PR56/3

Report No. NT/56/22.

GEOLOGY OF VICTORIA RIVER AREA

ASSOCIATED FRENEY OIL WELLS N.L.

PERMIT NO. 1, NORTHERN TERRITORY

BY

A.C.M. LAING AND R.J. ALLEN

OPEN FILE

NORTHERN TERRITORY
GEOLOGICAL SURVEY

Mines Administration Pty. Ltd.,
May 1956.

PR56/003

CONTENTS

LIST OF ILLUSTRATIONS

Separate Maps and Sections

SHEET 1. Geology of Victoria River Area (northern half)
Scale 2 miles to 1 inch.

SHEET 2. Geology of Victoria River Area (southern half)
Scale 2 miles to 1 inch.

SHEET 3. Geology of Jasper Gorge.
Scale 1.3 inches to 1 mile

SHEET 4. Locality Map.

SHEET 5. Stratigraphic Columns, Skull Creek Limestone.

SHEET 6. Stratigraphic Columns, Timber Creek Formation.

SHEET 7. Stratigraphic Column, Coolibah Formation.

SHEET 8. Diagrammatic Stratigraphic Columns, Victoria River Area.

SHEET 9. Geological Sections, Victoria River Area.

PLATE 1. Photographs and Figure.

SUMMARY.

The geology of Associated Frency Oil Fields Permit No. 1, Northern Territory, is described with the aid of 9 maps and sections.

The area consists almost entirely of Upper Proterozoic rocks which were subdivided into 6 mapped units.

Two drilling sites on structures are suggested to test the oil possibilities of the area.

INTRODUCTION:

The area mapped consists of 10,000 square miles covering the Associated Frenoy Oil Fields N.L. Permit No. 1, Northern Territory.

The Permit applied for is as follows:-

"Datum point of Latitude 17 degrees south Longitude 130 degrees east thence east along the southern boundary direct to Latitude 17 degrees south Longitude 131 degrees 30 minutes east thence north direct to Latitude 15 degrees 30 minutes south Longitude 131 degrees 30 minutes east thence west direct to Latitude 15 degrees 30 minutes south Longitude 130 degrees 30 minutes east thence southwest direct to Latitude 16 degrees 11 minutes south Longitude 130 degrees east thence south direct to the point of commencement, being an approximate area of 9,200 square miles."

The Permit covers part of 4 cattle stations, Auvergne, Coolibah, Victoria River Downs and Humbert River.

The area has a warm dry monsoonal climate with a short rainy season from December to March, and a long dry season from April to November. The average annual rainfall is 25 inches. Temperature during the day is high, often exceeding 100 degrees F. in summer. Night temperatures show greater variation throughout the year than day temperatures, the greatest variation being in winter.

Access:

Access to the area is by the following routes:

1. By road from the port of Wyndham.
2. By road from the port of Darwin, via Katherine.
3. By road from Newcastle Waters.
4. By water up the Victoria River to Timber Creek.
5. By air from Wyndham or Katherine.

1. The road from Wyndham to Timber Creek, 200 miles in length, is passable for vehicular traffic throughout the dry season, but impassable during the "wet". The Western Australian section is a formed metal road, sealed in part. The Territory section has been graded only.

2. The Darwin-Katherine section (220 miles) is part of the Stuart Highway, an all-weather bitumen road. From Katherine to Timber Creek (200 miles) the road is graded, but otherwise unimproved, except for a concrete crossing at the King River, near Katherine. The road is impassable during the wet season.

3. The overland route from Newcastle Waters - the Murrenji track - is open only during the dry season. It too is only a graded trace but it presents the shortest route of access to the area for vehicles travelling up the Stuart Highway from Queensland or South Australia.

4. The Victoria River is navigable to very small craft only as far as Timber Creek, where it is still tidal.

5. All parts of the area are less than three hundred air miles from Katherine or Wyndham. There are aerodromes at Coolibah, Timber Creek, Auvergne, Victoria River Downs and Sandford; all have at least a fortnightly plane service. Air travel is at present the most practicable form of transport during the wet season, when vehicular travel becomes impossible.

Communications :

The eastern half of the Permit (east of a line running south from Timber Creek Police Station) is well covered by vehicular tracks. On the west side of the Permit, bordering the West Baines River, a belt of sandstone country with deep gorges is difficult of access even by Land Rover.

All stations are linked by wireless to the Wyndham base of the Royal Flying Doctor Service and to one another.

Previous Work :

Geologists have passed through the area covered by the Permit but the only geological mapping done previously was by Traves (1955). His four mile to one inch field sheets were used and proved to be substantially accurate. His Victoria River Group was subdivided into 6 units by the authors.

Fieldwork :

This report was compiled after approximately 4 months fieldwork in the area.

From 20th June to 29th August the party consisted of A.C.M. Laing, R.J. Allen (geologists), E.G. Fudge (cook). From 29th August to 29th September the party consisted of A.C.M. Laing, R.J. Allen, S.S. Derrington (geologists), E.G. Fudge (cook.) From 16th October to 29th October the party consisted of A.C.M. Laing , J.E. Burbury and P.E. Power (geologists).

Air photographs were available in the field for the northern one third of the Permit, namely parts of Auvergne and Delamere 4 - mile sheets and runs 1 - 3, Victoria River Downs 4 - mile sheet. Photographs for Waterloo 4 - mile sheet, runs 8 - 15 were available during the last fortnight spent in the field. The remainder of the field work was done by Land Rover traverses supplemented by air photograph interpretation later in Canberra. Special attention was paid to structures and the 4 - mile field sheets prepared by Traves were used for locating these.

All geological information collected from field traverses and air photo interpetation was plotted on mosaics drawn at photo scale (approximately 1.3 inches to 1 mile).

The majority of these photo mosaics were assembled by National Mapping Section, Department of the Interior. However, in the Delamere and Auvergne sheets, mosaics compiled by the authors were used.

The Auvergne mosaic was a poor fit, but was only roughly adjusted.

Topography :

Five topographical divisions are recognized :

1. Plateaux
2. Limestone ridges and domes
3. Stony downs
4. Grassy plains
5. Alluvial flats

Plateaux:

The Victoria River, and its tributaries have dissected the sub-horizontal Jasper Gorge Sandstone, leaving great plateaux and deep gorges. The plateaux have different levels, ranging up to 600 feet above sea level, between Timber Creek and Coolibah, and up to 1000 feet at the headwaters of the Humbert River.

Limestone ridges and domes:

The Skull Creek Limestone forms low ridges and domes ranging to a maximum of 100 feet. These show typical karst pattern.

Stony downs:

This division consists of low, rolling, stony downs, developed on the Antrim Plateau Volcanics. The basalt "boulders" range up to 1 foot in diameter.

Grassy plains:

The Coolibah Siltstone and Auvergne Siltstone weather to form flat, open plains, with a heavy growth of kangaroo grass, and a few scattered trees, as seen between Skull Creek and Coolibah, and around Auvergne.

Alluvial flats:

These are developed along all the major streams, except where the latter run in narrow gorges through the plateaux.

STRATIGRAPHY:

The stratigraphy of the area may be summarised as follows:

Quaternary	alluvium	
Tertiary	laterite	
Lower Cambrian	Antrim Plateau Volcanics	
Upper Proterozoic	Pinkerton Beds sandstone and shales	1000+ ft.
	Auvergne Shale green shale	500-1000 ft.
	Jasper Gorge Sandstone red sandstone	maximum 600 ft.
	Coolibah Formation purple and green siltstone and shale	500 ft.
	Skull Creek Limestone dolomitic limestone and chert (thickness 900 ft.)	= Timber Creek Formation siltstone and siliceous limestone

The relationship and thicknesses of the formations are illustrated in Sheet 6.

Skull Creek Limestone:

The oldest formation cropping out in the Permit is the Skull Creek Limestone, which consists of about 1000 feet of dolomitic limestone, chert and very minor amounts of quartz sandstone and siltstone. The base is nowhere exposed. In the northern, western and south-western limits of its outcrop, the formation grades laterally into the Timber Creek Formation, a unit made up of siltstone, dolomitic limestone with chert, and sandstone.

The type section for the Skull Creek Limestone is in the domes on the Timber Creek-Jasper Gorge road, twenty miles from Timber Creek Police Station. At this locality, Skull Creek, from which the formation takes its name, runs close to the road, in the gap between the western two domes. Detailed studies were made of this type section, and two other sections in the Permit.

The Dolomitic Limestone:

The carbonate rock which forms the bulk of the unit is described as dolomitic limestone, on the basis of field determinations (on colour,

texture, hardness, resistance to acid, presence of dolomite rhombs on weathered surface) supplemented by etching and staining tests on a few selected specimens. The authors believe that more or less pure limestone occurs in the formation, but was not recognised definitely in the field.

The colour of the dolomitic limestone ranges from fawn to grey, rarely pink, on the weathered surface, and a fresh surface shows a different shade of the same colours, some with a tinge of pink. The grain size ranges from very fine to medium crystalline. Weathered surfaces show numerous small rhombs of dolomite. The very fine-grained beds tend to be silicified; otherwise, the carbonates are relatively pure, giving in acid solution, only a very little insoluble residue, probably argillaceous.

Exposed surfaces of the dolomitic limestone beds show fluting and potholing, characteristic of carbonate rock weathering. There are also many small fissures, possibly caused by dolomitisation, which results in slight reduction in volume of the rock affected.

Where the formation is considerably weathered, a secondary limestone or caliche has developed in the soil.

"Marker" Members:

Two members of the Skull Creek Limestone are sufficiently distinctive in lithology, and widespread in occurrence to be useful as marker beds. The first of these, the "upper marker", crops out about half way up the type section at Skull Creek. It consists of well-bedded, dark grey dolomitic limestone, grey to fawn in colour on fresh surface, fine to medium in grain, and shows dolomite rhombs on the weathered surface. In its typical outcrop, the rock is slightly fluted, deeply dissected and pot-holed (Figure 2). It ranges in thickness, the maximum measured being 36 feet in the middle dome at Skull Creek. In many outcrops the marker is underlain by a bed of dark grey dolomitic limestone, with numerous thin layers of chert. The marker bed itself rarely contains chert. It has its own characteristic vegetation, being favoured by a small compact bushy tree with a small broad green leaf.

This "upper marker" is very widely distributed, being found almost everywhere the Skull Creek Limestone crops out. In addition to being readily recognisable on the ground, it has a characteristic pattern on air photographs. It proved of considerable value in the elucidation of structure, and in correlating the numerous sections studied. Although it was used as datum in the latter work, this is not meant to suggest that this marker is considered to be isochronous throughout; rather, it probably varies slightly in age from one locality to another, i.e. we have purely "rock" correlation, not "time" correlation.

The second marker member, the "lower marker", is found some 80 to 100 feet stratigraphically below the "upper marker" in the type section. It consists of a number of beds of fawn dolomitic limestone, each with several horizons of small brown spheroidal bodies, of sizes up to 1/8" diameter, and apparently of argillaceous composition. Some beds are partly silicified. The member has a thickness of 80 feet (maximum) in the type section. No satisfactory explanation can be offered for the mode of formation of the small spheroidal bodies; they do not appear to be oolitic.

This "lower marker" is much more restricted in its distribution than is the "upper marker". Besides its occurrence in the sections at Skull Creek and Surprise Creek, it was found only near Bullita Outstation. Unlike the "upper marker" it does not form a prominent outcrop, and cannot be recognised on air photographs. It was of some limited use in correlating the Skull Creek and Surprise Creek sections.

Fossil "Algae":

Certain forms, believed to be of organic origin were found at many horizons within the Skull Creek Limestone (Figures 3 & 4). They are circular to oval in plan, and raised semi-circular in section, being composed of a large number of thin hemi-spherical layers, suggesting growth lines. In size they range from several inches to three feet in diameter. At certain localities they are numerous and form small biostromes. Most are composed of limestone, generally not

dolomitic. Some small representatives preserved as silica were collected near Timber Creek, and other siliceous forms, oval in section, were found north-east of Victoria River Downs.

None of the forms examined had any definite organic structure. However, they bear a superficial resemblance to the supposed fossil alga Collenia, described by Fairbridge (1950) from a late Precambrian limestone in Western Australia, and by Traves (1954) from a limestone (probably equivalent to the Skull Creek Limestone) at Top Spring, 80 miles east of Victoria River Downs. They have therefore been given for convenience, the general name "algae", pending palaeontological study.

These supposed fossils were not of stratigraphic value.

Chert:

The Skull Creek Limestone contains a large amount of chert, developed as thin irregular bands and nodular layers within the dolomitic limestone, (Figure 1), and thick irregular masses interbedded with it.

The chert composing the thin layers is fawn to brown in colour on the weathered surface, and grey on fresh surface. It is extremely fine grained, probably cryptocrystalline. In some outcrops, the chert cuts across the bedding planes of the limestone, and possesses fantastically contorted forms (Figure 7). These structures probably were formed by movement of the silica as a gel during consolidation of the beds after deposition.

The massive chert is white to red-brown in colour, and extremely fine grained. Outcrops of it may be seen at the junction of the Timber Creek-Coolibah road with the road to Jasper Gorge, and also where the Coolibah road crosses Skull Creek. It is up to 100 feet in thickness.

Both developments of chert appear to be chemical deposits.

The massive chert lies near the top of the Skull Creek Limestone and can be mapped as a separate member from its distinctive pattern on the air photographs. However, areas so mapped contain many inliers of the limestone not delineated.

Sandstone:

The Skull Creek Limestone contains very little sandstone. Near the base of the type section, at Skull Creek, there are several thin beds (the thickest 3 feet) of fine grained, pink, calcareous quartz sandstone. Similar sandstone crops out near the base of the Surprise Creek section. In the section west of the Pigeon Hole road, there is possibly thirty feet of quartz sandstone, siliceous in part, but having a very poor outcrop. In the middle of the anticline east of Bullita Outstation, there is a little white to brown fine quartz sandstone, with calcareous cement.

Siltstone:

Only an insignificant amount of siltstone was found within the Skull Creek Limestone. It is green and purple or dark red in colour, and mostly calcareous.

Depositional Environment:

The Skull Creek Limestone appears to have been formed as a chemical deposit in a quiet, marine basin, slowly subsiding. The lateral gradation with the Timber Creek Formation suggests that the shores of the basin lay to the north and west. The surrounding areas were probably almost at base-level, providing mainly fine detritus (clay and silt) and solutions rich in lime, magnesia and silica.

Timber Creek Formation:

The Timber Creek Formation is the new name given to the lateral variation of the Skull Creek Limestone and it consists mainly of purple siltstone with minor siliceous limestone, fine sandstone and chert. The type section is a hill on the east side of Timber Creek, 5 miles south of the Police Station. A well-defined marker bed of contorted chert boulders, in the section persists over an area of 5 or 6 square miles. Siliceous limestone predominates in the upper part of the formation.

The position of the gradational boundary has been estimated on the ground as the place where more than 10% purple siltstone enters into a predominantly limestone section. This was found to be about where a change in air photograph pattern took place from the distinctive limestone pattern to the pattern for bedded, fine grained, clastic rocks.

The gradational boundary swings around to the west of the Skull Creek Limestone and south to the Sandford Gorge.

A section was also measured in the upper Humbert River. This is presented as a stratigraphic column with the type section at Timber Creek (Sheet 6).

Five miles south of Timber Creek a 30 feet band of chart is found near the top of the Timber Creek Formation.

Current ripple marks are common in the siltstone of the Timber Creek Formation outcropping along Gibbie Creek north of Mt. Sandford Outstation. They were also found in limestone along the Humbert-Bullita Outstation track.

Coolibah Formation:

This formation includes the Victoria River Shale as described by Brown (1905). The formation is renamed Coolibah Formation to avoid confusion with the Victoria River Group of Traves (1955).

The type section of the lower part of the formation is at the crossing of the Victoria River at Coolibah; and of the upper part on a mesa just south of the Timber Creek-Coolibah road, some 4 miles from Coolibah.

The total thickness of the formation measured in its type sections is 900 feet. The plotted stratigraphic column of the upper 400 feet is given in Sheet 7.

The formation mostly consists of alternate 2 feet beds of purple siltstone and hard, light green, laminated shale. Both lithological types are dominantly siliceous but the formation becomes more calcareous in its lower part.

An indication of the environment of deposition can be obtained from the different sedimentary features seen. These included mud cracks, swash marks, ripple marks - all indications of shallow water deposition.

The following are the dimensions of ripple marks measured:

Wavelength	Amplitude	Index	Locality
3.12cm	.159cm	20	Jasper Gorge
5.03cm	.635cm	8	Victoria River Downs road
3.5cm	.5cm	7	Coolibah Crossing

The Coolibah Formation as mapped lies unconformably on the Skull Creek Limestone with an angular unconformity of about 5 degrees. This unconformity was examined on the ground in three localities, 8 miles west of Coolibah Homestead, 6 miles west of Humbert River Homestead, and at the head of Spring Creek, a few miles south-west of Bullita Outstation.

The unconformity is well exposed near Humbert River, where a band of limestone, apparently the basal member of the Coolibah Formation, overlies 2 to 10 feet of limestone fragments in a reddish recemented earthy deposit, taken as representing the old land surface. This surface dips northwards at about 2 degrees. About 2 miles south of this locality a small outlier of Coolibah Formation is surrounded by Skull Creek Limestone topographically higher.

The Coolibah Formation as mapped does not overlie on Timber Creek Formation anywhere. The following relationship probably holds :

Jasper Gorge Sandstone	Jasper Gorge Sandstone
	partly conformable partly disconformable
unconformity	
Timber Creek Formation	Coolibah Formation
	unconformity
	Skull Creek Limestone

Jasper Gorge Sandstone :

The Jasper Gorge Sandstone is equivalent to the Victoria River Sandstone of Broun (1895), who gave this name to the sandstone cropping out in scarps round the lower reaches of the Victoria River. Traves (1955) used the term Victoria River Group which included the Victoria River Sandstone (now Jasper Gorge Sandstone), Victoria River Shale (now Coolibah Formation) Skull Creek Limestone and Timber Creek Formation. As one widespread unconformity was found in the area (at the top of the Skull Creek Limestone and Timber Creek Formation), the term Victoria River Group has been abandoned. Because of possible confusion with the Victoria River Group, the names Victoria River Sandstone and Victoria River Shale have also been abandoned.

The type section for the Jasper Gorge Sandstone is at the eastern end of the JasperGorge where about 600 feet of red and white

predominantly quartz sandstones overlie green shale of the Coolibah Formation.

The base of the Jasper Gorge Sandstone was traced by eye along the scarp south of the Timber Creek-Coolibah road. The basal red marker sandstone was not continuous over this distance but as one sandstone bed lensed out another appeared just under or over it.

On a mesa about 5 miles west of the Coolibah Turn-off on the main road the following section was measured.

25 ft. red sandstone strongly outcropping

200 ft. green and purple shale partly obscured by scree

50 ft. red sandstone strongly outcropping.

The Jasper Gorge Sandstone can be traced on the air photographs west from Coolibah along the Victoria River to Timber Creek where only about 50 feet of red sandstone cap the mesas.

Further west still, south of Auvergne Homestead, in the East Baines gorge the Jasper Gorge Sandstone is about 150 feet thick. There it lies on Timber Creek Formation and is overlain by Auvergne Shales.

It is thought that the formation has a maximum thickness of 200 feet south of Auvergne, on the sandstone plateau east of the West Baines River.

South of the Sandford gorge the Jasper Gorge Sandstone lies unconformably on the Timber Creek Formation. Further south still it is found as inliers in the Antrim Plateau Volcanics south of Mt. Sandford Outstation.

The Jasper Gorge Sandstone is a red, mainly current-bedded, quartz sandstone. It becomes progressively more felspathic southwards suggesting its source was in that direction. The round, sand-size grains of quartz are either cemented with siliceous cement in optical continuity with the grains or with ferruginous cement.

Sedimentary features indicative of the origin of Jasper Gorge Sandstone are ripple marks, rain drop prints, mud cracks, salt crystal marks and probable worm tracks. There are conglomerates present containing mud pellets, shale and chert pebbles. The ripple

marks are oscillation ripple marks. The following is a list of those measured in the Jasper Gorge area :

Wavelength	Amplitude	Index
10.37cm.	1.27cm.	8
83.7cm	8.0cm	10
3.15cm	0.38cm	8
43.9cm	3.66cm	11.5
33.1cm	3.66cm	9.1
38.1cm	3.66cm	10.5

All that can be deduced is that the rocks containing the oscillation ripple marks must have been laid down in less than 60 fathoms of water, and probably in much shallower water close to a shoreline. As suggested by the mud cracks and rain prints.

It is believed that the Jasper Gorge Sandstone does not represent exactly the same time interval all over the Permit. Figure 8 shows the probable relationship in the northern half of the Permit.

South of Coolibah Homestead the Jasper Gorge Sandstone lies with probable disconformity on the Coolibah Formation. Of the chert and shale pebbles found in the sandstone, the chert pebbles appear to be from the Skull Creek Limestone, while some of the shale pebbles may be derived from the underlying Coolibah Formation.

In two places in Jasper Gorge itself and at the north end of Sandford gorge (30 miles north of Mt. Sandford Outstation), the Coolibah Formation grades up into the Jasper Gorge Sandstone without a distinct break.

In a small outlier five miles north of Bullita Outstation the Jasper Gorge Sandstone directly overlies the Skull Creek Limestone. This is apparently the case also in the Moolooloo Anticline on the eastern edge of the Permit.

At Timber Creek and also on the Mt. Sandford-Victoria River Downs road, the Jasper Gorge Sandstone lies unconformably on the Timber Creek Formation.

Auvergne Shale :

This is a new formation defined here for the first time. Previously it was included in Traves' Victoria River Group. The type area is the banks of the East Baines River around Auvergne Homestead.

The area of outcrop of the formation also includes the valley of the West Baines River from its junction with the Victoria River to 10 miles north of Kildurk Station, and the lower slopes of the Pinkerton Range.

Typically it is a green shale. It lies apparently conformably on the Jasper Gorge Sandstone. The exact contact was not found and the relationship is inferred from the field mapping and air photo interpretation, which indicate that the Jasper Gorge Sandstone dips gently below the formation.

The thickness of the Auvergne Shale is not definitely known. Measured dips are, as is usual with shales, rather anomalous. No bores have definitely penetrated the formation. The inferred thickness is about 1000 feet, although the formation may be twice that thickness. The average width of outcrop of the formation is about 16 miles.

There are several areas near the Jasper Gorge Sandstone boundary where a joint pattern rather similar to that of the sandstone can be seen on the air photographs, although there is no outcrop of sandstone. These areas are assumed to be of Jasper Gorge Sandstone with a thin cover of Auvergne Shale.

Pinkerton Beds:

The name Pinkerton Beds is used here for the unit overlying the Auvergne Shale in the Pinkerton Range. Traves (1955) included it in his Victoria River Group. The writers did not examine the unit thoroughly.

The thickness of the Pinkerton Beds is 600 feet plus. There are 600 feet of Pinkerton Beds exposed in the face of the Pinkerton Range a few miles north-west of Auvergne Homestead.

Traves (1955) gives the following section measured in the scarp of the Pinkerton Range west of Auvergne Homestead.

80 ft.	Medium bedded sandstone with ripple marks, mud pellets, and mud cracks.
60 ft.	massive quartzite.

140 ft. dolomite or limestone

10 ft. scree

70 ft. thin to medium bedded sandstone with ripple marks and mud pellets and beds of shale.

The Pinkerton Beds overlie the Auvergne Shale in the scarp of the Pinkerton Range but their exact relationship is not known.

Antrim Plateau Volcanics:

David (1932) first named this unit Antrim Plateau Basalts. Traves (1955) extended the unit over a wide area. He recognised andesites and tuffs in the unit as well as basalts, therefore renaming it Antrim Plateau Volcanics.

The unit as mapped by Traves extends in a semicircle, open at the north and around the Permit and thus the Victoria River Basin.

Antrim Plateau Volcanics were mapped in a belt running east of Coolibah and Victoria River Downs Homesteads to the north of Pigeon Hole Outstation and across to a few miles south of Mt. Sandford Outstation. Antrim Plateau Volcanics were also seen west of the Permit on Kildurk Station.

On the air photographs the country covered by the Volcanics can be distinguished by the soft outlines of the topography with some scarps with black screes formed of basalt boulders. On the ground the Volcanics are seen to be very thin on the average with frequent inliers of Jasper Gorge Sandstone that cannot always be distinguished on the air photographs.

There is a large unconformity between the Antrim Plateau Volcanics and the Jasper Gorge Sandstone.

The Volcanics have poured onto a deeply dissected topography carved in the Jasper Gorge Sandstone and filled valleys in the sandstone. At one place about 8 miles south of Mt. Sandford Outstation a welded, steeply dipping contact between basalt and sandstone was seen. In most places however, the only signs of the contact are the clusters of quartz crystals or massive lumps of quartz about 4 inches in diameter, lying scattered around on the surface. The clusters of quartz crystals are sometimes found in cavities in the lower part of the Volcanics.

The writers did not map either the Pinkerton Beds or the Auvergne

Shale anywhere in juxtaposition to the Antrim Plateau Volcanics so that the relationship of these younger Upper Proterozoic formations to the Volcanics is unknown.

The thickness of the Antrim Plateau Volcanics ranges from a maximum of 3300 feet (Traves 1955) in the Hardman Basin (Ord and Negri Rivers) to an average thickness of 50 feet within the area mapped.

Laterite :

On top of the Jasper Gorge Sandstone in the south-west portion of the Permit there is a laterite plateau giving a distinctive pattern on the air photographs and was therefore mapped as a separate unit. A black scarp with embayments shows on the edge of the laterite sheet. In the stereoscopic study of the air photographs the black edge is seen to be caused by a strong growth of trees enabling it to be distinguished from the scarps of Antrim Plateau Volcanics. On the main body of the laterite the photographs show flat country with scattered trees. In many places the laterite sheet is thin as steep zones in the underlying Jasper Gorge Sandstone show a subdued pattern through it.

The thickness of the laterite was measured in an outlier at the head of the Humbert River. There was about 30 feet of laterite, the upper part consisting of mottled clayey iron nodules, lying on fine red felspathic sandstone (Jasper Gorge Sandstone). No siliceous zone was seen in the laterite profile. The absence of quartz grains in the visible upper part of the laterite profile makes it likely that it was derived from a younger formation lying on top of the sandstone, possibly the widespread Cretaceous beds.

STRUCTURE :

Regionally, the area forms an Upper Proterozoic sedimentary basin, the Victoria River Basin. The oldest deposits now exposed in this basin have two distinct facies. A marginal one represented by the Timber Creek Formation and a deeper water one represented by the Skull Creek Limestone. The western and southern sides of the basin are defined by the gradational boundary of the Timber Creek Formation - Skull Creek Limestone.

Overlying these beds unconformably are very shallow water beds (Coolibah Formation and Jasper Gorge Sandstone) indicating that the basin was gradually filling up.

The geological structures in the area are of a type peculiar to the Precambrian nuclei on the western side of Australia and consist mainly of long narrow zones of steeply dipping beds between large areas of almost flat-lying strata.

The steeply dipping zones are not aligned consistently in any one direction but tend to lie around diamond-shaped blocks.

They can be classified into two types as follows :-

1. Monoclines
2. Domes and anticlines

The monoclines have an elbow in which there is a sharp change from flattish dips of about 15 degrees to steep dips of 40 degrees or more on the upthrow side. On the downthrow side there is a more gradual change from steep to shallow dips.

The monoclines run in long sinuous lines about 1/4 mile wide. They die out lengthwise by gradually flattening out.

The monocline 4 miles east of Bullita Outstation at the head of the East Baines River, forms the western limb of an assymetric anticline.

Domes and a few anticlines are found along the line of these steep zones. The domes are mostly faulted at an acute angle to their long axis with horizontal displacement of beds. Such faults were found with horizontal throw of up to 400 feet, in some cases in a clockwise sense, in others anticlockwise.

The domes are also peculiar in that there is a sharp transition from the steep (23 degrees plus) beds with closure to the surrounding gentle dipping beds (10 degrees).

The average dimension of the actual domes is about 60 x 40 chains though two domes, one at Humbert River, the other north-west of Mt. Sandford Outstation, were different in that they were circular in outcrop rather than elliptical.

The average dip of the Timber Creek Formation and Skull Creek Limestone outside the steep zones is 5 to 10 degrees. The overlying Jasper Gorge Sandstone and Coolibah Formation have an average dip of one to two degrees.

Steep zones mainly occur in the Timber Creek Formation and Skull Creek Limestone but there are a few in the Jasper Gorge Sandstone. One was seen in the Pinkerton Beds.

At Jasper Gorge the domes of Skull Creek Limestone pass under the almost flat-lying Jasper Gorge Sandstone; 8 miles along the prolongation of the axis of the domes is the Surprise Creek anticline, also formed of Skull Creek Limestone.

Between these two anticlines the line of probable structures in the Skull Creek Limestone is shown in the overlying Jasper Gorge Sandstone by a series of straight tension joints several miles in length. These joints are parallel to the supposed join of the Skull Creek and Surprise Creek anticlinal axes under the Jasper Gorge Sandstone. Along this line there is probably a dome at depth at the eastern end of the Jasper Gorge. There, four east-west faults in the Jasper Gorge Sandstone give, with some monoclinal steepening of dips, a total throw of about 400 feet to the south. The long joint trending south-south-east for 12 miles, 4 miles east of Coolibah, probably also represents a steeply dipping zone at depth as its line runs towards the Woolaloo Anticline.

The explanation here adopted for the monoclines, domes and anticlines is that they are formed by slight readjustment along diamond-shaped crustal blocks. Where these blocks have moved apart slightly a monocline was formed. Where they moved closer together an anticline resulted.

Where there is slight horizontal movement between blocks a dome is formed which if horizontal movement continues, becomes faulted approximately along its axis.

There are at least two periods of folding in the area, one before the deposition of the Coolibah Formation, one after the deposition of the Jasper Gorge Sandstone, although folding, caused by movement between the crustal blocks, probably occurred at intervals throughout geological time.

Since its deposition the Jasper Gorge Sandstone has been folded into a geanticline in effect inverting the Victoria River Basin. In the north-east portion of the Permit it has been tilted 2 degrees to the north-east. On the eastern side of the Permit it dips east-south-east under the Antrim Plateau Volcanics at about the same angle.

The majority of structures mapped were folds in either the Skull Creek Limestone or the Timber Creek Formation.

Most of the structures mapped in the Skull Creek Limestone were exposed to the same horizon about 600 feet below the top of the formation. The sequence below this is unknown.

However, there are a group of structures on the eastern and western sides of the area in which the Jasper Gorge Sandstone is folded. These are thought to be on the edge of the Victoria River Basin and to represent the best oil prospects.

REFERENCES:

BLATCHFORD, T., 1922 - Interim Report on the Occurrence of Glance Pitch near the junction of the Negri & Ord Rivers, known as "Oakes' Find". Geol. Surv. W.Aust., Ann. Prog. Rep., 1921,20-23.

BROWN, H.Y.L., 1895 - Government Geologist's Report on Explorations in the Northern Territory. S. Aust. Parl. Pap., 82.

FAIRBRIDGE, R.W., 1950 - "Precambrian algal limestones in Western Australia." Geol. Mag., 87, 324-330.

STPTON, E.S., 1921 - Bitumen, Terms Station, Kimberley Division. Geol. Surv. W. Aust., Ann. Prog. Rep. 1920, 23.

TRAVES, D.M., 1954 - Collenia Frequens in Upper Proterozoic Rocks in the Northern Territory of Australia. Proc. Linn. Soc. N.S.W. Vol. LXXIX, parts 3-4.

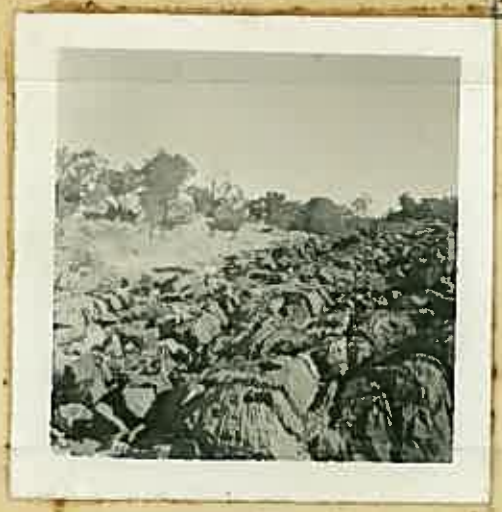
TRAVES, D.M., 1955 - Geology of Ord-Victoria Region. Bur. Min. Resour. Aust., Bull. 27.

ILLUSTRATIONS

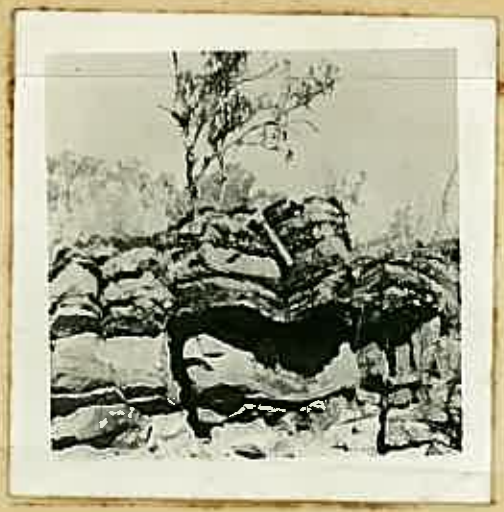
PLATE 1.

1. Skull Creek Limestone at Skull Creek, showing chert bands.
2. Upper marker member of the Skull Creek Limestone. Locality: western dome at Skull Creek.
3. Biostrome of "algae" in Skull Creek Limestone. Locality: middle dome at Skull Creek.
4. "Alga" in Skull Creek Limestone. Locality: middle dome at Skull Creek.
5. View north-east from middle dome at Skull Creek, towards Stokes Range. Skull Creek Limestone in foreground, Coolibah Formation in middle ground and lower part of scarp, Jasper Gorge Sandstone capping scarp.
6. Jasper Gorge Sandstone at Jasper Gorge.
7. Bands and nodules of chert (shaded) in dolomitic limestone (white). Locality: Sandford road, 7 miles from Victoria River Downs.

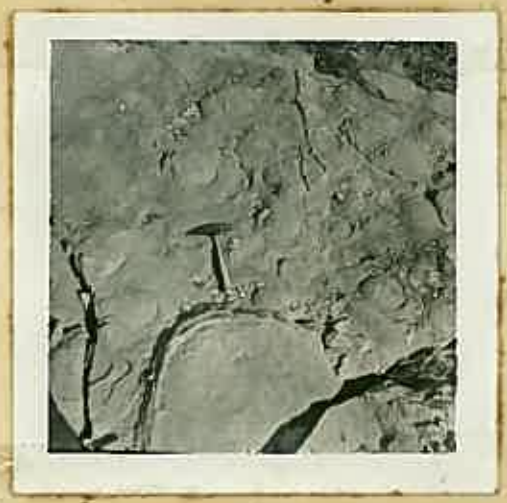
PLATE 1.



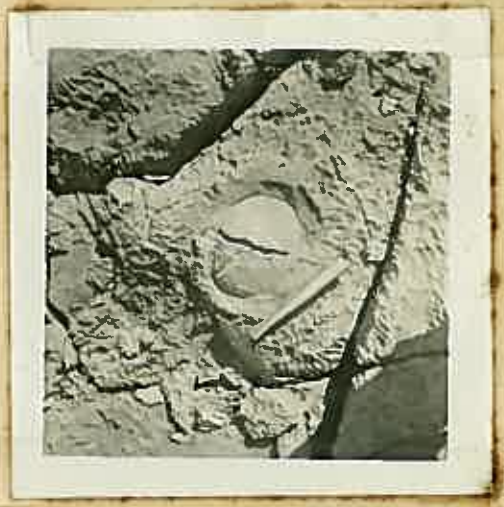
1.



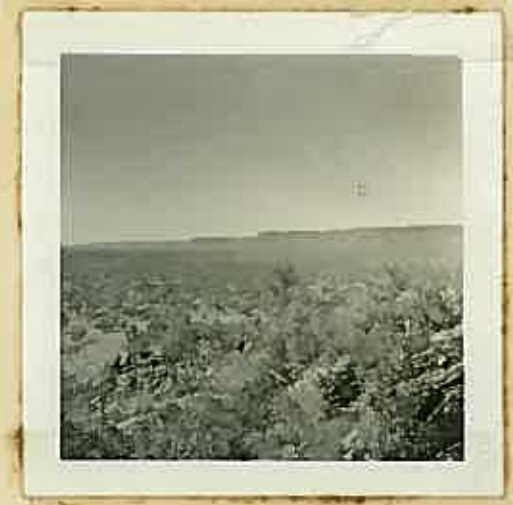
2.



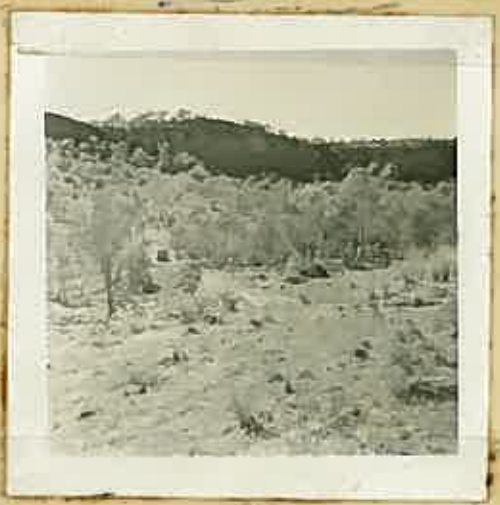
3.



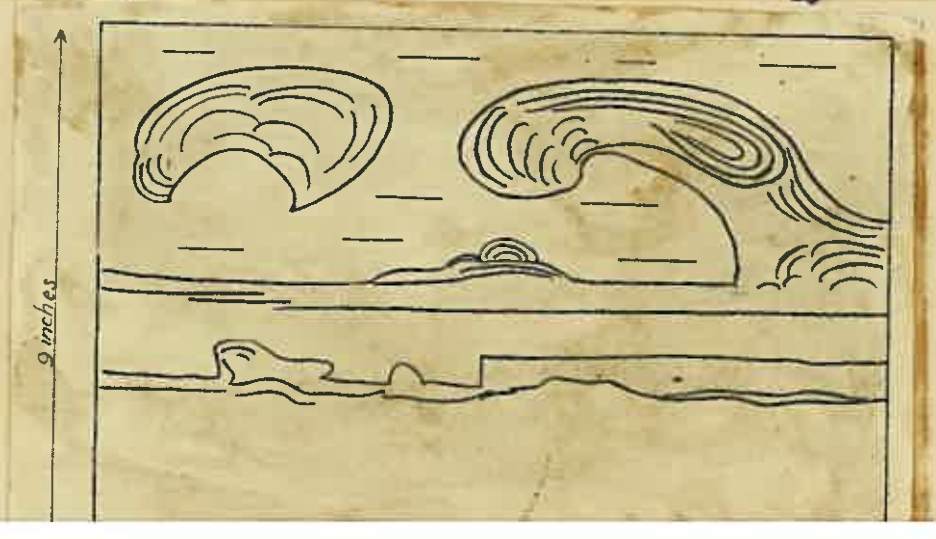
4.



5.



6.



BMR — Katherine Darwin Region

VRG.

Pug Coolamon Beds — Silic med. gr. Qz-sst with lenses of silic. Ls

Puf Fitzmaurice River Beds — Coarse to fine ripple marked & X bedded Qz-sst

Puj Angalarri Siltstone — Ferrug in places — siltstone & calcar. siltstone.

Pux Palm Creek Beds — Ripple marked & X bedded med. Qz-sst — silic. Ls. lenses near base.