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Report No. 4300-G-29

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GEOLOGY OF THE SOUTHEASTERN PART OF THE AMADEUS BASIN, N.T.

by

G. E. Wulff

Melbourne

January, 1960

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ILLUSTRATIONS

ABSTRACT

This report discusses the geology of the southeastern part of the Amadeus Basin, Northern Territory.

A thick succession of marine sediments from Upper Proterozoic to Upper Palaeozoic age was deposited in this part of the basin.

The proportion of clastics is greater than that of carbonates throughout the marine sedimentary succession.

The lithology as well as organic remains gives evidence of a shallow water environment at the time of sedimentation.

Indications of a closure of the basin in Ordovician time are present and the succeeding Upper Palaeozoic sediments apparently were laid down in epi-continental conditions.

Throughout the sedimentary section only two major breaks in deposition were noted though there are local unconformities.

The first major unconformity was after the deposition of Bitter Springs Limestone and the second before the deposition of the Pertnjara sandstone. However, the major orogeny took place some time after the Pertnjara Formation was deposited.

INTRODUCTION

An area of approximately 20,000 square miles in the southeastern part of the Amadeus Basin was assigned for field investigation to "Amadeus No. 2" field party. This area is situated between latitude 24°30' and 25°40' south and longitude 133°30' and 136°00' east and includes the Rodinga, Charlotte Waters and western parts of the Hale River and McDill standard map sheet areas (4 miles to 1 inch).

Stratigraphy of the Palaeozoic sediments, their thickness and facies changes, and the petroleum prospects of the area were the main objectives of this survey. It was also necessary to connect the present work with that completed during the 1958 season by J. MacLeod immediately north of this area.

From the beginning it was established that it was difficult to select reliable sections for measurement and regular spacing was impossible. The sections were measured with the Glauser rangefinder and geological compass.

Isopach and lithofacies maps were prepared for the entire Amadeus Basin in combination with R. Leslie and are appended to his report 4300-G-28.

Except for the east, access to the area is fairly good. It is served by the Port Augusta-Alice Springs railway. Roughly graded tracks as well as water bores at the cattle stations proved very useful, but the multitude of barbed wire fences created serious obstructions for field work.

The party personnel consisted of:

R. Leslie - geologist.	From 1/5/59 to 1/6/59 in charge of the party.
G. Wulff - geologist.	From 1/6/59 in charge of the party.
J. Bain - geologist.	From 7/6/59 to 17/8/59.
H. Meisinger - surveyor	
J. Williams - mechanic	
B. Burnett - cook	

The party was equipped with the following vehicles:

1 International four-wheel drive truck

1 Long wheel base Landrover

2 Short wheel base Landrovers

1 Trailer

The field operations were started on May 1 and finished on September 1, 1959.

The only available topographical map of the area is the aeronautical map at 1 : 1,000,000 scale. Aerial photographs which fully cover the survey area were the only reliable sources for orientation.

The photogeological map prepared by A. A. Weegar proved extremely useful and was widely used as a base for field observations. Later, after the field season was completed, photo-compilations of the Rodinga and Charlotte Waters map sheets became available from the Commonwealth Division of National Mapping. These served as a base for the geological map attached to this report.

GEOGRAPHY

The survey area is under the administration of the Alice Springs District Office of the Northern Territory Administration and plays an important part in the economy of the Territory.

The following 19 cattle stations are fully or partly situated in this area:-

Allambi, Andado, Deep Well, Idracowra, Kulgera, Lilla Creek, Love's Creek, Maryvale, Mt. Cavanagh, New Crown, Orange Creek, Owen Springs, Palmer Valley, Henbury, Horseshoe Bend, Ringwood, St. Theresa Mission, Todd River and Umbeara.

Altogether these properties occupy 65% of the area or 13,000 square miles and the remaining 35% or approximately 7,000 square miles are on the outskirts of the Simpson Desert. Andado Station extends into the desert and is surrounded by desert sand hills. The stations breed meat cattle which are annually transported by rail to Adelaide for sale. In addition, some of the stations carry sheep, e.g. Maryvale.

There are no mining or other important industries in the area at present, the primitive workings of the Rumbalara ochre mines having been closed after the Second World War.

This part of the Northern Territory lies in the zone of dry, continental climate, and harsh temperature changes are common. The average annual rainfall, 5 to 10 inches, occurs mostly in the summer months.

The alluvial plains are covered with fertile soils, desert loams, and carry sufficient food for livestock, especially during the years when the rainfall has been good. Spinifex grows well and there are great varieties of trees and bushes, even on the sandy and stony plains. There are large eucalypts along the valleys of the major streams. The country slopes gently down to the south-southeast towards the Simpson Desert, the highest points being in the northwest, at Mt. Polhill, 2,541 feet, and Mt. Ooraminna, 2,125 feet. Topographic relief is of the order of 300 to 400 feet.

All rivers and smaller streams are non-perennial, and two different drainage systems can be distinguished.

1. The major rivers, Finke and its tributaries, Hugh River and Orange and Lilla Creeks, Todd and Hale Rivers, are of the first superimposed drainage system. They usually cut deep gorges through the ridges independent of geological structures.

2. The smaller streams and gullies are of the second, much younger drainage system and are consequent to the present relief features and structures. They very seldom reach the main streams.

STRATIGRAPHY

ARCHAEOZOIC

The igneous and metamorphic rocks of Archaeozoic basement crop out in two separate parts in the survey area. They are represented by granite-granodiorite, granite-gneiss, gneiss, schists, pegmatites and dolerite dykes. At the Hale River, northeast of the map area, these rocks belong to the Arunta Shield.

The second region of their occurrence lies in the southwestern corner of the map area where they represent the northern edge of the Musgrave block.

PROTEROZOIC

The oldest sequence of unmetamorphosed sediments rests unconformably on Archaeozoic rocks and these are usually subdivided into four formations: Heavitree Quartzite, Bitter Springs Limestone, Pioneer and Pertatataka Formations.

These rocks are not fossiliferous, except for the cryptozoon algae in the Bitter Springs Limestone. The lithological succession and the presence of glacial derived material similar to series of the Proterozoic Adelaidean System of South Australia suggest the placing of these sediments in the Upper Proterozoic. At Deep Well homestead a coelenterate fossil was found at the contact between Pertatataka and the younger Arumbera Formation. This fossil was determined as Rangea arborea of Upper Proterozoic age (Taylor, 1959) and established more accurately the boundary between Proterozoic and Palaeozoic sediments.

Heavitree Quartzite

The Heavitree Quartzite was named by Chewings (1928). This formation occurs in the Hale River area and was measured in 1958 by J. H. MacLeod. No additional work has been done on this formation this season. The thickness of these hard siliceous sandstones is here about 1,000 feet.

With the exception of the Hale River area the Heavitree Quartzite does not crop out within the area surveyed. Its extent southward is unknown but probably is restricted to the south of the MacDonnell and Fergusson Ranges.

R. Brunnschweiler (1959) has reported beds of dense quartzite in the core of the Mt. Burrell anticline. These hard silicified beds are perhaps lithologically similar to Heavitree Quartzite but since they are underlain by limestones and overlain by Pioneer conglomerates they are assigned to the Pioneer Formation.

Bitter Springs Limestone

This thick limestone succession conformably overlies the Heavitree Quartzite. The type locality is situated at Bitter Springs gorge in the eastern MacDonnell Range where it was first described and named by Joklik (1955).

The limestones and dolomites of this formation are very fine grained, pure and olive-grey in colour. Gypsum is often present and the whole sequence is usually strongly contorted, with beds and nodules of chert, often silicified breccia and thin veins of calcite. The Precambrian alga Collenia is the only known fossil. This could be observed in large colonies in outcrops.

The full thickness, 2,000 to 3,000 feet, of this formation was measured in the Hale River area by J. MacLeod and K. Phillips. Elsewhere within the survey area only the upper part of the Bitter Springs Limestone crops out. It occurs in anticlinal cores or as small inliers adjacent to the fault zones.

South of Phillipsons Pound 1125 feet of the section was attributed to this formation. From the base of the section, 300 feet was comprised of limestones.

The upper 825 feet are comprised of rocks of volcanic origin and products of their weathering. These are tuffaceous and vesicular, maroon-red in colour and contain crystals of epidote.

These volcanic rocks can be traced from south of Phillipsons Pound through the small outcrops at Wallaby Gap to the Bronco Bore on Hale River where an intrusive andesite sill on top of Bitter Springs Limestone was described by K. Phillips (1959). It seems to be more likely that these igneous rocks are of ejected rather than injected character.

Pioneer Formation

This sequence was laid down unconformably on Bitter Springs Limestone or, in some places, on weathered volcanic rocks. The formation consists of conglomerates, sandstones, shales, siltstones and some interbeds of limestone and dolomite. The succession is not consistent.

The conglomerates occur mainly in the lower part of the sequence. They differ in their lithology. In some places they consist of pebbles of quartzite and silicified limestone, well rounded and polished, (Mt. Burrell); in others, as at east of Deep Well homestead, they are of tillitic character, containing poorly sorted material. This material varies in size from gravel to boulders of igneous rocks, quartzites and Bitter Springs Limestone. The pebbles and boulders are angular and have facetted and striated surfaces.

The material of this second type of conglomerate, obviously of a glacial origin, was probably dumped into the sea by advancing glaciers or icebergs. In the partly concealed south Phillipsons Pound section 4,750 feet of Pioneer Formation was recorded.

The section at Phillipsons Pound in ascending order consists of:

> Gravel conglomerates with red jasper interbedded with felspathic sandstone, siltstones and shales with interbeds of limestone and dolomite, and beds of very fine cross-bedded sandstone and sandy limestone.

These latter beds of sandstone and limestone are lenticular and the type of cross-bedding in them is typical of fluvioglacial deposits.

The occurrences of the above-mentioned beds at the top of the Pioneer Formation is very persistent. The boundary between Pioneer and overlying Pertatataka Formations was picked at the top of these beds.

Pertatataka Formation

This formation first acquired its named from Madigan. The sediments rest unconformably on the Pioneer Formation, 2,400 feet of them being measured in the most complete section which occurs at south Phillipsons Pound.

In ascending order this section consists of olive-green shales, alternating with calcareous sandstone or siltstone, or alternations of sandy limestone or dolomite with shale or siltstone. In the upper part of the section massive dolomite with interbeds of red micaceous siltstone are present. This lithologic sequence is common to the northern parts of the survey area where the Pertatataka is rich in carbonates.

In the south this formation occurs in tilted fault blocks which form the Mt. Kingston Range (Plate 5). It is probably thicker here because in incomplete sections thicknesses up to 2,500 feet were measured. No carbonates were observed and the whole section was composed entirely of clastic sediments. The section is represented by alternations of very micaceous and very glauconitic sandstones and shales. As was mentioned above, the only known fossil found in these sediments is Rangea arborea.

PALAEOZOIC

CAMBRIAN

Arumbera Formation

This unit was named after Arumbera Creek in the MacDonnell Range. It conformably overlies the Pertatataka Formation. The lithology remains constant throughout the area and consists of siliceous sandstone, siltstone, shale and pebble conglomerate. The beds and lenses of conglomerate are usually situated towards the top of the formation. The conglomerates contain rounded medium-sized pebbles of quartzite and silicified limestone.

The sediments are predominantly maroon-red, purple-red or only rarely buff in colour and very micaceous. A maximum thickness of 2700 feet was recorded at east Phillipsons Pound. No fossils other than worm burrows and arthropod tracks were found in these sediments.

The occurrence of the Arumbera Formation above the Rangea arborea zone and below the archaeocyathid zone of the Pertaoorrta limestones, indicates a Lower Cambrian age for the Arumbera. This formation does not crop out south of Bokhara.

Very often in the tightly folded structures outcrops of this formation are discontinuous. Tightly contorted limestones of the Pertatataka and Pertaoorrta Formations contact for a distance of a few miles.

The writer believes that the Arumbera Formation was deposited continuously and was not eroded in the places where it is missing at present. The broken-up occurrence of highly competent units between two plastic limestone units is considered as development of large scale boudinage (Fig. 2).

Owing to this, the contact between Pertatataka and Pertaoorrta Formations shown in some places on the map as a normal geological boundary , must be considered as one of a tectonic character.

Pertaoorrta Formation

This formation conformably overlies the Arumbera Formation.

In other regions of the Amadeus Basin this formation is commonly subdivided into three members.

1. Upper, arenaceous members of buff to dark brown micaceous sandstone.

2. Middle, composed predominantly of limestone or dolomite with interbeds of siltstone and shale.

3. Lower, with predominant siltstones and shales and only occasional limestone beds.

In the survey area these subdivisions are not distinct. The upper Pertaoorrta sandstone occurs mainly in the north whilst in the Mt. Charlotte anticline only thin transitional beds can be assigned to this member. Separation of the lower and middle members of this formation throughout the whole area is quite impracticable because predominance of carbonate or clastic beds varies from section to section.

The maximum thickness of 3,900 feet was measured in the Ooraminna anticline, Section 11. In this section the sediments comprise fine grained grey limestones or grey to white crystalline dolomite interbedded with red-brown or buff micaceous siltstones. The Upper Pertaoorrta sandstone is here 900 feet thick. The sandstone is fine grained, siliceous, cross bedded, soft or flaggy. On the whole, sediments of the Pertaoorrta Formation reveal very variable shallow water environment.

Archaeocyathids, algae, brachiopods and trilobites date the deposition of this formation from Lower to Upper Cambrian time.

ORDOVICIAN

Larapintine Group

The subdivision of the Larapintine Group is clearly distinguishable everywhere. The occurrence of these sediments is restricted mainly to the northwest part of the area (James Range).

The scale of the map does not permit subdivision on it of the Larapintine Group, which consists of the following formations.

Pacoota Sandstone

Sedimentation of the Pacoota Sandstone begins very gradually through the transition beds of the upper Pertaoorrta Formation.

The conventional boundary between these two formations was picked at the base of the hard quartzitic band which immediately underlies the first band of vertical worm tubes.

This boundary is conventional also because palaeontological evidence shows that the lower part of the Pacoota Sandstone was deposited in Upper Cambrian time, not in Ordovician.

This sandstone is fine grained, clean, well sorted, quartzitic and often silicified hard. Intervals riddled with vertical worm tubes (scolithus?) are common throughout the section. One thousand, four hundred and fifty feet of Pacoota Sandstone was recorded in James Range (Section 27). Towards the east pre-Pertnjara erosion left only the lower beds of these sandstones, in Ooraminna 520 feet, and at the Steele Gap about 100 feet thick.

The most southerly occurrence of this formation lies to the north of Bokhara.

A large collection of fossils was made from the Pacoota Sandstone. An Upper Cambrian fauna from Ooraminna contains trilobites of the genera Prosaukia, Sinosaukia, cf. Maniwa and cf. Coreanocephalus and crustacean Ribeiroid genus A. A Lower Ordovician fauna is usually represented by the brachiopod Leptembolon (D. Taylor, 1959) from the Deep Well section.

Horn Valley Formation

The Horn Valley Formation conformably overlies the Pacoota Sandstone. After recent work a few beds, about 100 feet thick, of the Pacoota Sandstone were added to this formation. These are considered as the lower member of Horn Valley Formation. Two prominent bands of green glauconitic sandstone are situated at the top and bottom of this member. In places, this green sandstone band becomes very ferruginous due to extensive weathering of the glauconitic matrix.

South of Maryvale in the Mt. Charlotte anticline a sandstone succession of 300 to 400 feet was noted which probably could be correlated to the lower member of the Horn Valley.

This succession, known as the Mt. Charlotte Sandstone, was laid down disconformably on upper Pertaoorrta transition beds. Fifty to 100 feet of the red ferruginous siltstone and sandstone on top of Mt. Charlotte Sandstone could be equivalent to the upper green sandstone band of James Range.

The upper member of the Horn Valley Formation is known only in the north. It consists of dark grey limestones, siltstones and shales. The formation on the whole, and the limestone in particular, are very fossiliferous.

Brachiopods, trilobites, gastropods, pelecypods and cephalopods indicate the lower Ordovician age of this formation. Thickness of the Horn Valley Formation does not exceed 400 feet.

Stairway Sandstone

The Stairway Sandstone conformably overlies the Horn Valley Formation in the north. To the south it was laid down disconformably on the lower part of Horn Valley at Mt. Charlotte, and further to the south at Mt. Watt it rests with angular unconformity on the Pertatataka Formation.

The occurrence of Stairway Sandstone on Mt. Watt. is the most southerly outcrop of any member of the Larapintine Group.

The Stairway sandstones are lithologically similar to the Pacoota Sandstone. They are white, grey or buff in colour, finely cross bedded. They differ mainly by the lack of vertical worm tubes and the abundance of trilobite trails which form massive beds.

Middle Ordovician fossils (trilobite trails, trilobites, brachiopods, pelecypods and gastropods) are found in this formation. The maximum recorded thickness of this formation is 600 feet but complete sections are rarely exposed in the area.

Walker Creek Formation

This formation is known only from the James Range. The full section is never exposed and erosion usually produces a distinctive strike valley along these sediments. A thickness of 200 feet was estimated here. Lithologically similar to the Horn Valley Formation, the Walker Creek Formation consists of limestones and calcareous siltstones and shales, the limestones being very fossiliferous. A Middle Ordovician fauna includes brachiopods, gastropods and trilobites.

MIDDLE TO UPPER PALAEOZOIC

Mareenie Sandstone

The Mareenie Sandstone was laid down with apparent conformity upon the Walker Creek Formation. Its occurrence in the map area is restricted to the James Range where a thickness of 1100 feet was recorded at Mt. Peachy. The sandstones are white to buff, well sorted, siliceous and cross bedded. Ripple marks are common. Some of the beds are hard silicified. Fossils were not found in these sediments and a Middle Palaeozoic age can be only tentatively assigned to them.

Pertnjara Formation

To the west and north of the map area the Pertnjara Formation is composed of three members. These members in ascending order are:

1. Shales
2. Sandstones
3. Conglomerates

Only the sandstones of the middle member occur in the area surveyed. A maximum of 2500 feet was recorded at Ooraminna. Their lithology is very similar to the Mareenie Sandstone. They are buff, often leached white, fine to medium grained and cross bedded.

Impurity is probably the main feature in which they differ from the Mareenie Sandstone. Silicification seems to develop on the surface of outcrops irrespective of the bedding and is very common along vertical joints.

In the western part of the James Range the Pertnjara sandstone rests disconformably on the Mareenie Sandstone but east from Mt. Peachy it overlies successive units of the Larapintine Group and finally the Pertaoorrta Formation.

A basal conglomerate is present at Deep Well homestead and at Ooraminna. In the sandstone member of the Pertnjara Formation on Deception Creek, in Tempe Downs homestead area, was found an impression of a stem of Sigillaria which indicates the Carboniferous to Permian age of these sediments.

Finke River Beds

In the southern half of the area the sediments of Finke River Beds are widespread. These include all variations of sediments which are usually produced by a land glacier and the area of their distribution suggests a considerable continental glaciation. The Finke River Beds are usually represented by:

1. Tillites with big blocks, boulders, pebbles and grit, mainly of igneous rocks and some sedimentary quartzites.
2. Pebbly, gritty and shaly sandstone.
3. Varve bedded red and green micaceous siltstones.

On the whole the features of these sediments, including angularity, striated and polished surfaces of the boulders, and poor sorting leave no doubt of their glacial origin.

The highly contorted grits and sandstones, observed in some places, were produced by the contemporaneous oscillation of the ice. The varved bedding of red and green siltstones reveal the presence of morainic lakes. Their exposure in the stretch of 30 miles along the Finke River at Horseshoe Bend, at Mt. Engoordina and at Mt. Musgrave reveals the probable size of one of those lakes.

De Souza Sandstone

" This sandstone, named in a publication by C. J. Sullivan and A. A. Opik (1951), is white to buff, micaceous, cross bedded and contains scattered pebbles and conglomeratic lenses. Outcrops were noted in the south and east of Horseshoe Bend. An Ordovician or Jurassic age was assigned to it by various authors.

The situation of these deposits in the middle of the area of widespread Finke River Beds and the character of their origin most likely suggest their close association with products of this glaciation. Therefore, on the map the De Souza Sandstone is not separated from the Finke River Beds.

After deposition of Finke River Beds peneplanation took place and more recent erosion dissected this post-glacial peneplain into a multitude of mesas.

This type of relief shades the typical surface features known for the regions of glaciation. The hills shaped like drumlins and roches moutonnées in the vicinity of Kulgera are the only remnants of the glacial relief which can be observed at the present.

A Permian age is tentatively assigned to Finke River Beds, mainly because at that time glaciation took place in many parts of Australia.

MESOZOIC TO RECENT

Cretaceous

Usually beds of limonite indicate the erosional surface of a post-Finke River peneplain. Upon this ferruginous layer Lower Cretaceous sediments were deposited unconformably. These younger strata are locally named the "Rumbalara Shale" and contain a marine fauna similar to that found in the Rolling Downs Formation of Queensland. They have a thickness of 200 to 300 feet and are lithologically very consistent, consisting of blue-grey clay with gypsum or white kaolinitic claystone, the latter often showing secondary hardening into porcellanite. White, orange and purple colour and conchoidal fracture are typical features of these deposits.

Cretaceous sediments are confined to the scutheastern parts of the survey area and probably mark the margin of the Great Artesian Basin here.

Mesozoic, undifferentiated

To the north of the Cretaceous sediments are isolated cappings of younger sediments of clastic origin, now mainly silicified. Not much time was spent examining these occurrences. Some of these deposits may belong to a lacustrine facies of Cretaceous age or some could be younger.

TERTIARY

Arltungan Beds

Small isolated occurrences of flat lying silicified limestones occur within the area. Similar sediments in the vicinity of Henbury homestead contain a fauna of ostracods and gastropods, and this permits correlation of these lacustrine limestones with the Tertiary Arltungan Beds of the Harts Range.

STRUCTURE

The Mt. Burrell anticlinorium is the dominant structural feature of the area (see Plate 2).

This zone of complementary anticlinal and synclinal folds trends west-southwest and east-northeast.

That the Proterozoic and Palaeozoic sediments have experienced severe compression is evidenced by both isoclinal and recumbent folds.

Strong faulting is characteristic throughout the area. Major faults are usually parallel to the fold axes while the supplementary cross faults truncate the main fold structures often causing considerable displacement of beds.

In the southwestern part of the survey area a distinctive structural feature forms the Mt. Kingston Range (see Plate 5). This is a narrow fault block some 50 miles in length tilted northwards at from 30° to 40°. The sediments which make up this block are of the Pertatataka Formation and at Mt. Watt they are overlain unconformably by the flat lying Stairway Sandstone. This indicates pre-Stairway orogenic movement. However, upwarped Finke River Beds adjacent to the margin of the fault block shows that some further uplift has occurred after deposition of the Finke River sediments.

The sedimentary rocks are confined between two areas of crystalline basement, the Arunta Block in the north and the Musgrave Block in the south. The shape of folds suggests that the more active pressures were exerted from the south while the Arunta Block in the north exerted passive resistance.

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January, 1960

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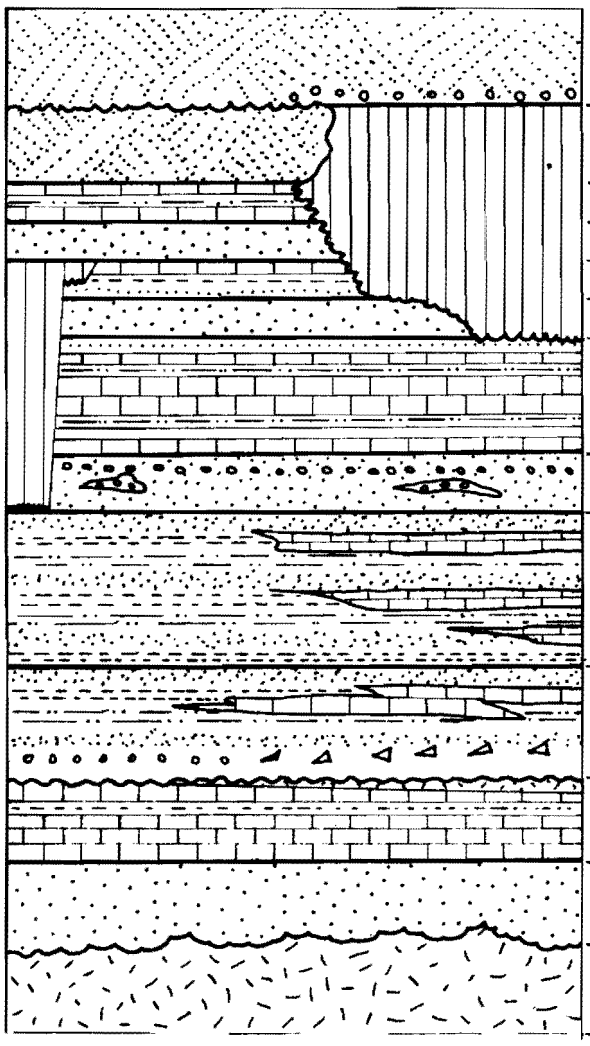


FIG. 1

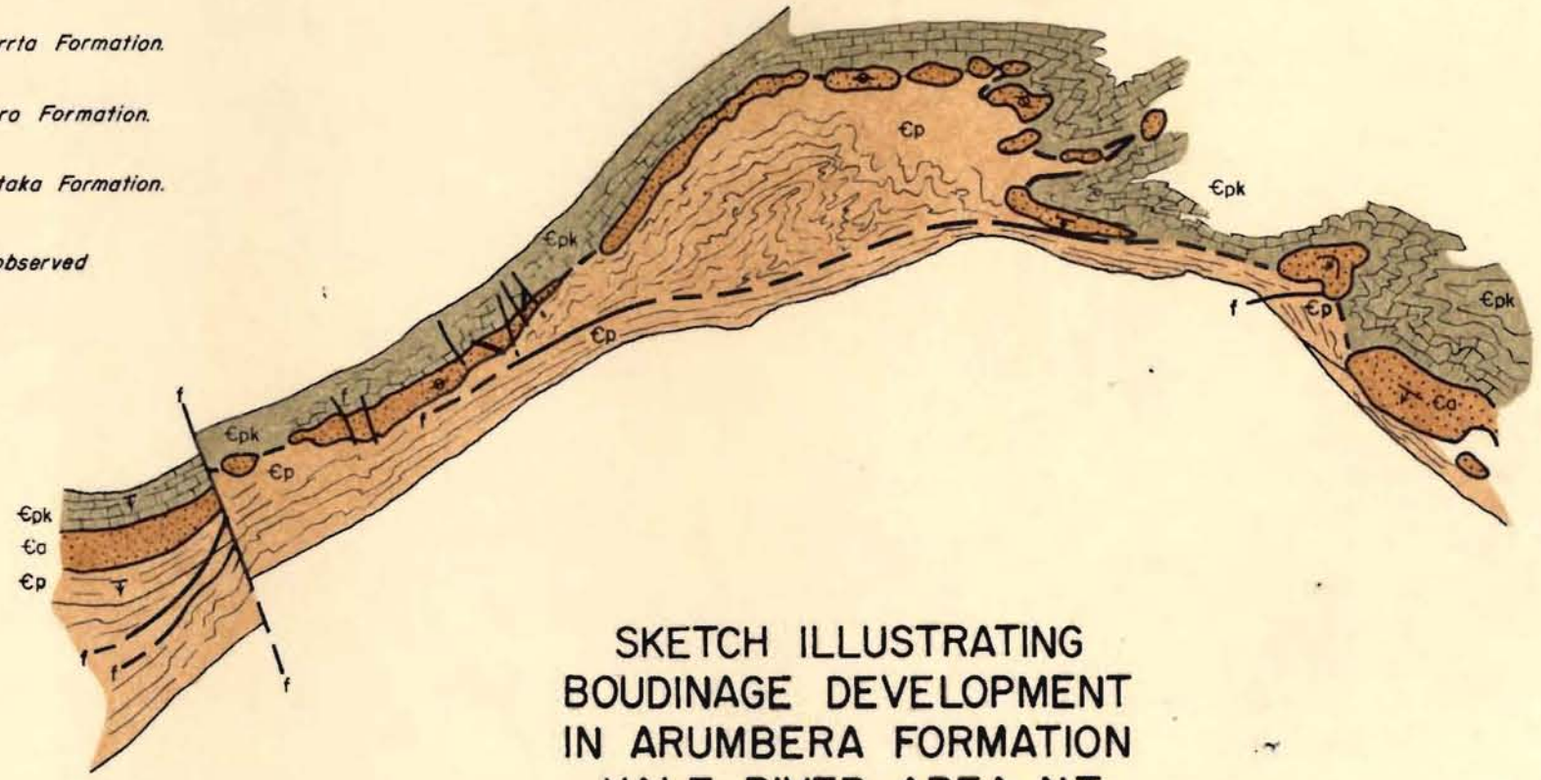
GENERALISED STRATIGRAPHIC COLUMN SOUTHEASTERN PART OF AMADEUS BASIN, N.T.

JAN. 1960

4300-G-29

LEGEND

- €p — Pertoooorrta Formation.
- €a — Arumbera Formation.
- €pk — Pertotataka Formation.
- f — Faults observed



SKETCH ILLUSTRATING
BOUDINAGE DEVELOPMENT
IN ARUMBERA FORMATION
HALE RIVER AREA, N.T.

FIG. 2

1 0 1 2 3 4 MILES

SCALE

JANUARY 1960.

4300-G-29

FRONTPIECE

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