Copy 3

COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1961/50

PROGRESS REPORT ON THE PALAEOZOIC GEOLOGY OF THE ELKEDRA 4-MILE SHEET, NORTHERN TERRITORY.

by

K.G.Smith, R.R.Vine and E.N.Milligan.

PROGRESS REPORT ON THE PALAEOZOIC GEOLOGY OF THE ELKEDRA 4-MILE SHEET, NORTHERN TERRITORY.

by

K.G.Smith, R.R.Vine, and E.N.Milligan.

RECORDS 1961/50

CONTENTS

PROGRESS REPORT ON THE PALAEOZOIC GEOLOGY OF THE ELKEDRA 4-MILE SHEET, NORTHERN TERRITORY

by

K.G. Smith, R.R. Vine and E.N. Milligan.

Records 1961/50

SUMMARY

During the months of September and October, 1960, a field party from the Geological Branch of the Bureau of Mineral Resources, Geology and Geophysics mapped the south-eastern part of the Elkedra 4-mile Sheet, Northern Territory. This mapping was part of a regional survey of the Georgina Basin and it linked the geology of the Elkedra sheet to that of the adjoining Huckitta and Tobermory 4-mile Sheets, which had previously been mapped by the same field party.

On the southern and south-eastern margins of the Davenport Range, the Sandover Beds of lower Middle Cambrian age dip gently off Precambrian sediments of the Hatches Creek Group and off Precambrian igneous rocks which intrude that Group. The Sandover Beds are about 500 feet thick in outcrop, and consist of 150 feet of conglomerate and sandstone, which is succeeded by 350 ft of richly fossiliferous siltstone and shale with limestone interbeds. These sediments disappear beneath sand cover to the north of the Sandover River, and there are no outcrops south of this stream except in the south-eastern part of the sheet, where the Upper Cambrian Arrinthrunga Formation and the Cambro-Ordovician Tomahawk Beds are exposed. The boundary between these two units is faulted. About 1000 ft of limestone, dolomite and sandstone in the top part of the Arrinthrunga Formation, and about 300 ft of the lower part of the Tomahawk Beds, are exposed.

Numerous successful water bores have been drilled in the Sandover Beds and a few in each of the Arrinthrunga Formation and the Tomahawk Beds. In 1956 a water bore encountered natural gas in the Sandover Beds. These Beds may contain source and reservoir beds for petroleum, but a thick cover of younger Palaeozoic carbonate rocks may prohibit the use of seismic methods of exploration in many areas of the Elkedra 4-mile Sheet.

INTRODUCTION

During September and October, 1960, a field party consisting of K.G. Smith, R.R. Vine, P.J. Jones and E.N. Milligan from the Geological Branch of the Bureau of Mineral Resources began mapping the Palaeozoic sediments exposed on the Elkedra 4-mile Sheet, Northern Territory. These sediments crop out sporadically over three quarters of the sheet. In the remaining part, i.e., in the north-west quadrant, Precambrian sedimentary and igneous rocks had been mapped previously (Smith, Stewart and Smith, 1960, unpubl.) and the approximate position of the Precambrian/Cambrian boundary had been delineated. Only the south-eastern section, covering four one-mile sheets, was mapped in 1960.

The specific objects of the survey were:

(a) to map the area at photo-scale, and to link the mapping to that done already on the adjoining Huckitta and Tobermory 4-mile Sheets.

(b) to measure sufficient stratigraphic sections to establish the sequence and its variations.

(c) to assess the underground water potential of the area.

(d) to assess the petroleum prospects of the area.

(e) to assess the mineral potential of the region.

A complete air photograph cover at 1:50000 scale was available from photographs taken by the Royal Australian Air Force in 1950. In the field, observation points and specimen localities were marked on the photographs and notes on these points were recorded in field note-books. Controlled templates at photo scale were available from the Division of National Mapping; geology was transferred from the photographs to the templates which were then reduced to publication scale (two miles to one inch).

Area

The Elkedra 4-Mile Sheet is bounded by the 21st and 22nd parallels of south latitude and the meridians of 135 degrees and 136 degrees 30 minutes of east longitude, and occupies about 7000 square miles of land surface.

Location and Access.

Figure 1 shows the location of the Elkedra 4-mile area, with reference to the town of Alice Springs. Figure 2 shows the major roads of the area, and the more important vehicle tracks. In addition, there are numerous roads leading to watering - places for stock. All of the major roads are formed with an earth surface; they may become impassable for several days after heavy rainfall.

Communications.

The area has no normal telegraph and telephone facilities and there is no scheduled service for surface mail. All of the station homesteads (see Figure 2) operate transceivers which are linked with the Alice Springs Base Station of the Royal Flying Doctor Service. This Service provides prompt medical attention and transmits and receives telegrams. From its base at Alice Springs, Connellan Airways operates a weekly mail, passenger and freight service to most of the cattle stations in the area.

Alice Springs is the northern terminus of the railway operated by Commonwealth Railways from Port Augusta; the service provides ~~one~~ two passenger rail services per ~~fortnight~~ week in winter and one per week in summer.

Climate.

Long, hot summers and short, mild winters are normal. Throughout the year the prevailing wind blows strongly from the south-east. The average annual rainfall is ten inches.

Water Supplies.

In the western part of the Elkedra river system, the river and some of its important tributaries contain several large waterholes. Towards the flood-out area to the east there are some waterholes but we have no information about them at present.

The several flood-out areas of the Sandover River sometimes contain water in small holes, after heavy rain. The pastoral industry is generally dependent on supplies of underground water.

Topography.

Figure 3 shows the main drainage systems, some levelled heights (obtained by Surveyors from the Department of the Interior) and the main areas of hills. The remainder of the area is either gently-undulating, soil-covered country, or sand plain with low, broad dunes.

Area A on Figure 3 contains the Davenport Range, which has the only rugged topography of the area. The Range consists of steep-sided, flat-topped, roughly-parallel ridges, separated by wide, flat valleys. The ridges rise generally 200 feet above the valley floors, and the tops of the ridges are about 1600 feet above mean sea-level; an exception is Mt. Alone, which is the highest topographic feature in area A; it is about 400 feet above the level of the surrounding plains and about 1700 feet above mean sea level.

The hills of area B are low and heavily dissected by young streams. These hills rise generally less than 100 feet above their bases. In area C there is a discontinuous, north-east trending belt of ridges. These are about 125 feet above the surrounding country; the country around the base of the ridges is usually rough, with numerous erosion holes, in dolomite, filled with blown sand.

Area D contains low, discontinuous hills, and mesas. The highest mesas rise about 200 feet above the surroundings. Two areas of low sand dunes are shown on Figure 3.

Vegetation.

Spinifex grows abundantly in most of the area. Tall eucalypts line the courses of the larger streams; there are extensive stands of mulga, and numerous patches of gidyea. In semi-desert areas there are many types of low shrubs, and acacias.

PREVIOUS INVESTIGATIONS

H.Y.L. Brown made the first geological reconnaissance of the area, traversing part of the Davenport Range (Brown, 1896). In 1898, A.A. Davidson led a prospecting team through part of the area (Davidson, 1905). At a locality 45 miles south-east from the (old) Elkedra station homestead, Davidson collected fossils; Etheridge (1902) described them as Pagetia significans (Eth) and Peronopsis elkedraensis (Eth). Whitehouse (1936) re-described these fossils.

Hossfeld (1954) published an account of the stratigraphy and structure of the Northern Territory; this

publication includes references to the geology of the Elkedra area. Opik and Casey, in 1953, made a geological reconnaissance along the Sandover River. Opik (1957) gave the informal name "Sandover Beds" to the lower Middle Cambrian sediments which crop out on the Elkedra 4-mile Sheet; he described the lithology of these sediments and identified several fossils which occur in them.

In 1956, a field party from the Bureau of Mineral Resources mapped the Precambrian rocks in the Davenport Range area of the Elkedra 4-mile Sheet (Smith et al., 1960,(a) unpubl.). The area mapped by this survey is shown on Figure 4. Also in 1956, Mackay and Jones, from the Bureau's Northern Territory Resident Staff, reported on an area to the north-east of Ammaroo station where an occurrence of natural gas had been found in a water bore. (Mackay and Jones, 1956, unpubl.). This area was inspected during 1956, by several geologists from exploration companies interested in the occurrence.

On numerous occasions between 1952 and 1960, officers from the Bureau's Resident Staff at Alice Springs made geological observations on the area of the Elkedra 4-mile Sheet. These officers include Bell, Firman, Jones, Catley and Quinlan; their observations are not documented but have been made available to the present field party.

The geology of the adjoining Huckitta 4-mile Sheet was mapped in 1957 and 1958 (Smith et al., 1960,(b) unpubl.) and that of the adjoining Tobermory Sheet was mapped in 1959 (Smith and Vine, 1960, unpubl.).

GEOLOGY

In the area mapped, the oldest Palaeozoic sediments (the Sandover Beds) dip unconformably off Lower Proterozoic sedimentary and igneous rocks of the Hatches Creek Group and off igneous rocks which intrude that Group. The stratigraphic section increases southwards and eastwards from the Davenport Range. Combination of poor outcrop, sand cover, probable concealed faults and indefinite date from some water bores drilled along the Sandover River made predictions of regional structure and stratigraphy very difficult. The distribution of sedimentary sequences discussed in this report is given in Plate 2.

The names for Groups, Formations and Beds used in this report have previously been accepted by the Territories Committee on Stratigraphical Nomenclature and are in accordance with the Australian Code.

Precambrian

Lower Proterozoic

Hatches Creek Group. Hossfeld (1954) names this Group in the Hatches Creek area, on the adjoining Frew River 4-mile Sheet. Smith et. al., (1960,(a) loc.cit.) traced the Group from the Hatches Creek area southwards to the north-west quadrant of the Elkedra 4-mile Sheet.

The Hatches Creek Group is confined mainly to the north-west part of the Elkedra 4-mile Sheet but scattered inliers protrude through a thin cover of Sandover Beds, to

the south of Andagera Bore. The Hatches Creek Group consists of silicified quartz sandstone, silicified quartz greywacke, siltstone and shale, with some members of both basic and acid rocks. The arenites generally form strong, steep-sided, roughly-parallel strike ridges which are separated by flat valleys. In the floors of the valleys, lutites and the more resistant igneous members of the Group crop out sporadically.

The Hatches Creek Group has been folded strongly about axes which trend generally north-west, and the Group has been faulted extensively and intruded by granite, porphyry and basic igneous rocks. The ages of several granites which intrude the Hatches Creek Group have been determined by the potassium/argon method and averaged 1400 million years (Hurley et.al., 1959). One of these granites was obtained from the Elkedra 4-mile Sheet area. The Hatches Creek Group is regarded as Lower Proterozoic.

Palaeozoic

Middle Cambrian

The Sandover Beds. Opik (1957, loc.cit.) gave this informal name to the lower Middle Cambrian sediments which crop out to the north of the Sandover River on the Elkedra 4-mile Sheet. Because the mapping of these sediments is incomplete, neither a formal name nor a type section is proposed for them here, and the informal name will be retained in this report.

The Sandover Beds crop out mainly in area B, Figure 3. There are a few low outcrops on plains to the south and west of this area. In a small proportion of area B, in its northern part, there are mesas of the basal, arenitic part of the Sandover Beds. But in the greater part of area B, the younger lutitic units of the Sandover Beds crop out; these outcrops are in the form of low hills which have a strong, dendritic drainage pattern.

During 1960, the Sandover Beds were mapped from No.12 Bore westwards to longitude 135° 30' E and northwards to latitude 21° 30' S. The oldest unit of the Beds is arenitic; it rests unconformably on the Hatches Creek Group and consists of either a boulder conglomerate or a sedimentary breccia, succeeded by quartz sandstone with bands of pebble and cobble conglomerate. The basal boulder conglomerate contains sub-angular boulders of Precambrian rocks; the breccia contains large blocks, up to 4 feet across, of Precambrian rocks and it probably formed by cementation of surface rubble almost insitu. Higher beds of the arenite unit consist of medium-grained, pink, ripple-marked quartz sandstone with bands of pebble and cobble conglomerate. No fossils have been found in the arenites. No sections have yet been measured; the maximum estimated thickness of the arenite unit of the Sandover Beds is 200 feet; exposures thicker than an estimated 100 feet are rare.

The overlying lutite unit contains numerous beds which are richly fossiliferous; the fauna is of a lower Middle Cambrian age (Opik, 1957). This unit conformably overlies the arenite unit but in some localities it rests unconformably on Precambrian rocks.

The lutite unit is usually poorly exposed and the beds have been extensively silicified. In some localities all traces of original bedding have been obliterated; less silicified beds are invariably crumpled and contorted, due to slumping. Exposures of beds with reliable dips are found mainly in incised meanders of some of the larger creeks.

In the area mapped the lithology of the lutite unit is dominantly hard white or buff siltstone; there are rare thin beds of light-grey limestone. It is probable that the siltstone is the weathered equivalent of a sediment which originally contained a large proportion of carbonate material: the logs of water bores record much more "limestone" than is apparent in surface outcrops. The thickness of the lutite unit has not yet been measured: the maximum thickness observed is 250 feet.

Dips in the Sandover Beds are usually less than 10 degrees. The regional dip is to the south-south-west; there are numerous minor rolls which probably reflect underlying Precambrian surfaces. The Sandover Beds have not been folded but have been affected by north-west and west-trending faults; at one locality the throw on one of these faults is estimated at 300 feet.

Upper Cambrian

(a) The Arrinthrunga Formation.

This has been named and defined previously (Smith et. al., 1960,(b) loc. cit.) from the adjoining Huckitta 4-mile Sheet, where the Formation occupies a large area in the central and north-eastern part. On the Elkedra 4-mile Sheet, the Arrinthrunga Formation crops out in two distinct areas; these are area C and the western part of area D, Figure 3.

In area D the outcrops are continuous with those of the Huckitta 4-mile Sheet. The beds exposed are high in the Arrinthrunga Formation and the regional dip is to the east, at a low angle.

The oldest beds exposed are of dense blue limestone with some interbeds of grey and yellow dolomite. Outcrops usually are low, but there are some sharp ridges along a structural line to the south-west of Weepita Bore. The limestone unit is succeeded by a thin, poorly-outcropping sandstone unit; although the characteristic outcrop is flags of quartz sandstone strewn on the surface, some small mesas occur. The thickness of this unit is estimated at 50 feet.

The highest unit of the Arrinthrunga Formation is a sequence of yellow and brown dolomite, dolutite and dolarenite. In the upper part of this unit, rapid lateral gradations between dolarenite and quartz sandstone occur. This is more noticeable on the Huckitta Sheet but the same gradation occurs to some extent on the Elkedra Sheet. The unit is faulted against the younger Tomahawk Beds along a major NW-trending fault whose overall length is about 75 miles. In area D the throw on this fault is of the order of 200 feet. The thickness of the Arrinthrunga Formation in area D has not been measured; it is estimated at 1,000 feet.

Area C contains low, discontinuous outcrops of dolomite, dolarenite and dolutite, with interbedded quartz sandstone. To date, only the south-western part of Area C has been mapped. The sequence is believed to belong to the top part of the Arrinthrunga Formation, but alternative stratigraphical positions could be considered, e.g., Middle Cambrian. No fossils have been found.

In area C, the maximum thickness observed is of the order of 300 feet. Lithologies are: yellow, medium-grained, thin-bedded sandy dolomite; brown, medium-grained, thin to medium-bedded dolarenite; brown, clean, friable, cross-bedded quartz sandstone with thin bands of yellow chert, and green, red and buff dolutite. The sandstone unit is prominent in the sequence and is probably the source of sand which obscures outcrop in the area.

Numerous small rolls occur in the beds, but the regional dip is to the south-east at less than 3 degrees. Two prominent sets of vertical joints strike at 300 degrees and 30 degrees. Traces of this joint system are visible on air photographs of surrounding areas, which are mainly sand-covered.

On the Elkedra 4-mile Sheet there is no evidence of age of the Arrinthrunga Formation. Its Upper Cambrian age is known from the Huckitta Sheet, where the Arrinthrunga Formation overlies fossiliferous sediments of Middle Cambrian age, and underlies fossiliferous Upper Cambrian sediments of the Tomahawk Beds.

(b) The Tomahawk Beds.

This unit has been named and defined (Smith et. al., 1960(b) loc. cit.) from the Huckitta 4-mile Sheet, where the age of the Beds ranges from Upper Cambrian to the top of the Lower Ordovician. On the Elkedra 4-mile Sheet the Tomahawk Beds crop out only in area D, (Figure 3) where they occur on the eastern (downthrown) side of a major fault.

In part of the area the Tomahawk Beds crop out in mesas and peaks which are about 150 feet high; elsewhere, the outcrop is poor. The beds are fossiliferous and several collections of fossils of Upper Cambrian age (J. Gilbert-Tomlinson, pers. comm.) have been made. The collections have not yet been thoroughly examined and therefore whether they contain fossils of Ordovician age is unknown.

A part-section of the Tomahawk Beds has been measured at X1 (see Figure 5) near the southern boundary of the Elkedra 4-mile Sheet. Here the sequence in descending order is:

Top of hill

85 feet of quartz sandstone; weathered, thin-bedded; grades laterally to dolarenite; has numerous trails of burrowing organisms; some thin interbeds of yellow, weathered dolutite;

10 feet of quartz sandstone; soft, friable, porous, thin bedded, with trails and "pipes";

3 feet of quartz sandstone; soft, thin-bedded, medium-grained, silty;

27 feet of quartz sandstone; brown, soft, friable, porous, clean, thin-bedded; Tibeirbids 5 feet above base of the interval;

10 feet of quartz sandstone; white, medium-grained, cross-laminated;

7 feet of dolarenite; brown, hard, coarse-grained, thin-bedded;

7 feet concealed;

3 feet of quartz sandstone; white, medium-grained; cross-bedded, friable;

4 feet of dolarenite; light-brown, medium-grained, medium-bedded;

2 feet of quartz sandstone; white, medium-grained, thin-bedded, friable;

2 feet of dolarenite; brown, medium-grained, medium-bedded;

4 feet concealed;

8 feet of dolarenite; brown, coarse-grained, medium-bedded;

3 feet concealed;

2 feet of dolarenite; brown, hard, sandy, coarse-grained, thin-bedded;

4 feet of dolarenite; brown, hard, coarse-grained, thin-bedded;

3 feet of dolarenite; light-brown, sandy, medium-grained, cross-laminated;

3 feet concealed;

1 foot of dolarenite; grey-brown, coarse-grained;

2 feet concealed;

2 feet of dolarenite; grey-brown, coarse-grained;

3 feet concealed;

8 feet of dolarenite; grey, medium-grained, thin-bedded;

2 feet of dolarenite; light-brown, sandy, medium-grained, cross-laminated;

3 feet of dolarenite; grey, medium-grained, medium-bedded;

7 feet of dolarenite; brown, sandy, medium-grained, thin-bedded, cross-bedded;

15 feet concealed;

5 feet of dolarenite; grey, medium-grained, medium-bedded.

Total 235 feet thickness of part-section of Tomahawk Beds.

~~Soil~~ ~~cover~~.

Section X1 is summarised graphically in Figure 6. Fossil collection E3 came from a hill adjacent to X1, and was obtained from a horizon equivalent to that at 60 feet above the base of X1.

The lithologies observed in X1 are representative of much of the Tomahawk Beds exposed in the Elkedra 4-mile Sheet. Quartz sandstone and dolarenite commonly grade rapidly and laterally into each other but such gradations did not occur on the section line. Peaks of weathered, thin-bedded, slumped, fine-grained dolomite are common in some areas.

The regional structure of the Tomahawk Beds is ill-defined because paucity of outcrop prevents the connection of numerous low, rolling dips into an overall pattern of folds. In general, in the eastern side of the road from No.16 Bore to Lucy Creek, dips in the Tomahawk Beds are to the east; on the western side of this road, there are many local flexures in the strata. This structural difference persists from the southern boundary of the Elkedra 4-mile Sheet northwards for about four miles, where a strong cross-flexure with a west-trending axis is evident.

Near their western boundary of outcrop, the Tomahawk Beds are down-faulted against the top dolomite unit of the Arrinthrunga Formation, but the contact has not been seen. In some places near the fault, beds of the Arrinthrunga Formation dip at about 50 degrees, but observed dips in the Tomahawk Beds nearby are always low.

Economic Geology

Wolfram

There are no known occurrences of this metal in the Palaeozoic sediments of the area, and none are expected. Wolfram has been won previously from quartz veins in a Precambrian granite which is exposed about 12 miles west of Andagera Bore and which is overlain unconformably by thin Cambrian sediments. Any inliers of Precambrian rocks should be examined for wolfram; examinations to date have been unsuccessful.

Lead

No surface occurrences of lead ores have been recorded in Palaeozoic sediments exposed on the Elkedra 4-mile Sheet. Galena has been reported in samples of limestone from the Cherry Creek Bore and in 1960 fairly extensive showings of galena were located in surface outcrops of the Arrinthrunga Formation on the Huckitta 4-mile Sheet. Such occurrences are of academic interest but as the deposits found to date are small, their geographical location makes them non-commerical.

Underground Water

In the area mapped, the ratio of successful to unsuccessful bores is high. Nevertheless, this general success appears to be fortuitous. The present survey is the first attempt at systematic mapping in the area; whilst we can now identify some formations from which water has already been obtained, the results of the mapping do not shed much new light on the underground water potential. The location of additional successful bores is very much a matter of chance because:

(i) Large expanses of sand conceal underlying rocks;

(ii) Surface outcrops of the Tomahawk Beds change rapidly from sandstone to carbonate rocks; much of the Tomahawk Beds is often concealed and in such places it is speculative whether a drill will penetrate hard carbonate rocks or softer sandstone. Two bores on Ooratippra Station and one on Argadargada Station were abandoned because of drilling difficulties in concealed dolomite of the Tomahawk Beds. Another, Trackriders Bore on Ooratippra Station, was successfully completed after drilling 156 feet of concealed, soft Tomahawk Beds.

(iii) Faults may be present, along Ooratippra Creek and along the Sandover River, which would affect, or change the distribution of formations penetrated by Nos. 14, 15 and 16 Government Stock Route Bores. All of these have been drilled on the northern side of the Sandover River. The Formations penetrated in these bores cannot be determined reliably from the drillers' logs.

(iv) Relatively shallow water cannot be predicted from weathered carbonate rocks of the Arrinthrunga Formation. Two bores on Ooratippra Station, namely Weepita and one at the new homestead, have obtained supplies from such rocks (now vuggy cherts; called "boulders" by drillers). In general, many holes in the Arrinthrunga Formation have been abandoned because of difficult drilling conditions. The sub-surface extent of the weathered carbonate rocks is unknown, but two additional shallow bores in Ooratippra Station have obtained shallow water from such rocks. These two bores are also on Ooratippra Creek but are located on the Huckitta 4-mile Sheet. All four bores may have been drilled along a fault zone.

(v) The sub-surface lithology of the Sandover Beds is not sufficiently known. In outcrop they do not look promising for water but the surface exposures are probably the silicified equivalents of sub-surface sediments rich in carbonate content. The frequent occurrence of "limestone" recorded from bores in the Sandover Beds indicate this. Fractures, rather than aquifers, are probably the source of water in most bores drilled into the Sandover Beds.

(vi) There is always a possibility of drilling through the Sandover Beds into Precambrian rocks which may or may not be favourable for water. For example, Andagera Bore (~~Figure~~ Plate 2) was drilled through Sandover Beds into a fractured feldspar porphyry which provided sufficient water. About 14 miles to the south-west of this bore, an unsuccessful bore was drilled through the Sandover Beds into granite.

The drillers' logs of Government Bores Nos. 12-16 inclusive, drilled along the Sandover River, are as follows:

Name	No.12	No.13	No.14	No.15	No.16
Elevation	1170*	1118'*	1085'	1031'*	979*
Total depth	350'	154'	173'	785'	320'
Water level	160'	131'	110'	120'	80'
Water struck at	-	137, 153'	110'	140'	-
Pump depth	-	149'	156'	420'	234'
Date drilled	May, 1950	July, 1950	July, 1953	Jan., 1951	July, 1951
Supply	1800 gph	1100 gph	480 gph	850 gph	570 gph
Samples	0-14' soil	0-3' soil	0-20' sand & gvl.	0-35' clay	0-13' clay
	14-140' yellow clay	3-18' red clay	20-30' limestone	35-62' gravel	13-29' river sand
	140-196' limestone	18-30' white kaline	30-42' silty lst.	62-100' qtz & lst.	29-40' red clay
	196-310' brown clay	30-36' gravel	42-60' rubbly lst.	100-150' qtz & slate	40-60' gravel.
	310-320' broken limestone	36-100' brown clay	60-65' jasper	150-180' kaline	60-80' quartz
	320-350' gravel	w. lst. boulders	65-75' hard bands of lst.	180-200' sandstone	80-95' jasper
		100-137' yellow clay		200-250' quartz & slate	95-160' clay and quartz
		137-153' limestone	75-110' soft limestone	250-750' blue white & red clay	160-250' white clay & quartz.
		153-4' sand	110-120' gravel & limestone	750-754' limestone	250-320' sandstone with some layers of slate (Hard drilling at 2'/day for last 14 days)
			120-145' limestone	754-785 white clay	
			145-152' grey clay		
			152-163' sandstone & japser		
			163-170' broken quartz		
			170-172' grey rock		
			172-3' blue clay		
Authors Comments	See below	See below	None	See below	See below

* Levelled by Department of Interior Surveyors.

Author's Comments:

No.12. Drilled into Sandover Beds. In 1956 K.G. Smith obtained agnostid trilobites in chert chips from this bore. The gravel at 350ft. may indicate a pebble conglomerate at the base of the Sandover Beds.

No.13. Examination of bore drain (1960) revealed chips of chert of Sandover Beds, and rounded quartz pebbles.

No.15. May be drilled into part of the Arrinthrunga Formation but log is too sketchy to confirm this.

No.16. By 1961, the supply from this bore was reduced to about 200 G.P.H., probably due to silting at the aquifer or aquifers.

Petroleum Prospects.

These must remain speculative until additional subsurface information, both geological and geophysical, is available. On the Elkedra 4-mile Sheet the Sandover Beds may provide source, reservoir and cap rocks, and the Arrinthrunga Formation could furnish reservoir and cap rocks.

In 1956, natural gas was struck in a water bore at Cherry Creek, on Ammaroo Station; the bore was drilled through limestone and shale of the Sandover Beds. The gas was discovered when a spark from welding apparatus dropped into the hole and set off an explosion. Sprigg, (1958) reported that "ethane and higher homologues of hydrocarbons" were the explosive gases. Mackay and Jones (1956, unpublished) reported on the surface geology near the bore and collected samples of the gas. An analysis of the samples gave the following results: Methane 10%, Ethane 15%, Air 75%, Hydrogen Sulphide nil.

Although the analysis of the gas showed no content of hydrogen sulphide, and none could be detected in the initial emanations of gas, a strong smell of hydrogen sulphide was evident a few days after Mackay and Jones collected the sample for analysis (N.O. Jones, pers.comm.). Undescribed "smells" periodically have been recorded by local people, from No.13 Bore on the Sandover River, which also was drilled in the Sandover Beds.

The Sandover Beds crop out over a considerable area and may underlie much of the sand-covered area shown in the southern and western part of Plate 2. It is not known whether younger Middle Cambrian sediments occur beneath the sand cover in this area. One reconnaissance traverse was made in the sand-covered area shown on the north-eastern part of Plate 2, but only near-outcrop of chert, and boulders of dolomite were observed. Trew Bore (shown on Plate 2) penetrated an apparent thickness of 678 feet of shale which is assumed to belong in the Sandover Beds, but this is the only record, to date, of these Beds in the north-eastern part of the Elkedra 4-mile Sheet. Their time equivalents, as well as younger Middle Cambrian sediments, may be represented by dolomite sequences in that area.

It is considered that an evaluation of the petroleum prospects of the Sandover Beds and other Middle Cambrian sediments, if present, would require:

(a) core drilling to examine the fresh lithology; the fracture porosity in carbonate rocks will be particularly important.

(b) geophysical surveys, preferably aeromagnetic, to determine the configuration of the Precambrian basement. The Geophysical Branch of the Bureau has already made reconnaissance gravity traverses in part of the area, and additional work is scheduled for 1961.

(c) stratigraphic drilling, to establish the sequence in concealed areas.

If the programme outlined above revealed that Middle Cambrian sediments offer reasonable prospect, and if it be assumed that these sediments underlie the Arrinthrunga Formation and/or the Tomahawk Beds, the location of a suitable drilling target, by geophysical means, may be difficult. It is considered a difficult task to obtain reasonable seismic reflections through the thick, dominantly carbonate sequence of the Arrinthrunga Formation. Therefore the alternative would seem to be the drilling of a suitable surface structure, on the assumption that it reflects structure in the target beds at depth.

The evaluation of the Arrinthrunga Formation requires core drilling to examine the lithology. There are many soft, concealed beds between benches of outcropping carbonate rock and both cap and reservoir rock types may be represented. Some thin beds of green siltstone have been observed in outcrop, and several water bores in the Formation have drilled through beds of blue grey siltstone below the water-table. The possibilities of source beds in the Formation are unknown; fossils are very rare, but algae are common.

LIST OF REFERENCES

Brown, H.Y.L. 1896 Report of Northern Territory Explorations. S.Aust.Parl.Pap. No.127. Adelaide.

Davidson, A.A. 1905 Journal of Explorations in Central Australia, 1898-1900. S.Aust.Parl.Pap. No.27, Adelaide.

Etheridge, R.Jr. 1902 Official contributions to the palaeontology of South Australia. No. 13. Evidence of further Cambrian trilobites. S.Aust.Parl.Pap. Adelaide.

Hossfeld, P.S. 1954 Stratigraphy and structure of the Northern Territory of Australia. Trans.Roy.Soc.S.Aust., vol.77, p.103.

Hurley, P.M. et al 1959 Geochronology of Proterozoic Granites in the Northern Territory, Australia. U.S. Atomic Energy Comm. Rept. NYO-3940, p.122-149.

Mackay, N.J. and Jones, N.O. 1956 Report on a gas occurrence in a bore on Ammaroo Station, N.T. Bur.Min.Resour. Aust.Rec. 1956/67 (unpubl.)

Opik, A.A. et al 1957 The Cambrian Geology of Australia Bur. Min. Resour. Aust. Bull. 49.

Smith, K.G., Stewart, J.R. and Smith, J.W., 1960(a) The Regional Geology of the Davenport and Murchison Ranges, Northern Territory Bur.Min.Resour.Aust. Rec. 1960/80 (unpubl.).

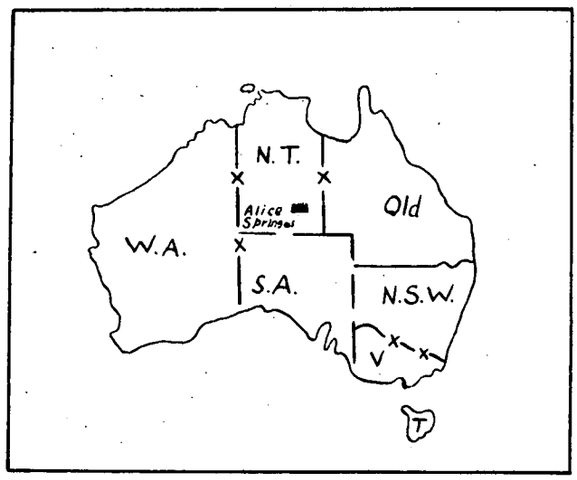
Smith, K.G., Vine, R.R. and Woolley, D.R.G., 1960(b) Geology of the Huckitta Area: Second Progress Report. Bur. Min.Resour.Aust. Rec. 1960/66 (unpubl.)

Smith, K.G. and Vine, R.R. 1960 Summary of the Geology of the Toberwory 4-mile Geological Sheet. Bur.Min.Resour.Aust. Rec. 1960/71 (unpubl.)

Sprigg, R.C. 1958 Petroleum Prospects of western parts of Great Australian Artesian Basin. Bull. A.A.P.G. 42, 10. pp 2465-2491.

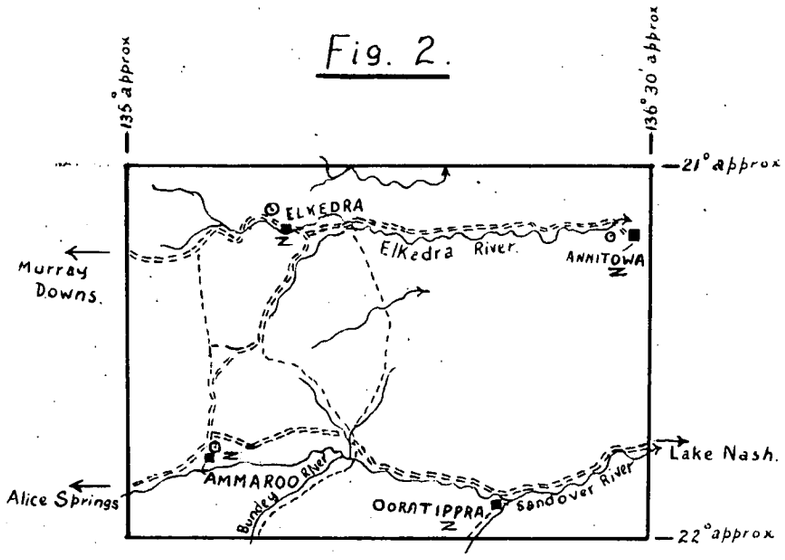
Whitehouse, F.W. 1936 The Cambrian faunas of north-eastern Australia. Parts 1 and 2 Mem.Qd.Mus. vol 11, p59.

Fig. 1



Locality Map, showing Elkedra area.

Fig. 2.



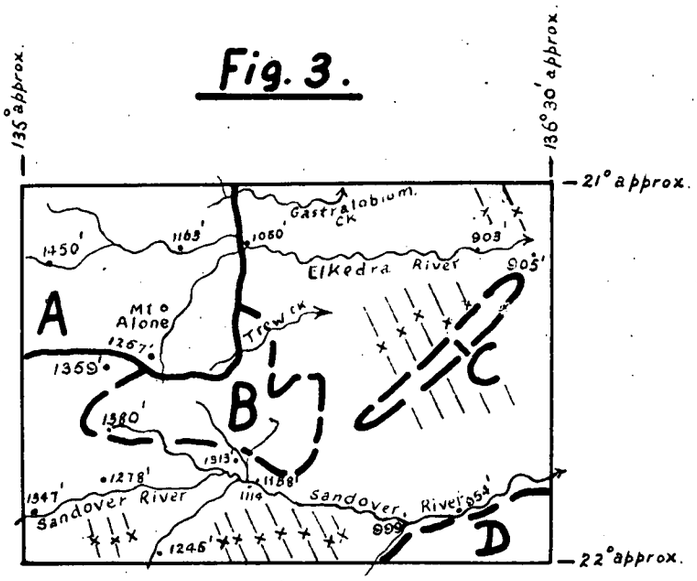
Locality Map.

Scale: 32 Miles to 1 inch.

Reference:

====	Road
----	Vehicle Track
■	Homestead
⊙	Landing Ground
Z	Transceiver.

Fig. 3.



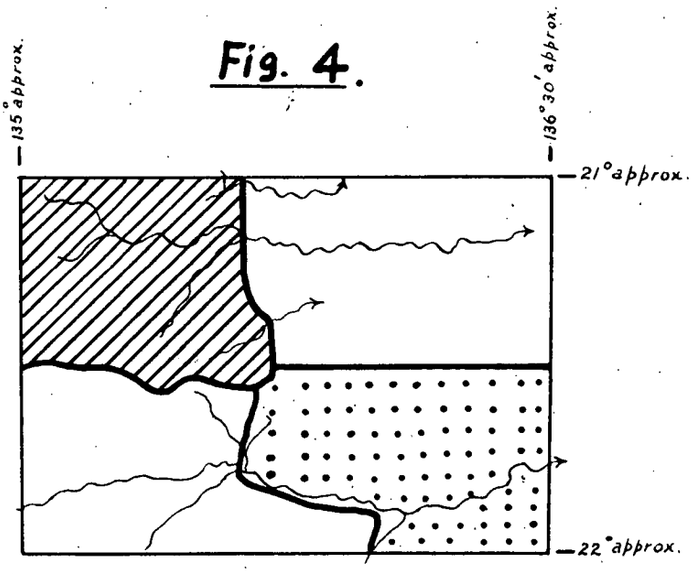
Topographic Map.

Scale: 32 Miles to 1 inch.

Reference:

- A — Davenport Range area.
- B — Low, heavily-dissected hills.
- C — Belt of low, discontinuous ridges.
- D — Mesas and low, discontinuous hills.

Fig. 4.



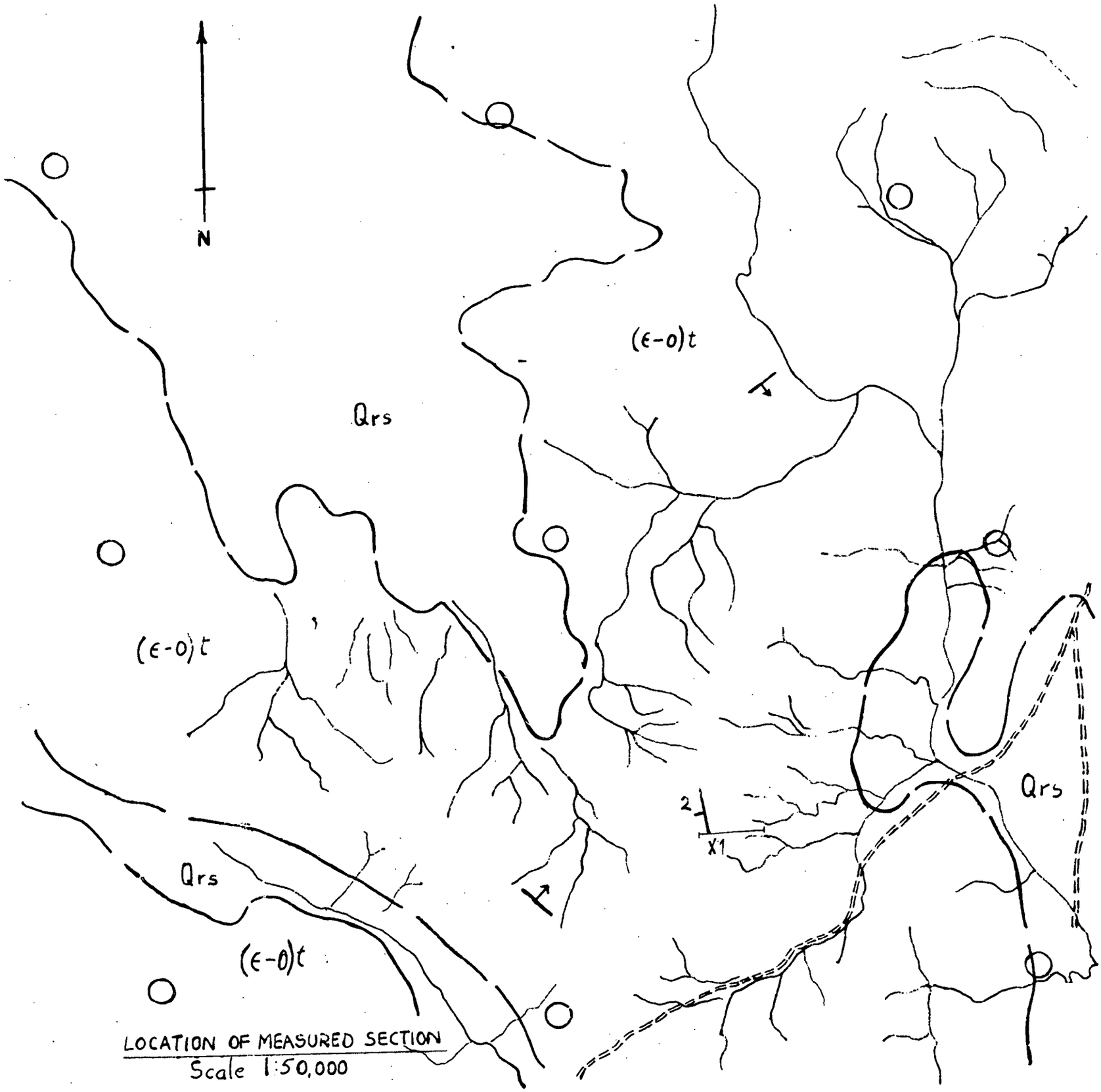
Plan showing areas mapped

Scale: 32 Miles to 1 inch.

Reference:

- Area mapped 1956.
- Area mapped 1960.

Fig. 5.



LOCATION OF MEASURED SECTION
Scale 1:50,000

5079

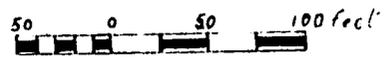
ELKEDRA RUN 15

Fig. 6.

TOMAHAWK BEDS

Section x 1

Vertical Scale



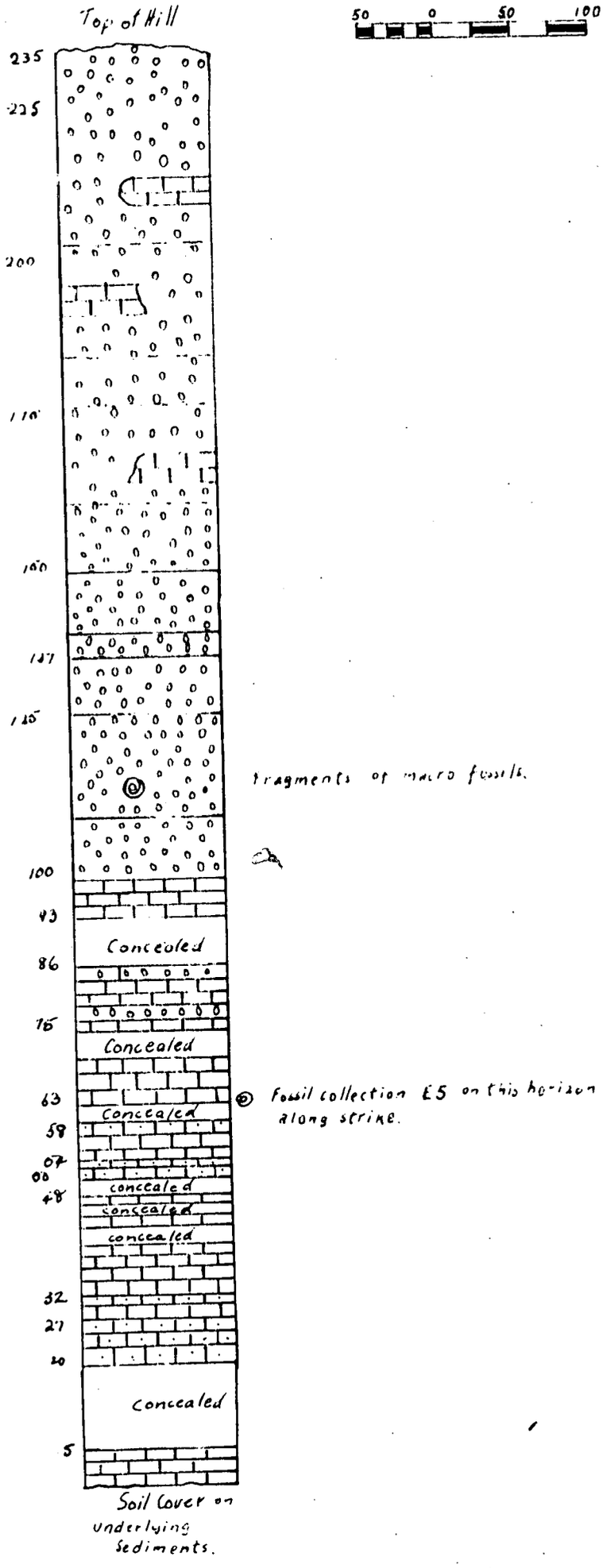
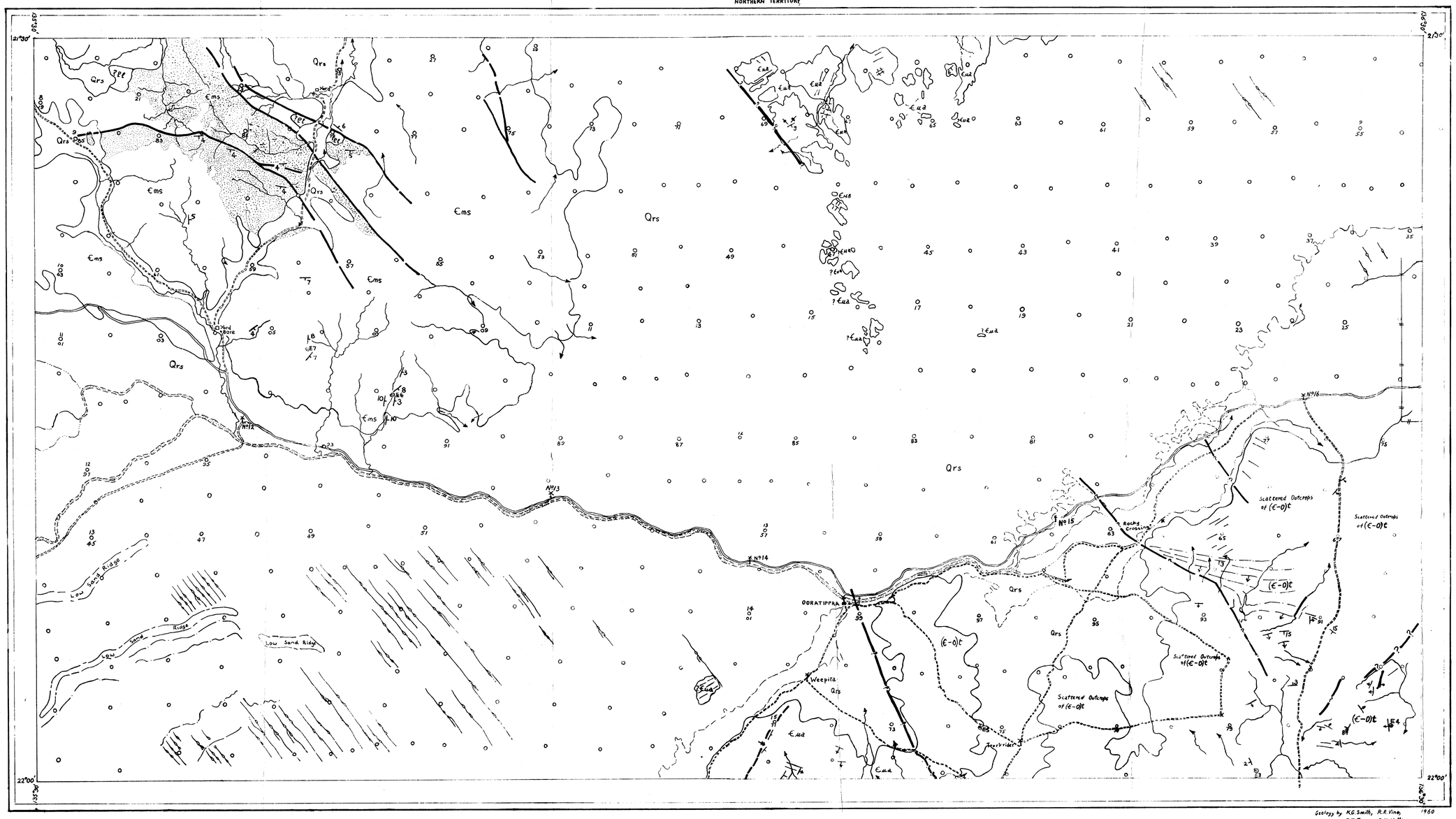


Plate 1.

GEOLOGY OF

SOUTH EASTERN PART OF **ELKEDRA** NORTHERN TERRITORY FOUR-MILE SHEET



	Qrs	Undifferentiated soil, sand and alluvium.
CAMBRIAN — Tomahawk Beds	(Ꞓ-O)t	Calcareous sandstone, green siltstone, brown dolomite grey limestone, ferruginous sandstone sandy dolomite, richly fossiliferous.
CAMBRIAN — Arrinthrunga formation	Ꞓua	Brown massive dolomite, yellow flaggy dolomite, blue and purple oolitic limestone, quartz sandstone.
CAMBRIAN — Sandover Beds	Ꞓms	White siliceous siltstone. Red brown pebbly quartz sandstone, conglomerate
?LOWER PROTEROZOIC	?Pl	Metamorphosed feldspar porphyry

REFERENCE

- Geological boundary
- Monocline
- Fault — Where location of boundary, fold or fault is approximate, line is broken; where inferred, queried.
- Strike and dip of strata.
- Strike and dip of strata determined from aerial photographs; dip less than 15°.
- Strike of joints.
- Strike of vertical joints.
- Trend of bedding; determined from aerial photographs.
- E5 — Macrofossil locality.
- 57 — Centre point, aerial photographs
- OORATIPPRA — Homestead
- Fence.
- Water bore.
- Nº16 — Water bore with wind pump
- Sand dune.
- Main road.
- Minor roads & 4 wheel drive vehicle tracks.

Geology by K.G. Smith, R.R. Vine, P.J. Jones, E.N. Milligan 1960

INDEX TO FOUR MILE SHEETS

BONNEY WELL	FREW RIVER	AVON DOWNS
BARROW CREEK	ELKEDRA	SANDOVER RIVER
ALCOOTA	HUCKITTA	TOBERMORY

Scale
2 Miles to 1 inch

Miles 0 2 4 6 8
Yards 2,000 0 2,000 4,000 6,000 8,000 10,000 12,000 14,000
Kilometres 2 1 0 2 4 6 8 10

Plate 2.

Progress Map, Elkedra, N.T.