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1960/28

EXPLANATORY NOTES ALLIGATOR RIVER 4-MILE SHEET

by

P.R. Dunn

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Introduction - The Alligator River 4-mile Sheet covers the estuaries and lower reaches of the Wildman and West, South and East Alligator Rivers. The area includes the north-eastern marginal portion of the Lower Proterozoic Pine Creek Geosyncline and its basement rocks. In the south-east of the area Upper Proterozoic rocks of the Arnhem Land Plateau overlie the older rocks.

Oenpelli Mission, Nourlangie Camp and Mudginbarry Homestead are the only places in the area with permanent inhabitants totalling about 20 whites and 200 aboriginals. A dry season track from Pine Creek provides ready access to the area for about 5 months of the year; other tracks in the area are open to 4-wheel drive vehicles during the dry season only. Airstrips at the three inhabited localities provide access throughout the year. Oenpelli Mission is also supplied by sea to a landing on the East Alligator River.

Photographs and maps available for the Alligator River 4-mile sheet are:-

Air photographs at a scale of 1:50,000 flown by the Royal Australian Air Force in 1950;

A photomosaic at 4 miles to 1 inch;

A planimetric map at 4 miles to 1 inch prepared by National Mapping from a controlled photo-scale slotted template assembly.

The area is also included in the Military 8 miles to 1 inch map of Arnhem Land. Detail on this map is very sketchy.

Previous Investigations

H.Y.L. Brown was the first geologist to record a visit to the area covered by the Alligator River 4-mile sheet. In September 1907 he landed from the Government steamer "Federal" in the estuary of the South Alligator River and examined rocks cropping out immediately west of the river-mouth. He regarded these rocks as Precambrian and correlated them with the Precambrian of the Brocks Creek - Pine Creek area to the south.

G.J. Gray travelled across the area in 1914-15 and made several local traverses around Ooenpelli. He divided the rocks into Precambrian, Permo-Carboniferous, and Cretaceous, with some igneous rocks of unknown age. He gave a Permo-Carboniferous age to the sandstone of the Arnhem Land Plateau, by analogy with previous work of H.Y.L. Brown and H.I. Jensen, on the rocks elsewhere on the Plateau.

In 1946, the C.S.I.R.O. Land Research Survey of the Katherine - Darwin region covered part of the Alligator River 4-mile sheet. However, the survey was strictly reconnaissance, and most of the mapping of the Alligator River 4-mile area was based on photointerpretation (Noakes, 1949). C.S. Christian and G.A. Stewart (1952) commented on the geomorphology of the area.

Between 1953 and 1957 the area was visited several times by geologists of the Bureau of Mineral Resources engaged in regional geological mapping of the Katherine-Darwin region. These notes are based on information obtained during this survey.

During 1955 and 1957 geophysicists of the Bureau of Mineral Resources conducted gravimetric traverses across part of the area (Langren, 1959) (See Appendix). Also, in 1957, the geophysical section carried out an aerial radiometric survey of the South Alligator River area which included the south-west portion of this 4-mile area (Livingstone, 1958).

Physiography

Christian and Steward (1952) have divided this part of the Katherine - Darwin region into three main geomorphological units:- (1) Northern Lateritic Plains (2) Elevated Backbone Country (3) Estuarine Alluvium.

On the scale of this map (2) can be subdivided into Central Uplands, and the Arnhem Land Plateau (see Plate 1). The Northern Lateritic Plains are referred to here as Northern Plains.

Northern Plains: the northern plains cover most of the area and grade into the uplands in the south and west. In the south they are about 100 feet above sea level and towards the sea, are considerably lower. The plains are the remnants of a middle Tertiary peneplain and partly lateritized surface. The low relief of the surface allows very little direct run-off and erosion is slow. In low-lying regions the top of the water-table is just below the ground surface and numerous small depressions in the surface form lagoons, many of which have no surface drainage system.

Erosion of the laterite is most intense in the south where its relief is greatest and laterite scarps 10 feet to 20 feet high are formed in places. Where the laterite has recently been eroded away a surface drainage pattern of very shallow creeks has developed.

Central Uplands: the central uplands are composed of Precambrian rocks. Some of the more resistant rocks form hills up to 300 feet above local plain level (Mt. Basedow, Mt. Cahill) but, in general, the hills are less than 200 feet above plain level. The highest ridges and hills existed as residuals above the original Tertiary peneplain. Other parts of the uplands were exposed after the complete erosion of the overlying laterite. Further erosion has produced a mature land-surface with broad valleys.

Near Myra Falls a window of older rocks crops out in the Arnhem Land Plateau. Within this window steep valleys are formed near the falls themselves, and the relief grades down to a flood-plain near the East Alligator River. The topography is similar to that of the main central uplands region.

Arnhem Land Plateau: the Arnhem Land Plateau is a sandstone plateau which in most places rises abruptly out of the laterite plains with a near-vertical scarp. North of Cooper Creek the scarp has been reduced to a steady grade rising to the top of the plateau. The plateau rises to a maximum of 600 feet above plain level. A series of joints and faults deeply dissect the area and control the stream pattern. The hardness of the sandstone, combined with the controlled run-off for surface water, has preserved the plateau and most of its scarps.

Estuarine Alluvium: large areas covered by alluvium bound the estuaries and lower reaches of the main rivers; they are seasonally flooded and in some places remain as swamps throughout the year. The ground is very flat and not more than a few feet above river level. In areas on the coastline below high tide level, mangrove swamps have been formed. In some places small sand dunes, up to a mile or so inland from the coast, mark ancient coastlines. In general, the estuarine alluvium represents recently emerged sediments exposed by a drop in sea level.

The general history of the formation of the present land-forms may be traced from early Tertiary times:

A large portion of the Alligator River 4-mile area was peneplained to a general base level in early Tertiary times. Several ridges of more resistant sediments and the sandstone of the Arnhem Land Plateau remained above plain level.

The peneplain was lateritized; subsequent movement of the surface caused an uplift in the south with a warp downwards to the coast and up again north of Cooper Creek; consequent

streams developed flowing northwards. Cooper Creek flows westward along a trough formed by the warping.

Later erosion of the higher laterite plain in the south exposed the underlying sediments which have since reached a mature stage of erosion.

A rise in sea-level drowned the estuaries of the main rivers. This was probably in Pleistocene time when a general rise in sea level occurred around the Australian continent. A smaller and more recent drop in sea level has exposed large sections of the drowned estuaries. However, the drop was not sufficient to cause a significant rejuvenation in the stream system and subsequent erosion has been confined to deepening the river channels in the flood plains above the old estuaries.

Stratigraphy

The stratigraphy is summarized in the accompanying chart. (Table 1).

The ages given to the Precambrian formations are not based on an absolute time-scale but on structural and stratigraphical relationships. Age determinations on granites intruding the Lower Proterozoic sediments give the granites an age of about 1650 million years.

Archaean?

Myra Falls Metamorphics - the Myra Falls Metamorphics consist mainly of quartz-mica schist, mica schist, and amphibole schist, with some quartz sandstone and biotite granulite. They are best exposed in the Myra Falls window. North and east of Oenpelli, outcrop is very poor with quartz-mica schist and mica schist cropping out in a few isolated localities.

The quartz-mica schist is a metamorphosed sandstone or quartz greywacke. Some schist contains fragments of feldspar which have remained unaltered. Almost pure quartz sandstone has not been affected by metamorphism and shows no alteration.

The mica schist varies in composition from an altered shale, almost completely composed of muscovite, to a partly altered siltstone in which a few sericite bands give the rock a schistose appearance.

The quartz-mica and mica schists are the major rock types in the western half of the Myra Falls window. Farther east they are interbedded with amphibole schists which are divided into two main types: a black and white medium to coarse actinolite-albite-quartz schist with rare garnets, and a dark fine-grained amphibole schist. The actinolite-albite-quartz schist is made up of alternate bands of actinolite and quartz-feldspathic material which give the rock a banded appearance. It is probably an altered dioritic or basic igneous rock. The amphibole schist contains accessory sphene, magnetite, and biotite, with subordinate feldspar. The small feldspar content suggests that the original rock was an ultrabasic igneous type or possibly an impure dolomitic rock.

In the extreme west of the Myra Falls window several outcrops of what appears to be a granitic gneiss or biotite granulite occur. This description suggests a degree of metamorphism discordant with that of the surrounding rocks. However the original rock may have been a coarse arkose which has been recrystallized.

The rocks throughout the Myra Falls window area have been regionally metamorphosed; by pressure only, in the west and by moderate temperature and pressure farther east.

Contact of the Myra Falls Metamorphics with the Lower Proterozoic sediments is not visible. Differences in grade of metamorphism and structural pattern suggest that the metamorphics are older than the Lower Proterozoic sediments and the structure of the Lower Proterozoic Pine Creek Geosyncline suggests that the basement to the geosyncline may crop out in this area. Therefore the Myra Falls Metamorphics are considered to be Archaean and to

form part of the eastern shore of the Pine Creek Geosyncline.

Lower Proterozoic?

Nanambu Granite: very little is known about this formation. A few outcrops of garnetiferous and gneissic granite have been discovered in creekbeds and below the laterite scarp. They are mostly very weathered. The granite is a medium-grained grey rock with very little dark mineral and weathered brown garnet is scattered throughout.

Small outcrops of altered basaltic rock (or greenstone) were found near the granite in the Nanambu Creek area; they are too small to appear on the map. The rock is very fine-grained, dark green with small scattered laths of amphibole. Under the microscope the green material is seen to be mostly chlorite with some calcite showing ghosts of a former basaltic texture.

The outcrops of both rocks are too small and scattered to give an idea of their relationships to each other or the Lower Proterozoic sediments. Similar granites in the west of the Katherine-Darwin area are Lower Proterozoic; the "greenstone" resembles the altered basalt(?) in the South Alligator Valley (Mt. Evelyn 4-mile Sheet) which is regarded as Archaean.

LOWER PROTEROZOIC - Agiscordian System

GOODPARLA GROUP: the Goodparla Group comprises the Lower Proterozoic sediments deposited in the main trough of the Pine Creek Geosyncline and derived from the north and east. In this 4-mile area it is represented by the Mt. Partridge and Masson Formations.

Mt. Partridge Formation: the Mt. Partridge Formation is the oldest Lower Proterozoic formation in the area.

The formation is made up of coarse arkose, arkose conglomerate, coarse greywacke conglomerate, quartz greywacke, sandstone and siltstone with some silicified dolomite.

Feldspathic sediments are characteristic of the formation in the Spring Peak - Mt. Basedow area. Here also, some of the sediments have been modified by considerable shearing stress which has formed sericite and muscovite. Some bands of arkose which contain coarse pink feldspar crystals now have the appearance of a foliated granite, caused by the recrystallization and realignment of the feldspar and quartz grains (Gray refers to a crushed quartz porphyry in this region). Some siltstone bands have been almost completely transformed to a muscovite rock. Near Spring Peak an arkose conglomerate, containing large rounded and subangular quartz pebbles, forms a well defined horizon. This conglomerate, and the arkose at Mt. Basedow, are radioactive in places, probably owing to the presence of detrital thorium minerals.

Farther north near the Wildman and West Alligator Rivers the feldspar content of the rocks is much smaller; and they have not been subjected to the same shearing stress. Quartz greywacke and sandstone are the principal clastics. Siltstone is interbedded with the coarser clastics and forms about 40% of the outcropping rocks, but its percentage of the total formation is considerably higher. Greywacke conglomerate containing flattened chert fragments forms several lenticular beds. Many of the quartz greywackes are stained red by haematite. An ilmenite-and haematite-rich siltstone crops out between the South and West Alligator Rivers and again west of the Wildman River.

Several isolated outcrops of quartz sandstone, silicified dolomite and quartz-muscovite schist (altered quartz greywacke) exist between the South Alligator River and Nanambu Creek.

The sediments of the Mt. Partridge Formation were deposited in a shallow-water shelf environment on the north and east margins of the Pine Creek Geosyncline. The nature of the sediment suggests rapid deposition in a near-source environment.

No accurate estimate of thickness can be made, but the formation is probably not more than 10,000 feet thick.

Masson Formation: Although the relationships are not clear in this area, the Masson Formation conformably overlies the Mt. Partridge Formation. The boundary between the two is gradational.

The Masson Formation is typically composed of quartz greywacke, sandstone, greywacke conglomerate, and banded siltstone. However, in this area several well defined horizons of ferruginous siltstone containing chert nodules and some massive chert (silicified reef dolomite) are also present.

The outcrops of quartz greywacke and sandstone are small and scattered, which suggest that the clastics are local and lenticular, the main mass of the formation being composed of banded siltstone.

The ferruginous siltstone is a pyritic carbonaceous siltstone when fresh, and the nodules are silicified dolomite. The silicified dolomitic sediments are similar to those in the Koolpin Formation and in part, at least, suggest a transition between the two formations.

The Masson Formation was deposited on the north and eastern slope of the Pine Creek geosyncline and contains reworked sediments of the Mt. Partridge Formation.

South Alligator Group: The South Alligator Group includes all the Lower Proterozoic sediments deposited in a secondary trough formed on the eastern margin of the Pine Creek Geosyncline. The group has been divided into three formations of which only the Koolpin Formation has been recognized in this 4-mile area. East of Mt. Basedow several outcrops of sediments belonging to the group do not crop out well enough to allow subdivision into formations. This area is mapped as undifferentiated South Alligator Group. The outcrops consist of ferruginous siltstone and ferruginous siltstone containing chert nodules. They appear to unconformably overlie sediments of the Mt. Partridge Formation.

Koolpin Formation: the Koolpin Formation crops out in the south-west portion of the area. The outcropping formation is composed of massive chert and chert breccia, ferruginous siltstone and ferruginous siltstone containing chert nodules.

The massive chert and chert breccia are at the base of the formation on the western side. They represent the silicification of reef dolomite and dolomite breccia.

The massive chert grades up into the ferruginous siltstone. The chert forms bands, lenses and nodules within the siltstone. The siltstone is a pyritic carbonaceous dolomitic siltstone below the zone of weathering and the chert nodules represent silicified dolomite. The pyrite content of some of the rocks is so high that they form a massive limonite gossan on the surface.

The dolomite reefs were deposited a ridge of basement rocks or Goodparla Group sediments which was upfaulted towards the close of Goodparla Group sedimentation. This ridge formed the western margin of the Eastern Trough of the geosyncline.

The maximum thickness of the Koolpin Formation is about 5000 feet in this area.

Upper Proterozoic

Kombolgie Formation: The sediments and volcanics of the Kombolgie Formation make up the Arnhem Land Plateau, the most distinctive physical feature in the Alligator River 4-mile area.

The formation is part of the Upper Proterozoic Katherine River Group. It is mainly composed of quartz sandstone and quartz greywacke with pebble conglomerate bands. Basic vesicular volcanics and interbedded tuffaceous material are present in some places.

The sandstone and quartz greywacke are coarse to medium-grained with a feldspathic or tuffaceous matrix. The rocks are buff, grey or iron-stained, and those with a tuffaceous matrix are

purple. Bedding is thick and the sediments are commonly current-bedded; beds up to 20 feet thick crop out on the scarp of the plateau.

The Kombolgie Formation rests unconformably on Lower Proterozoic and Archaean rocks. It has an irregular base which is below plain level north of Oenpelli and up to 200 feet above plain level elsewhere. No accurate measurements have been made but the maximum thickness of the formation in this area is estimated at 1500 feet.

Lower Cretaceous

Mullaman Beds - some lateritized shale, sandstone and conglomerate crop out in the Cooper Creek area. The sediments unconformably overlie Upper Proterozoic sediments and, in appearance, resemble rocks regarded elsewhere as belonging to the Lower Cretaceous Mullaman Beds.

Cainozoic

Laterite: a laterite surface occupies large portions of the area, especially near the coast. The ferruginous zone alone is up to 20 feet thick in places. Where the ferruginous upper zone has recently been eroded away, the differences in lithology of the parent rock are expressed on the surface by the soil and vegetation which have developed on the underlying softer zones of laterite. This has made it possible to identify the structure of the underlying rocks in large areas where little or no surface outcrop is visible.

Sand: sand derived from the weathering of Lower Cretaceous and Upper Proterozoic sediments has been laid down along many of the rivers and creeks and over much of the laterite surface. Near the coast several sand dunes mark old coastal strand-lines.

Rubble: on the edge of the Arnhem Land Plateau masses of rubble from the overhanging Upper Proterozoic scarp obscure the rocks of the underlying formations. Rubble from the laterite also covers large areas of the low-lying regions.

Ferruginous sediments - in some of the creek beds ferruginous sandstone and conglomerate have developed. They are formed by the cementing of normal stream deposits by iron dissolved from underlying sediments and precipitated in the creek beds.

Soil - soil is not well developed except in the areas of alluvium. It has formed fairly well over Masson Formation sediments which have just been exposed from beneath the iron-rich laterite horizon, but is not very deep. An iron-rich red soil with a mixture of sand has developed in places on top of the laterite. The soil over areas of basic intrusions is lime-rich and forms gilgai. These soils are neither good enough nor widespread enough to have agricultural possibilities.

Quaternary

Alluvium - large areas of alluvium cover the estuarine flats. This alluvium is black and has a high humus content. During the wet season it is frequently flooded and becomes boggy. It dries very hard during the dry season and numerous cracks, up to 9 inches across, develop. The alluvium in the river and creek valleys is more silty and does not crack when dry. It is up to 30 feet thick in the valleys of creeks which were backed up during the Pleistocene rise in sea level. Most of the river alluvium forms good agricultural soil but seasonal flooding makes its use impracticable.

Basic Intrusives - The basic rocks in the area have not yet been systematically studied, but they have been tentatively divided into two groups.

Intruding the Lower Proterozoic west of the East Alligator River are doleritic rocks with granophyric differentiates. The granophyres form the greater proportion of the outcropping intrusive and have a dioritic or granodioritic composition. All the rocks of this group which have been studied are uralitized and saussuritized, probably by deuteric processes during intrusion. The rocks range in colour from the very dark grey of the dolerites to the mottled black and white (or pink) of the more

acid rocks. Dykes of pegmatitic feldspar and amphibole traverse the intrusives in places. They form part of the suite of intrusives which intrudes sediments in the South Alligator River valley further south.

Porphyritic gabbroic rock intrudes the Myra Falls Metamorphics in the north-east of the area. They differ from the previous group of intrusives in being commonly porphyritic and having no granophyric differentiates. In the hand specimen the rock is grey; some specimens contain greenish white phenocrysts of feldspar up to two inches long. Under the microscope coarse-grained specimens show typical gabbroic composition with ophitically intergrown labradorite and augite, and accessory biotite, olivine, apatite, and magnetite. Finer-grained specimens appear to be derived from the same magma. Some of the specimens were remarkably fresh and showed no alteration, but others had been saussuritized and uralitized. Black sand in creek beds reflected the abundance of magnetite in some of the intrusions.

Both groups form discordant intrusions and were intruded after the folding of the sediments but before granite intrusion.

Nimbuwah Granite - the Nimbuwah Granite crops out in the extreme north-east of the 4-mile area. It is a grey biotite-hornblende granite which has basic phases, probably developed through the partial assimilation of a previously existing gabbroic intrusion. Just north of Cooper Creek a gabbroic rock similar to those intruding the Myra Falls Metamorphics is completely enclosed within the granite. The boundary between the two is gradational and suggests assimilation by the granite. Near this inclusion large feldspar crystals in the granite show schlieren structures but no large scale lineation was seen.

The exposures of granite are remarkably fresh, although the area is one of low relief, and the granite outcrops are commonly in the form of flat pavements.

The Nimbuwah Granite is regarded as being of similar age to the other granites of the Katherine-Darwin region because of: (i) the granite-basic rock relationship which is similar to that elsewhere and (ii) the absence of any tectonics affecting the granite.

Structure

The Pine Creek Geosyncline is the dominant regional structure in the Lower Proterozoic rocks of the Katherine-Darwin region. In the Alligator River 4-mile area the north-eastern portion of the geosyncline and its basement are exposed. The Archaean rocks form the basement. The Mt. Partridge and Masson Formation sediments were deposited on the eastern shelf and slope of the geosyncline and the South Alligator Group sediments were deposited in a late-stage marginal trough (South Alligator trough). Subsequent orogeny has caused local folding and deformation of the sediments, but the original sedimentary structures and relationships still dominate the regional structure of the area.

The ridge of Archaean rocks which forms the western margin of the South Alligator trough is not exposed but the gravity traverse indicates its presence in the south-west corner of the sheet.

The Upper Proterozoic Kombolgie Formation was deposited in a shallow intracratonic basin.

The Mullaman Beds were deposited during the initial incursion of a Cretaceous epicontental sea which covered a large portion of Northern Australia.

Folding - The main folding trends in the Archaean Myra Falls Metamorphics are preserved in the resistant and competent quartz schist and sandstone. The main structure exposed in the Myra Falls window area is an east-trending anticline. The dips are generally of the order of 60° to 70°, but in one part of the area the dips are as low as 15°. Even where the dips are low the

quartz schist is drag-folded on the limbs of the anticline: the incompetent mica and amphibole schists are intensely folded and crumpled.

The Lower Proterozoic sediments have been folded along north-trending axes.

The Mt. Partridge Formation sediments in the Wildman-West Alligator River area form a large syncline where they have warped below the secondary South Alligator trough. Superimposed on the limbs of the syncline is a series of steep folds in the competent beds. The dips of these folds range from 50 to 80° and some of the structures have been overfolded. Near Mt. Basedow, the Mt. Partridge Formation sediments have been very tightly folded and overturned. Crumpling in the arkose has formed ptygmatic folds. The Masson Formation clastics have been folded into small close folds and the incompetent siltstones have been isoclinally folded.

The South Alligator Group sediments are all incompetent and locally are severely crumpled and distorted. Their principal structure is controlled by the outlines of the trough in which they were deposited; west of Spring Peak they form a broad syncline.

Some shallow dips - up to 10° - are present in the almost flat-lying sediments of the Kombolgie Formation: some are depositional dips; others are due to a slight downwarping of minor basin structures. Dips up to 50° occur adjacent to faults in some places.

Faulting - A prominent fault determines the course of the East Alligator River. This structure trends south-east and can be traced for about 100 miles south of the sheet to the Bulman area on the Mt. Marumba 4-mile sheet area. It has displaced the Upper Proterozoic sediments about 50 feet vertically. It may have formed an eastern boundary fault to the Lower Proterozoic Pine Creek Geosyncline and was active until post-Upper Proterozoic times.

The Myra Falls Metamorphics have been considerably faulted and many of the faults are now quartz-filled. These faults trend mainly north and north-north-east. Whether they are Archaean or Lower Proterozoic faults is not known; as some contain quartz-tourmaline veins they are probably not younger than the intrusion of the granite.

Faulting in the Lower Proterozoic sediments appears to accompany the main folding as is best illustrated in the sediments in the Wildman-West Alligator River area where a series of north-east-trending faults is at 45° to the folding stress. Shearing has developed at right angles to the main directions of pressure in the Spring Peak-Mt. Basedow area.

Two directions of faulting affect the Upper Proterozoic rocks; they trend north-west and west. These faults show only small displacement but are many miles in length and are probably due to late-stage movements along previously existing fault zones (e.g. East Alligator Fault). The intense jointing of the Upper Proterozoic sandstones was probably caused partly by tension associated with these faults.

Economic Geology

No mineral deposits of economic importance have been proved in the area.

Water - As the area is in a high rainfall area there is no shortage of water. Surface water serves all current needs; during the wet season all the water courses are running and in the "dry" there are numerous permanent waterholes in the main creeks and rivers. Several permanent springs exist on the Arnhem Land Plateau and in the laterite covered areas.

No wells or bores have been sunk in the area. In the dry season good fresh water should be available anywhere within 20 feet of the surface of the laterite and not deeper than 100 feet almost anywhere in the Precambrian rocks.

Uranium - Radioactivity has been reported from several localities in the Alligator River 4-mile area. No uranium minerals have been discovered.

The Nanambu Granite is slightly radioactive in places.

Radioactivity at Spring Peak was investigated by geologists of Enterprise Exploration Pty. Ltd., who concluded that it was due to thorium minerals in the arkosic sediments. This anomaly, together with some near Mt. Basedow, were picked up by the airborne radiometric survey in 1957 (Livingstone 1958 - see Plate 2). Ground investigation showed that the Mt. Basedow anomalies were also due to the presence of Thorium minerals.

Minor radioactivity was noted in Upper Proterozoic breccia along the line of the East Alligator Fault.

Tin - Alluvial tin was discovered near Myra Falls about forty-five years ago. It has been worked by several prospectors without much apparent success; no records are available.

In 1955, fine vein tin was discovered in the arkosic rocks just east of Spring Peak. Costeans were dug but no economical lode was revealed.

Rutile - the presence of large rutile crystals was reported from a creek bed about 6 miles north east of Oenpelli Mission. Fine rutile is common in washings from the creek below Myra Falls.

Copper - Minor copper mineralization has been discovered in amphibole schist below Myra Falls and in a quartz reef a mile or so to the south. The showings are not promising.

Gold - a few grains of gold have been picked up in washings from the creek below Myra Falls.

Iron and Titanium - the Bureau of Mineral Resources investigated an ilmenite-rich siltstone cropping out between the South and West Alligator Rivers. The original sample taken assayed 52% iron oxide and 22.6% TiO_2. A subsequent grab sample of rich-looking surface material gave an iron oxide content of about 48%

and TiO_2 about 7.5%. The siltstone extends for about a mile, is lenticular, and about 50 feet thick at a maximum, but it dips at 80°. It does not appear to have any current economic possibilities.

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TABLE 1

TABLE OF STRATIGRAPHIC UNITS

AGE	ROCK UNIT AND SYMBOL	LITHOLOGY	MAXIMUM THICKNESS	STRATIGRAPHIC RELATIONSHIPS
RECENT	Alluvium (Qra)	River and estuarine alluvial deposits	Approx. 50 ft.	
CAINOZOIC	Superficial Deposits (Czs)	Laterite, sand, rubble, soil and ferruginous deposits.	Approx. 20 ft.	
LOWER CRETACEOUS	Mullaman Beds (Klm)	Lateritized sandstone, conglomerate and shales	Approx. 50 ft.	Flat lying Unconformably overlies Kombolgie Formation sediments and Myra Falls Metamorphics. Also on Cooper Creek Granite.
UPPER PROTEROZOIC	Kombolgie Formation (Puk)	Coarse to medium grained sandstone and quartz greywacke. Some pebble conglomerate beds. Interbedded basic amygdaloidal volcanics and tuffaceous sediments.	Approx. 1500 ft.	Almost flat lying. Unconformably overlies Archaean and Lower Proterozoic sediments.
	Nimbuwah Granite (Pgu)	Biotite hornblende granite with basic phases		Intrudes Myra Falls Metamorphics and basic intrusives.
	Basic Intrusives (i) Bdi (ii) Bdl	(i) Altered doleritic rocks and its granophyric differentiates (ii) Porphyritic gabbroic rocks		Intrude Lower Proterozoic sediments. Intrude Myra Falls Metamorphics.
LOWER PROTEROZOIC	South Alligator Group (Pl†)	Several small outcrops of ferruginous siltstone some containing chert nodules. Also rocks of Koolpin Formation.	?	Unconformably overlies Mt. Partridge Formation. Includes Koolpin Formation.
	Koolpin Formation (Plk)	Silicified reef dolomite and dolomite breccia. Ferruginous siltstone with chert bands and nodules. Ferruginous siltstone-when fresh ferruginous siltstone is pyritic carbonaceous siltstone.	Approx. 5000 ft.	Disconformably overlies Masson and Mt. Partridge Formation sediments. In part, grades into Masson Formation.
AGICONDIAN SYSTEM	Goodparla Group			Includes Masson and Mt. Partridge Formation.
	Masson Formation (Plm)	Red and white banded siltstone, quartz greywacke, sandstone, greywacke conglomerate; ferruginous siltstone containing chert nodules and silicified reef dolomite.	?	Conformably overlies and grades into Mt. Partridge Formation. Upper portion grades into Koolpin Formation.
	Mt. Partridge Formation (Plp)	Arkose, arkosic conglomerate, sandstone, quartz greywacke, ferruginous siltstone; greywacke conglomerate. Some silicified dolomite.	approx. 10,000 ft.	Unconformably overlies basement rocks.

TABLE 1

AGE	ROCK UNIT AND SYMBOL	LITHOLOGY	MAXIMUM THICKNESS	STRATIGRAPHIC RELATIONSHIPS
LOWER PROTEROZOIC (?)	Nanambu Granite (Pen)	Garnetiferous and gneissic granite		Not known
ARCHAEAN (?)	Myra Falls Metamorphics (Am)	Quartz mica schist, mica schist, amphibole schists some containing garnets, quartz sandstone and biotite granulite.	?	Unconformably overlain by Upper Proterozoic and Lower Cretaceous sediments.

TABLE 2

SUMMARY OF TECTONIC HISTORY OF ... LIGADOR RIVER 4-MILE AREA

AGE	SEDIMENTATION ETC.	FOLDING AND FAULTING	VULCANISM
RECENT	Erosion of Tertiary landsurface - deposition of alluvium.		
	Fall in sea-level (about 20 ft.)		
PLEISTOCENE	Rise in sea level (about 100 ft.) and Deposition of estuarine alluvium.		
TERTIARY		Uplift and warping of land surface	
	Lateritization of landsurface		
	UPLIFT, EROSION AND PENEPLANATION		
LOWER CRETACEOUS	Marine transgression and sedimentation in epicontinental basin	Depression of land surface	
	UPLIFT AND EROSION -	UNCONFORMITY	
UPPER PROTEROZOIC		Development of major faults and joints in Arnhem Land Plateau area. Continued movement on East Alligator Fault.	
	Deposition of clastic sediments in an intracratonic basin.	Slight warping during sedimentation	Basic Vulcanism. Lavas and pyroclastics.
		UNCONFORMITY UPLIFT AND EROSION	
LOWER PROTEROZOIC			Intrusion of granites with associated quartz veins and mineralization.
			Intrusion of basic igneous rocks.
		Major folding of sediments in Pine Creek Geosyncline. Small complementary faults developed during folding movements. Shearing in Mt. Partridge Formation.	
	Deposition of sediments in Eastern Trough	Continued downwarping of trough zone.	
	Formation of reefs on uplifted ridge. Commencement of deposition of sediments of South Alligator Group in Eastern Trough. Final stages deposition of Masson Formation.	Formation of ridge on western margin of trough by faulting and warping with concomitant downwarping of Eastern Trough. Contemporaneous minor folding and erosion of Lower Proterozoic sediments.	

TABLE 2

AGE	SEDIMENTATION ETC.	FOLDING AND FAULTING	VULCANISM
LOWER PROTEROZOIC (CONT.)	Deposition of sediments on shelf and slope areas of geosynclinal depression	Downwarping and marginal faulting of main geosyncline.	
	U N C O N F O R M I T Y EROSION		
ARCHAEAN		Intense folding and consequent metamorphism of Archaean rocks. Possibly some associated faults.	
	Deposition of original sediments in Myra Falls Metamorphics		Basic lavas and pyroclastics.

PLATE I

SKETCH MAP SHOWING PHYSIOGRAPHIC UNITS

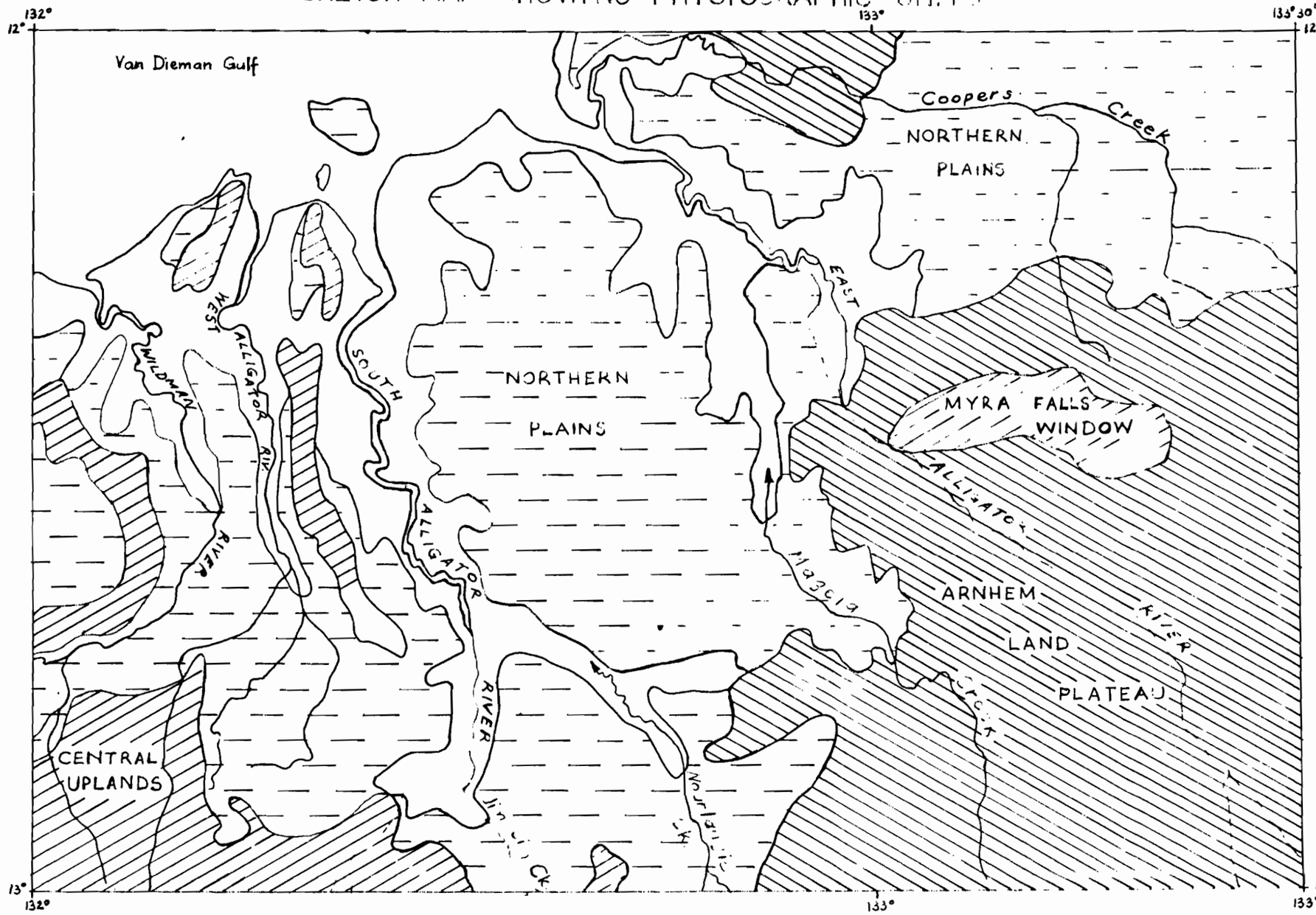
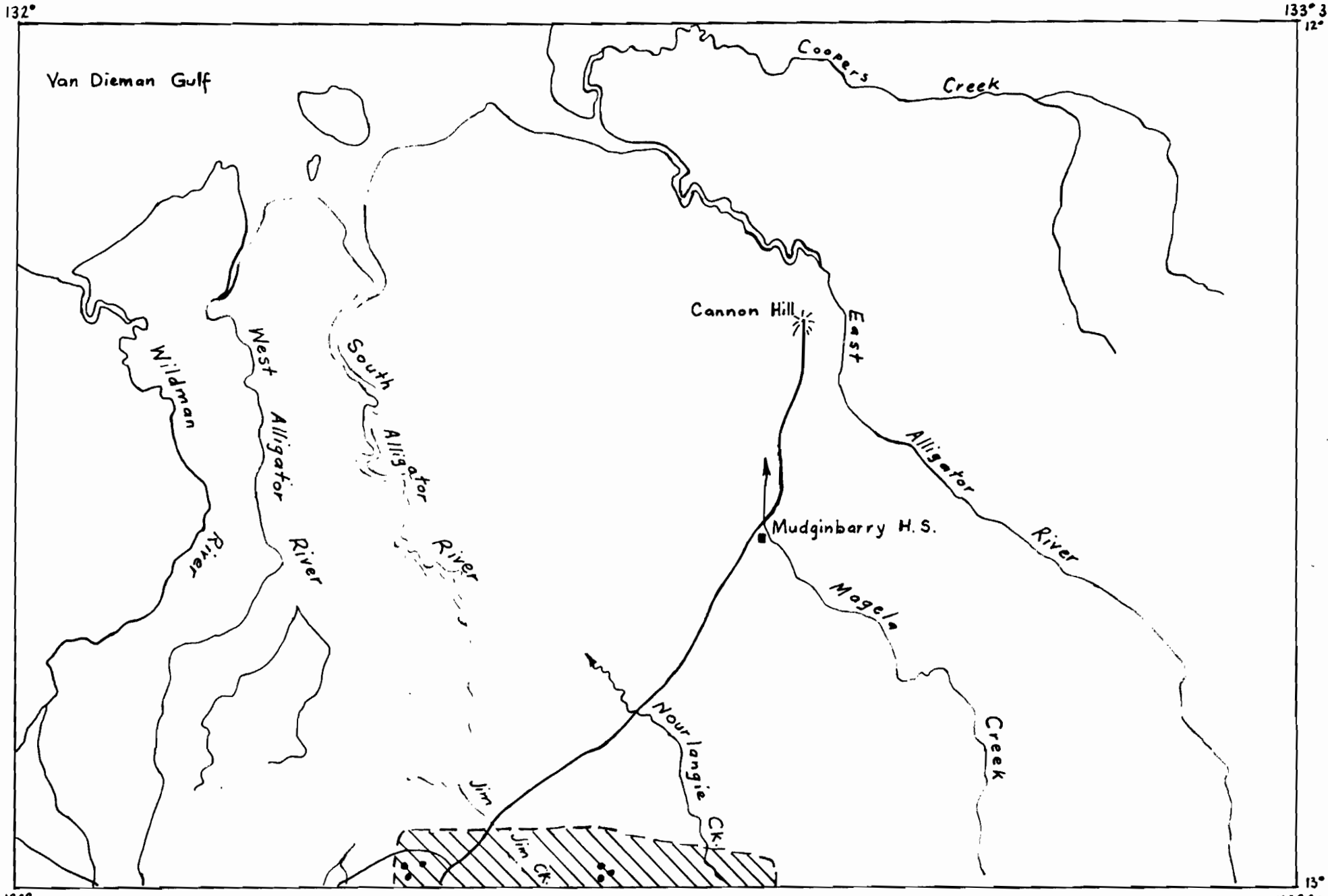


PLATE 2

GEOPHYSICAL SURVEYS ALLIGATOR RIVER 4 MILE AREA



Area covered by Auster-borne Radiometric Survey 1957

Radiometric Anomalies

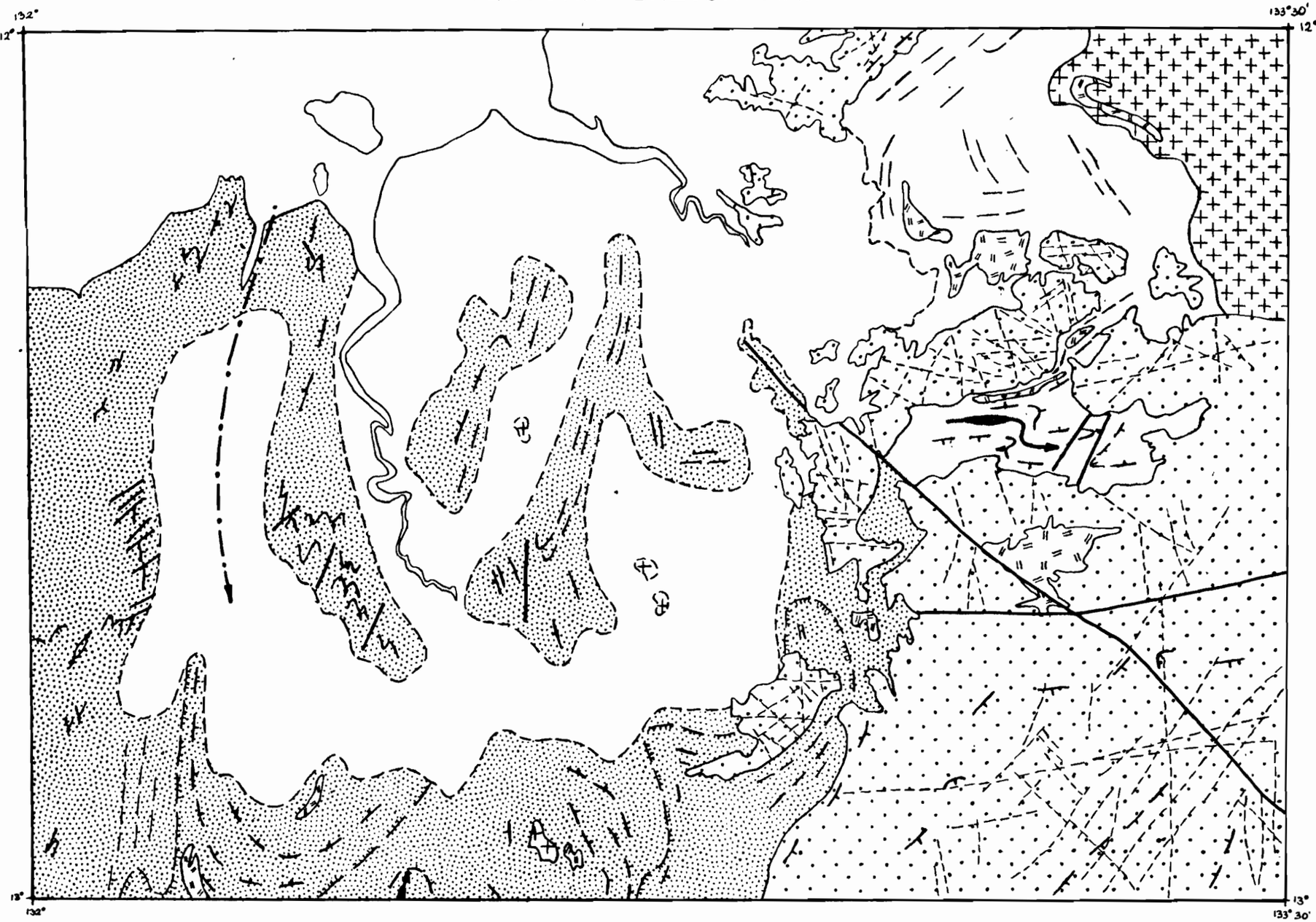
Line of Gravimetric Survey 1955-1957

10 5 0 10 20 30 MILES

SCALE

PLATE 3

TECTONIC SKETCH MAP



REFERENCE

- Tertiary and Recent cover sediments
- UPPER PROTEROZOIC — Platform sandstone and volcanics.
- AGICONDIAN — Granite intrusions
- Basic sills and dykes
- Folded geosynclinal sediments
- ARCHAEAN — Basement - low-grade metamorphics
- Strike and direction of prevailing dip
- Trend lines
- Fault
- Margin of Eastern Trough
- Vertical tension joints
- Anticlinal axis showing direction of plunge
- Synclinal axis showing direction of plunge
- Plunge of minor fold

SCALE

10 5 0 10 20 30 MILES