. The elongate troughs were supplied largely from sources in the adjacent basement, and include a high proportion of lithic fragments similar to volcanic metamorphic and plutonic rock types known from the Bewani and Torricelli basement. Sedimentary structures indicate that deposition was at least partly by turbidity currents, and some sections contain rocks typical of flysch deposits. Aggregate measurable thicknesses exceed 6000 m in the Aitape and Lumi troughs (Fig. 2), but tectonism, uplift, and erosion are thought to have proceeded at the same time as deposition, and the higher parts of the sequence were probably derived partly by erosion of older deposits deposited in the troughs. Although sediments of the Lumi and Aitape troughs are very thick close to the mountain front, they thin rapidly towards the Sepik plains in the south and the Oenake-Serra uplift in the north. The Amanab uplift was also a positive area during the Neogene, and many units thin or cut out over it. At various times the Oenake-Serra and Amanab uplifts were sites of shallow-water carbonate sedimentation.

On present evidence volcanic activity ceased over most of the north Sepik region during earliest Miocene time, and limestones intercalated with the youngest volcanics yield larger foraminifera indicative of early Miocene (Upper Te) age. A fundamental unconformity separates the last volcanics from the oldest cover rocks, which in the west and northeast have been dated as 'Upper Te' on larger foraminifera, and basal Miocene (zone N.4) on planktonic foraminifera. The unconformity is younger to the east, and the youngest dated andesitic dykes in the Prince Alexander Mountains are late early Miocene in age. The basal cover rocks also became progressively younger eastwards, until the Pliocene oversteps the Miocene and rests directly on basement metamorphics southeast of Mt Turu.

During the early Miocene, large-scale, dominantly transcurrent faulting resulted in the uplift of the Bewani-Torricelli axis, probably as a chain of mountainous islands. Sedimentation started with a thick, but laterally discontinuous, polymict conglomerate, which commonly contains lenses of arenaceous bioclastic limestone. More extensive shallow-water carbonates were laid down in the Oenake and Border Mountains, and these can be tentatively correlated with the Hollandia Limestone in adjacent parts of Irian Jaya. In the Lumi and northern Wewak troughs the conglomerate is overlain by a mixture of neritic siltstone and lithic sandstone, and in places by sandy flysch. In contrast, the Aitape trough was probably considerably deeper-water and accumulated Globigerina marl and siltstone. Much of the eastern Lumi trough was initially emergent, but the sea transgressed steadily eastwards during the Miocene. Although the major depositional trends parallelled the east-west structural framework, a number of north-south faulted uplifts strongly influenced sedimentation in the central Lumi trough from Miocene time onwards. Farther to the south these uplifts are large gentle anticlines, but recent drilling by oil companies on the largest of these, the Bongos Anticline, has shown that faulted rocks of unknown age form effective economic basement at very shallow depths.

By the beginning of the Pliocene, the Lumi trough had opened to the sea at its eastern end, and begun filling up from the west, a process which has continued to the present day. Meanwhile, deep-water sedimentation continued in the Aitape trough and adjacent to the mountain zone in the Lumi trough. Large quantities of polymict conglomerate, some deposited by turbidity currents, accumulated in an enlarged Wewak trough, reflecting its enclosure by two source areas. Away from the Bewani-Torricelli axis shallower-water sedimentation developed in the Lumi trough later in the Pliocene.

The late Pliocene to early Pleistocene was a period of further basin infilling in the Lumi trough, and at the same time a thick regressive sandstone sequence was deposited in the west. The western part of the Aitape trough also began filling at this time, with the deposition of similar marginal-marine sandstone and conglomerate. Open marine sedimentation became restricted to small areas of the central Aitape trough, and deep-water distal turbidites, consisting of graded Globigerina siltstone and mudstone, were deposited southeast of the Prince Alexander Mountains. Cropping out along the southern flanks of the Wewak trough is a coarse conglomerate of uncertain, but possibly early Pleistocene age, which contains fresh angular clasts in an arkosic matrix. This has been tentatively interpreted as an intermontane fanglomerate.

In the late Pleistocene and Holocene, shallow-water carbonate reefs developed on actively rising parts of the coastline, in the vicinity of Vanimo, the Serra Hills, and Wewak. Meanwhile, possibly post-tectonic fluviatile gravels formed a series of low-angle, coalescing fans adjacent to the Sepik River and also along the northern side of the Bewani-Torricelli Mountains. The Bismarck Volcanic Arc was active at that time, as it is at the present day.

The region has been the object of spasmodic hydrocarbon exploration since the late 1920s, so far without success. Surface oil and gas shows are known from all three troughs, and source rocks are abundant. Several large surface anticlines are known in the Aitape trough, but extensive crestal faulting probably lowers their potential as hydrocarbon traps. Though the results of recent exploration have been disappointing, the flanks of the gentle anticlines in the Lumi trough could still be worth investigating for stratigraphic traps. Also, there is potential for reef carbonate reservoirs in the western part of the Aitape trough.

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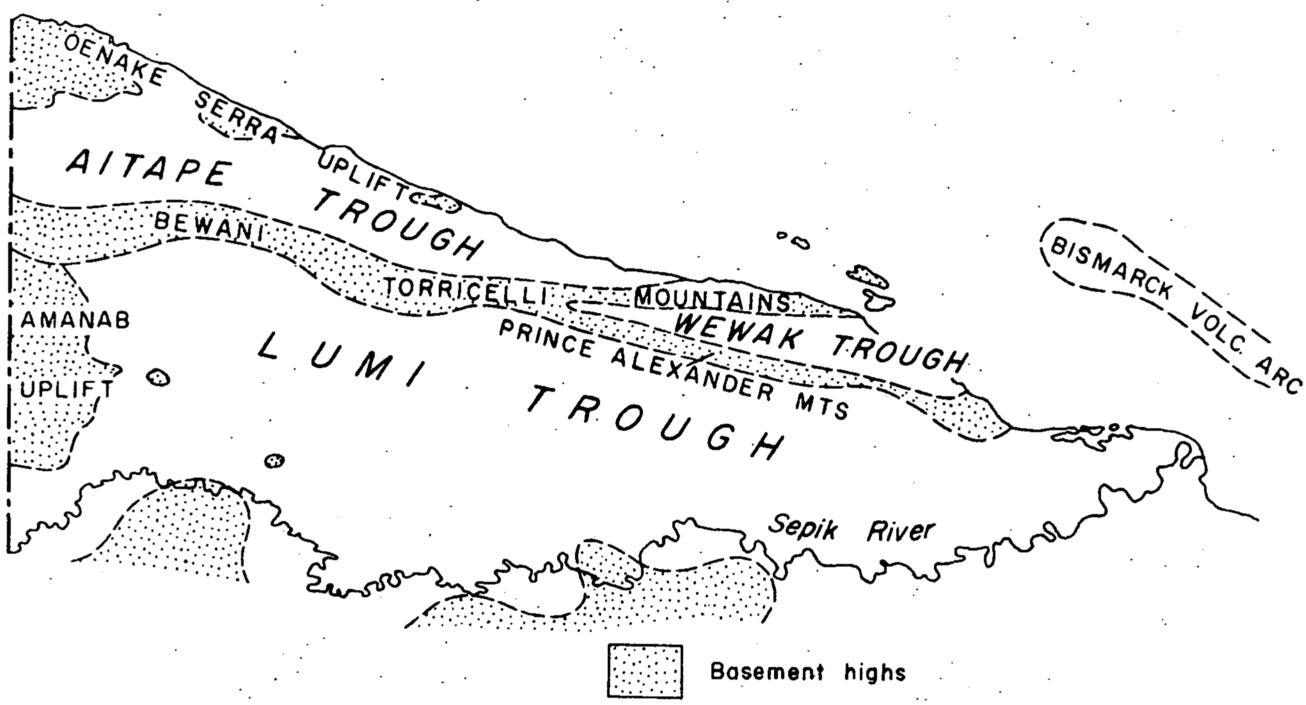

Fig.1 Principal structural features of the North Sepik Region

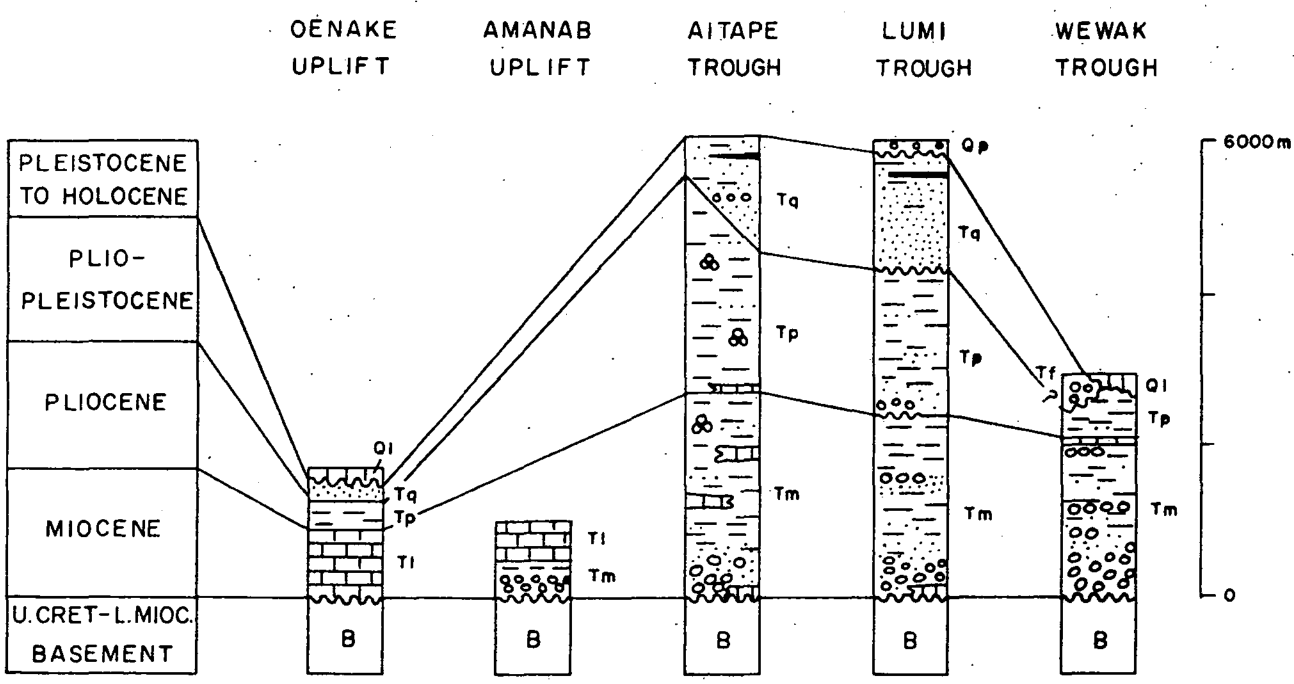

Fig. 2 Typical Neogene sedimentary successions in the North Sepik Region

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GRAVITY LINEATIONS ON THE AUSTRALIAN CONTINENT AND AN ACCRETION MODEL OF CONTINENTAL GROWTH

P. Wellman

The gravity coverage of the whole of Australia is now almost complete. The gravity anomalies can be divided into a short wavelength (20-100 km) component due to local density variations in the crust, and a long wavelength component due to regional variations in the mean density and thickness of the crust and regional variations in upper mantle density. Short wavelength gravity anomalies generally have amplitudes of 20 to 60 mGal and usually consist of a sequence of elongate highs and lows that extends over both basement outcrop and basin areas.

Australia can be divided into 21 crustal blocks within which anomaly axes are subparallel, the axes in each block being all straight or all with the same gentle curve. The boundaries of these blocks are usually parallel to the axes of anomalies on one side, and oblique to the axes of anomalies on the other side. The relative ages of adjacent blocks can be inferred because the block with anomalies oblique to the boundary is likely to pre-date the formation of the boundary, whereas the block with anomalies parallel to the boundary is likely to post-date it. Using the gravity anomaly pattern the Australian crustal blocks are inferred to have stabilized in the following order. First to be formed, before 2.5 b.y. ago, are the Yilgarn Block, a block containing the Pilbara Block and Hamersley Basin, and probably a block forming the basement to the Kimberley Basin. Crust then accreted around these blocks, forming small continents, and these small continents then joined. Subsequently there was accretion to the east with two-thirds of Australia forming a single continent by 1.7 b.y. ago. In the last 1.7 b.y. there have been large amounts of accretion to the east of this continent and smaller amounts to the west and north. Further accretion has occurred, but the additional crust that was formed now comprises parts of India, Antarctica, and New Zealand-New Caledonia.