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COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES

GEOLOGY AND GEOPHYSICS.

RECORDS.

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GEOLOGY OF THE HUCKITTA AREA: SECOND PROGRESS REPORT

by

K.G. Smith, R.R. Vine, and D.R.G. Woolley

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SUMMARY

During the 1957 and 1958 field seasons, a field party from the Geological Branch of the Bureau of Mineral Resources, Geology and Geophysics mapped the Huckitta Four-Mile Sheet, Northern Territory. This report gives the results achieved in 1958, when about three-quarters of the Huckitta Sheet was mapped. During this season, Devonian fossils were found in the Dulcie Range, and Lower Cambrian fossils were found in several localities in the Mopunga and Elyuah Ranges. Precambrian metamorphic and igneous rocks, including mica-bearing pegmatites, were mapped over a large area in the southern half of the Sheet, and numerous sections were measured in sedimentary rocks. The ages of the sedimentary rocks include Upper Proterozoic, Cambrian, Ordovician, Devonian, ?Permian and Tertiary.

INTRODUCTION

In 1958 a field party from the Geological Section of the Bureau of Mineral Resources, Geology and Geophysics continued the mapping of the Huckitta four-mile sheet, which had commenced in 1957 (Smith et al, Records 1960/16). In 1958 the field party consisted of K.G. Smith, K. Gough, R.R. Vine, D.R.G. Woolley and W.A. Robertson. W.A. Robertson confined his activities to detailed mapping of the Jervois copper mines and of a small area surrounding these mines (reported in Records 1959/103); the other geologists were responsible for the regional geology.

The following officers of the Bureau of Mineral Resources visited the field party: Dr. N.H. Fisher (17/6/58 - 21/6/58.); E.K. Carter (20/5/58 - 3/6/58); Dr. A.A. Öpik (11/8/58 - 17/8/58); M.A Condon (6/9/58 - 21/9/58). Brief visits were made by N.O. Jones and G.R. Ryan, Resident Geologists, Alice Springs. The following Company geologists visited the field party: B. Hopkins, of Broken Hill Pty.Ltd. (10/9/58 - 13/9/58); A. Blatchford, of Clutha Development (3/10/58 - 9/10/58).

The survey was part of a proposed survey of a large part of the southern portion of the Northern Territory; this general survey had commenced in 1956 when a field party had mapped part of the Western MacDonnell Ranges; in the same year another party, whilst engaged on work of a different type, made a reconnaissance survey of Palaeozoic sediments on the margins of the Davenport Ranges.

The specific objects of the survey were:

(a) to map the area at photo scale for publication of four-mile maps;

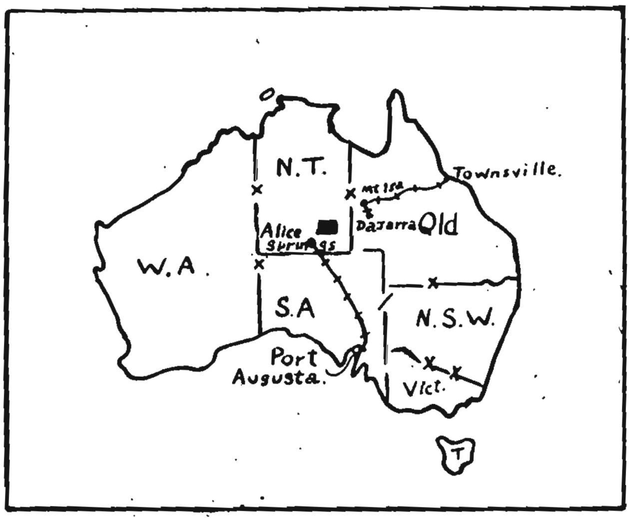
(b) to measure sufficient stratigraphic sections to establish the sequence and its variations;

(c) to assess the petroleum prospects of the region;

(d) to assess the underground water potential of the region;

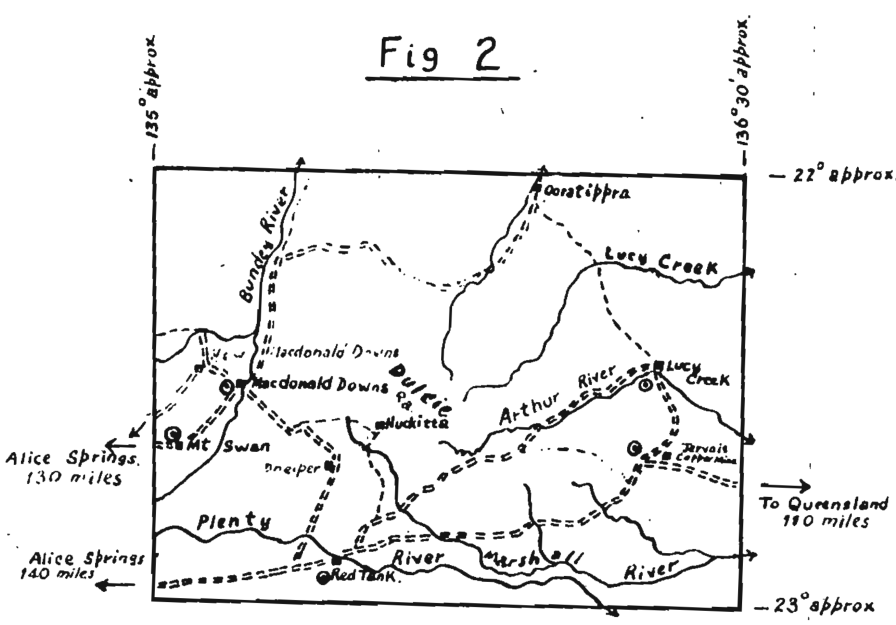
(e) to assess the mineral potential of the region.

Fig 1



Locality Map, showing railheads.

Fig 2



Locality Map

Scale : 32 Miles to 1 inch

Reference :

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

A complete aerial photograph cover was available from photographs taken by the Royal Australian Air Force. The scale of these photographs is 1:50,000. In the field, observation points and the localities where specimens were collected were marked on the photographs and notes on these points were recorded in field note-books. For each alternate photograph, squares of transparent drawing plastic were made and geological data transferred to them.

During the 1958 field season the regional geology of the Huckitta four-mile sheet was completed. Controlled base maps of this area have now been compiled by the Division of National Mapping. The geology was plotted on these maps, which will subsequently be reduced to four-mile scale for preparation of the final map to be published in the Bureau's Four-Mile Series.

AREA

The area mapped is covered by the Huckitta four-mile map sheet. This is bounded by the 22nd and 23rd parallels of South latitude and the meridians of 135 degrees and 136 degrees 30 minutes of East longitude.

LOCATION AND ACCESS:

Fig. 1 shows location with reference to two rail-heads, at Alice Springs in the Northern Territory and at Dajarra in Queensland. Fig.2 shows the major roads in the area; all of these are formed, earth-surfaced roads and they are usually impassable for periods of several days after heavy rainfall. There are many tracks which lead to watering places for stock, and a network of tracks covers a mica-mining area in the south-western part of the map sheet.

Fig. 2 shows also the location of homesteads, and landing grounds licensed for light aircraft.

DEVELOPMENT:

(a) Pastoral: The area is divided into large pastoral leases, some of which are unoccupied. Most of the occupied leases are used for the raising of cattle for beef; sheep are raised on a small number of leases. During 1958 the Northern Territory Administration had intended to conduct a ballot for the unoccupied leases. The severity of a drought over much of the southern part of the Northern Territory forced a change in the Administration's intention and the leases were then made available as "Drought Relief" areas.

(b) Mining: The Plenty River Mica Field is located in the south-western portion of the map sheet. This Field and the adjoining Harts Range Mica Field to the west together form the most important mica-mining area in Australia. The number of persons engaged either in mining mica or in prospecting for it fluctuates. In October 1958 there were ten miners and prospectors on the Plenty River Mica Field.

Secondary copper ores are mined near the Jervois Range. In the past, lead and silver ores were obtained from the same mines. During 1957 a leaching plant was erected at the mines for the purpose of producing copper sulphate. By October 1957 about 13 tons of copper sulphate had been produced but contamination of this product by sand and dust created problems which could be overcome only by re-designing part of the plant. This work was done and in October, 1958, production of a high-grade copper sulphate commenced. When the party left the area no sulphate had been sold.

Prior to the erection of this treatment plant the copper ores were transported by road to smelters at Mt. Isa. The distance from the copper mines to Mt. Isa is about 320 miles.

COMMUNICATIONS:

The area has no normal telegraph and telephone facilities conducted by the Postmaster-General's Department, and there is no scheduled service for surface mail. From its base at Alice Springs Connellan Airways operates a regular mail, passenger and freight service once a fortnight to the western part of the area and once a week to the eastern part.

All of the station homesteads, and some miners, 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.

Alice Springs is a port of call on regular airline services operated by Trans-Australia Airlines between Adelaide and Darwin.

Alice Springs is the northern terminus of the railway operated by Commonwealth Railways from Port Augusta to the Northern Territory. The frequency of passenger rail services is two a week in winter months and once a week in summer.

CLIMATE:

Long, hot summers and short, mild winters are usual. Throughout the year the prevailing wind blows strongly from the south-east and in times of drought this wind transports much soil and sand.

The average annual rainfall is ten inches. The reliability of seasonal rainfall is very low and frequently no rain falls for periods that may exceed 12 months.

WATER SUPPLIES:

The area has very little surface water, either of a permanent or of a temporary nature. After heavy rains the Oorabra Rockholes and other similar features hold water for a short period. The Arthur, Bundey, Marshall and Plenty Rivers are wide streams with sandy beds but they run only after exceptionally heavy rains. In the bed of the Plenty River water can usually be obtained by excavating a few feet below the surface of the sand.

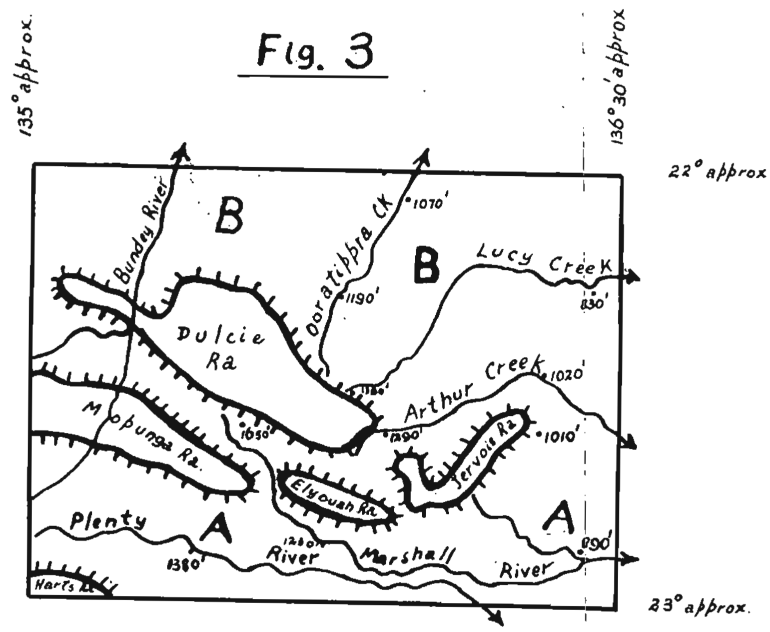
Water for stock and domestic purposes is therefore obtained from bores, and from shallow wells sunk in the bed of the Plenty River. Some earth tanks have been excavated; these suffer a high loss by evaporation in the summer months.

TOPOGRAPHY:

The majority of the area of the Huckitta four-mile sheet consists of gently undulating country which is mostly soil-covered; the remainder of the area consists of ranges. The ranges are in three divisions:

(1) An arcuate portion of the Harts Ranges which occupies a small area in the south-west.

Fig. 3



Topographic Map

Scale: 32 Miles to 1 inch.

References:

Ranges

A, B. Undulating Country.

• 1020' Spot Height.

(2) A narrow, linear, discontinuous belt which extends across the area from west to east and includes the Mopunga, Elyuah and Jervois Ranges. At about the longitude of Thring Creek the trend of this belt changes from south-east to north-east. The available barometric data indicate that this belt reaches its highest elevation in the Elyuah Range, at Mt. Baldwin, which is about 1800 feet above sea level.

(3) A tableland known as the Dulcie Range, whose highest point is about 1900 feet above sea level.

The areas of gently-undulating country are separated by the Dulcie Range and by the linear belt outlined in (2). In the south, the area marked A on Fig.3 is drained by the Plenty and Marshall River systems. The land has a general slope to the east and the total drop in elevation is about 500 feet.

The area marked B on Fig.3 is more undulatory than A because of shallower soil cover and a different type of underlying rock. The land slopes to the north and to the east.

The elevations marked on Fig.3 are taken from the controlled base maps provided by the Division of National Mapping. These elevations were obtained during a ground survey in 1951. During 1958, officers of the Division of National Mapping obtained a considerable number of spot heights on the Huckitta four-mile area but these are not yet available. In the 1958 survey these heights were obtained from a set of altimeters carried in light aircraft.

VEGETATION:

Spinifex grows abundantly throughout the area; it increases in abundance and in the size of individual clumps wherever there are outcrops of dolomite and limestone. Natural grasses are sparse and grow usually in patches. The courses of the larger streams are lined with tall eucalypts. Gidgee and mulga, both of which occur in patches, are the most common of the smaller trees.

PREVIOUS INVESTIGATIONS

Prior to 1957 most of the investigations conducted in the area were either in the nature of reconnaissance traverses over large areas or inspections of copper mines near the Jervois Range and of mica mines on the Plenty River Field.

H.Y.L. Brown made the first geological reconnaissance of the area (Brown, 1897). Brown named several topographic features, including Grant Bluff. He described the sedimentary rocks which crop out at Grant Bluff and also the arkose which crops out nearby. To the east of Grant Bluff a large number of quartz reefs crop out on a plain which is underlain by granite; Brown prospected these reefs for gold and other metals but his search was unsuccessful.

In 1929 two prospectors, Messrs. Hanlon and Mudge, discovered copper and lead ores near the Jervois Range. Despite the isolation of the area at that time, a number of leases were soon pegged on the new mineral field. Investigations by representatives of mining companies soon followed.

The first of these investigations was made by C.C. Gibson, who in 1929 inspected the mines and prospects on behalf of Broken Hill interests (in Blanchard, 1940, unpublished). S.R.L. Shepherd in 1929 made an inspection for Brisbane clients (in Blanchard, 1940, unpublished). Both Gibson and Shepherd reported adversely on the mineral potential of the area; both considered that the lack of visible large tonnages of ore, and the costs of labour and transport in such an isolated area, prohibited any large-scale development.

Hodge-Smith, in 1929 also inspected the mineral deposits of the Jervois Range area (Hodge-Smith, 1932). In 1931, P.S. Hossfeld inspected this area on behalf of the Federal Government.

Tindale (1931) observed a sequence of sedimentary rocks in the Mopunga Range and he measured stratigraphic sections at a number of localities in this range. Tindale applied the name "Mopunga Beds" to the sediments which crop out in the Mopunga Range. He also measured and described a thickness of 800 feet of sandstone and quartzite at Mt. Ultim in the Dulcie Range and recorded Ordovician fossils in the slopes beneath Mt. Ultim.

Madigan (1932,b) journeyed through the Eastern MacDonnell Ranges and extended his traverses to the Elyuah and Mopunga Ranges. He considered that some of the sedimentary formations of the Elyuah Range were the equivalents of formations which he had mapped previously in the Western MacDonnell Ranges (Madigan,1932a) e.g., he reported equivalents of the Pertaknurra, Pertatataka, Pertaoorta and Larapintine Series. Madigan reported Ordovician fossils in the scarp of the Dulcie Range near Huckitta Station homestead, and he reported also the discovery of poorly preserved ? Archaeocyathids at a locality north-west of Oorabra Rockholes. Madigan also made observations on some of the Precambrian schists and gneisses and on the granites which intrude them.

Joklik (1955) published the results of a survey of mica mines in the Plenty River Field, and of a reconnaissance through the sedimentary rocks to the north-east of that mica field. He considered that the Oorabra Arkose formed the basal unit of the Upper Proterozoic succession in the area. In reporting upon the Precambrian rocks of the area Joklik considered that the rocks exposed at Mt. Sainthill rested unconformably on the schists and gneisses of the Harts Range Group; he applied the name "Sainthill Grit" to the rocks of Mt. Sainthill and considered them to be of Lower Proterozoic age.

Noakes (1956) published a composite section of the Mopunga Group, as a result of reconnaissance surveys in the Huckitta and Tobermory areas. Noakes here first used the name "Mopunga Group".

Casey and Tomlinson (1956) published an account of the geology of part of the Huckitta area. This publication included a list of fossil localities which had been discovered in the area up until that time.

Swindon and Rowe, 1956 (in Sprigg,1957) mapped the geology and structure in several small areas of sedimentary rocks. Their results have been included in a publication by Sprigg (1958); this gives an Upper Proterozoic or Lower Cambrian age to a sequence of carbonate rocks which are, in fact, of Upper Cambrian age.

N.O. Jones (Resident Geologist, Alice Springs) made geological observations in the Huckitta area on several occasions between 1954 and 1958. These observations are not documented but Jones has made them available to the Bureau's field parties.

In 1957 a Bureau of Mineral Resources field party began to map the area covered by the Huckitta four-mile map sheet. About one quarter of the area was mapped and detailed work was done on two of the Jervois copper mines. In addition, samples of granite were collected for age determination by methods based on radioactivity (Smith et al. Records 1960/16).

CONCURRENT INVESTIGATIONS

In 1958 a field party of Frome-Broken Hill Pty. Ltd. mapped some of the sedimentary rocks on the Huckitta four-mile sheet area and measured numerous stratigraphic sections.

NOMENCLATURE

In this report the current practice of the Bureau of Mineral Resources, Geology and Geophysics, with respect to time divisions of the Precambrian is followed. This practice is to recognise two Eras, namely the Archaean and Proterozoic; the Proterozoic Era is divided into Lower Proterozoic and Upper Proterozoic Periods.

This practice is not uniform in Australia. Some States follow it; others adopt the practice of Western Australia where the Archaean Era is divided into Lower and Upper Archaean Periods and where the Proterozoic is not divided. Browne (in David, 1950) used Lower, Middle and Upper Precambrian Periods. Hossfeld (1954) used Archaeozoic and Proterozoic Eras and divided the Proterozoic into Lower, Middle and Upper Proterozoic Periods.

The Australian Code of Stratigraphic Nomenclature has been followed in naming rock units or revising existing names. New names and revisions have been approved by the Territories Committee on Stratigraphic Nomenclature.

GEOLOGY

The regional geology is one of Precambrian metamorphic and igneous rocks, overlain unconformably by sedimentary rocks of Upper Proterozoic, Palaeozoic and Cainozoic ages. In 1958 the mapping extended from the areas mapped in 1957 and the four-mile map sheet was completed. The regional geology will be discussed in two sections:

(a) Precambrian metamorphic and igneous rocks.

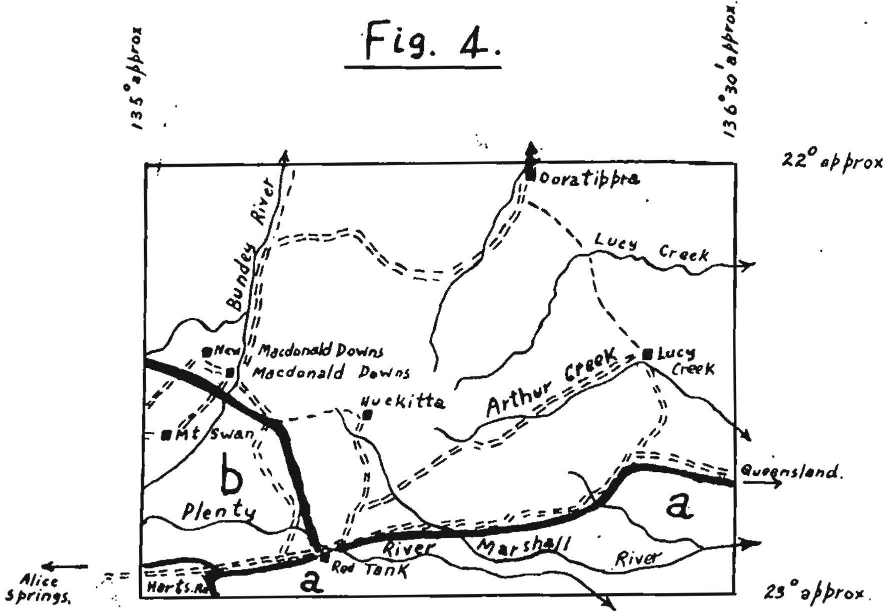
(b) Sedimentary rocks.

PRECAMBRIAN METAMORPHIC AND IGNEOUS ROCKS

In the areas mapped in 1958 there are Precambrian metamorphic and igneous rocks of at least three different ages. These rocks are:

(i) a suite of gneisses, schists, metaquartzites. This suite crops out over an extensive area. It

Fig. 4.



Locality Map,
showing areas a and b mapped
in Precambrian metamorphic rocks, 1958

Scale: 32 miles to 1 inch

is believed to belong to the Arunta Complex of Archaean age but no determinations of age, based on radiometric methods, are available for any of these rocks exposed on the Huckitta four-mile area;

(ii) basic rocks which intrude the metamorphic rocks and which have not undergone regional metamorphism to the same degree as them;

(iii) extensive areas of granite which intrude the metamorphic rocks and which may intrude the basic rocks. Some of the granite may be of Archaean age but most of it is believed to be Lower Proterozoic in age; two determinations of age, based on radiometric methods, are now available and each is of the order of 1400 million years.

Within the metamorphic rocks and granite there are numerous pegmatite veins, some of which carry muscovite in commercial quantities. A small number of the pegmatites are believed to be of metamorphic origin but most are probably related to granitic intrusions.

In 1958 it was hoped to correlate, and if possible to link, the metamorphic rocks with the formations of the Harts Range Group (Joklik, 1955) which crop out in the Harts Range in the south-western corner of the Huckitta four-mile sheet. This object has not been achieved. Paucity of outcrop has prevented a direct linkage with the Brady Gneiss (Joklik, 1955, Plate 3); correlation between formations is not yet possible because descriptions of thin sections are not available.

The authors believe that the Brady, Irindina and Cadney gneisses and a formation of metaquartzite are present on the Huckitta four-mile sheet (excluding the Harts Range area). But outcrops are small and discontinuous and without supporting evidence from thin sections it would be unwise either to map formations as the Brady, Irindina and Cadney gneisses or to correlate with them. Therefore the results of the 1958 mapping of the metamorphic rocks are presented in a purely descriptive form.

<u>Gneisses, schists, metaquartzites</u>

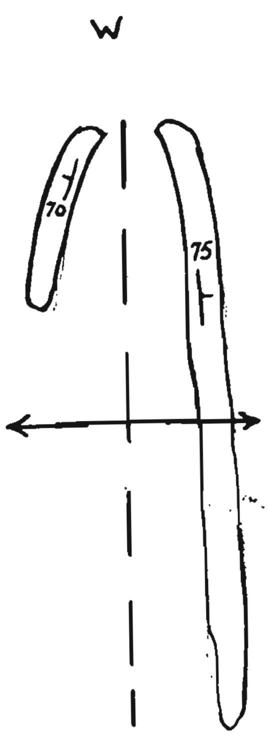
For the purposes of description two geographical areas are considered. These, which are shown on Fig.4, are:

(a) south of the Alice Springs-Queensland road, and extending across the whole of the Huckitta four-mile sheet (the outcrop in the Harts Range is excluded);

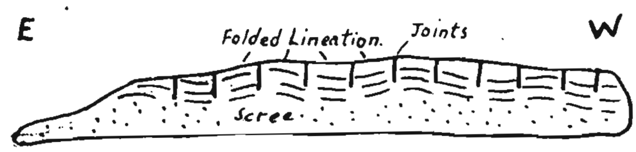
(b) north of the Alice Springs-Queensland road and west of the longitude of Red Tank. The northern limit of this area is at about the latitude of New Macdonald Downs homestead.

<u>Southern Area</u>: The typical outcrop of Archaean rocks in this area is in the form of small peaks, rarely exceeding 100 feet above the plains. There is one ridge about three miles long (at about the longitude of Grant Bluff) and numerous very low outcrops which are less than 5 feet high. Many of the small peaks are "stiffened" by narrow, short, ramifying pegmatite veins.

Fig. 5.



Plan.



Elevation

Scale: 100' to 1" approx (horizontal and vertical.)

The following suites of rocks have been mapped:

1. A medium-grained, bluish-coloured quartz-biotite-feldspar gneiss of saccharoidal texture, with subordinate bands of garnet-biotite-feldspar gneiss, quartz-biotite gneiss, quartz-muscovite gneiss and grey metaquartzite. The quartz-biotite-feldspar gneiss is the most abundant rock type east of the longitude of Thring Creek. Dips of foliation are generally steep and the foliation, which is probably parallel to the original bedding, has a regional north-west trend.

2. A hard, quartz-feldspar-biotite gneiss with alternating layers of quartz and feldspar. Tight second order folds (after Joklik, 1955) are common and in several instances third order folds (after Joklik, 1955) are well shown by the quartz laminae. The axial planes of these third order folds are approximately parallel to the foliation. B-axis lineation is visible on some beds of this gneiss. In many localities the gneiss contains streaks and clots of biotite, and irregularly-shaped aggregations of feldspar. This rock type has been mapped throughout the area but is more prevalent in the western part of it. Associated with the rock type are bands of hornblendites and biotitites and a slightly garnetiferous quartz-feldspar-biotite gneiss. The suite <u>may</u> belong to the Brady Gneiss.

3. A suite in which the dominant rock type is a garnetiferous quartz-feldspar-biotite gneiss; subordinate types are hornblendites, biotitites and thin metaquartzites. Biotite-rich phases of the quartz-feldspar-garnet-biotite gneiss are very common and there are abundant examples of aggregation of feldspars. This suite is believed to underlie (2), although no evidence for the facing of beds is available. It is probable that this suite belongs to the Irindina Gneiss. It crops out in the western portion of the area.

4. A few outcrops of a gneiss which consists of alternate layers of quartz and feldspar, with some thin layers and streaks of biotite. This gneiss bears some resemblance to that of (2) and the differences are more apparent in the field than in description. It is always tightly folded (second order folds) and nearly always strongly exhibits b-axis lineation. In one locality this lineation has been gently folded about fold axes which trend north. The gneiss may be the Cadney Gneiss; no field relationships between the gneiss and the suites 1-3 were recorded. It crops out in the western part of the area.

The regional structure of the southern area is indefinite because of the paucity of outcrop, the indefinite formational mapping and the doubt in using lineation to predict structure. A general view of portion of one outcrop with strongly-developed b-axis lineation is shown in photograph No.5. Photograph No.6 shows another portion of the same outcrop with a slight flexure in the lineation; it shows also the strong joints developed during the folding movement which caused the flexures in the lineation. Fig. 5 shows the whole outcrop diagrammatically. The authors contend that when lineation is mapped in a small outcrop, e.g., the size represented in Photograph No.5, the lineation may give a misleading picture of regional structure and therefore in this area use cannot be made of such a feature.

Northern Area: In the northern area there are two suites of gneisses which correspond to suites (2) and (3) of the southern area. This northern area is the westerly and north-westerly continuation of the 'Marshall Bore' area (Smith et al. 1960) and the rocks are substantially similar to those recorded there. In the southern part of the area there are quartz-feldspar-biotite-garnet gneisses; their foliation has a regional strike of about 270 degrees and a steep south dip. Associated with this suite are quartz-muscovite schists, muscovite schist, chlorite schist and thin bands of metaquartzite.

In the north and north-west of the area there is a hard quartz-feldspar-biotite gneiss (see Photographs Nos. 7 and 8) which is very similar to suite (2) of area (a) and which is believed to belong to the same formation. Associated with this gneiss are soft quartz-muscovite schists, muscovite schists and quartz-muscovite-feldspar schists. The regional strike of foliation in the gneiss ranges from 280 degrees to 330 degrees, and it dips steeply to the south or south-west, except in the extreme north of the area where some north dips have been recorded.

Considerable lithological variation in the quartz-biotite-feldspar gneiss has been recorded in areas where the gneiss has been either intruded by granite or metamorphosed to a granite. This granite will be discussed in a later section of this report.

Basic Rocks

Numerous outcrops of these rocks were mapped in 1958. Some of them were in the form of narrow ramifying dykes in the gneisses and schists; other larger outcrops seemed to be in sequence with metasediments but may, in fact, be sills. Examination of thin section of basic rocks collected in 1957 revealed that all had an igneous texture and were probably of igneous rather than metamorphic origin. During 1958 no large intrusive bodies of basic igneous rocks, large enough to show on a four-mile map, were recorded.

GRANITES:

During 1958 the results of age determinations of three granites exposed on the Huckitta four-mile area became available. The work was done by Professor P.M. Hurley, at the Massachusetts Institute of Technology. Two of these granites, namely the Jinka Granite and the Jervois Granite are intrusive. The third, the Mount Swan Granite, is believed to be of metamorphic origin; this belief is based on field evidence only. Until petrological studies have been carried out on the Mt. Swan Granite and on the rocks from which it may have been derived, this granite will be included in this section of the report.

The Jinka Granite

This granite was completely mapped in 1957 and present comments on it are made only to record its age. The age, determined by P.M. Hurley, is 1440 million years. The determination was made from one sample. Until more precise definitions of the Precambrian time scale are forthcoming, the Jinka Granite will be referred to the Lower Proterozoic.

The Jervois Granite (new name)

This granite is here named and defined as the mass of coarse-grained quartz-feldspar-mica granite which occupies a large area east and south-east of the Jervois copper mines. In composition the Jervois Granite resembles the Jinka Granite but separate names are preferred because the two masses are not sensibly continuous. Within the area of the Jervois Granite there are numerous roof-pendents of gneiss of the Arunta Complex.

The age of the Jervois Granite has been determined by P.M. Hurlsy as 1420 million years. One sample was used in this determination.

The Dneiper Granite (New name)

This granite is here named as the mass of quartz-feldspar-mica granite which crops out to the north-east and east of Dneiper Station homestead. The name is taken from this homestead, which is located about two miles west of the south-western extremity of the outcrop area (refer Plate 1). The granite does not crop out strongly and it contains numerous roof pendents of Archaean gneiss and schist. The Dneiper Granite has not been sampled for age determination.

The Marshall Granite

This granite was mapped completely in 1957. It has not been sampled for age determination.

The Mt. Swan Granite (New name)

This granite is here named and defined as the mass of feldspar-quartz-biotite granite which crops out between the station homesteads of Mt. Swan and New Macdonald Downs; both of these are near the western border of the Huckitta four-mile sheet.

The Mt. Swan granite generally crops out as a series of pinnacles which rise to heights of 100 feet above the plains. On aerial photographs the Mt. Swan Granite has a dark-toned, rough pattern relieved by numerous straight lines which are the expression of strong joints.

The age of the Mt. Swan Granite, determined by P.M. Hurley, is 1460 million years. One sample was used for this determination.

The most characteristic feature of the Mount Swan Granite is its feldspars; these are frequently 1½ inches long, ½ inch wide, and always show a preferred orientation. Photograph No.9 shows a characteristic block of the Mt. Swan Granite.

The Mt. Swan Granite has either a magmatic or a metasomatic origin; it has either intruded a quartz-feldspar-biotite gneiss (? Brady Gneiss) and associated quartz-muscovite schist and muscovite schist or it has been formed by metasomatism of the ? Brady Gneiss. Photographs Nos.7 and 8 show typical outcrops of the quartz-feldspar-biotite gneiss in the area adjacent to outcrops of the Mt. Swan Granite. Photograph No.10 shows a close-up view of a dark-coloured (? Biotitic) phase of the gneiss in which there are feldspars of two generations - the swirling aggregate of feldspar is a common product of metamorphism exhibited by many of the Archaean gneisses in the Huckitta four-mile area;

the feldspar crystals in the gneiss and also in the feldspar aggregate are younger ones which have been formed presumably at the time of formation of the Mt. Swan Granite. Photograph No.11 shows a contact and an intermediate zone between granite and gneiss. At this locality the feldspars in the granite have a preferred orientation of 320 degrees; in the gneiss the orientation is generally at 280 degrees.

Common features in the granite are (excluding the oriented feldspars):

(a) clots and large streaks of biotite (relic of the gneiss); these sometimes have large feldspars showing random orientation.

(b) large portions of quartz-feldspar-biotite gneiss containing a few feldspars, randomly oriented. In some instances the gneiss may be 300 feet long and 20 feet wide, completely surrounded by granite and with some irregularly-shaped segments of granite within the gneissic mass. In all cases the contacts are fairly sharp. Photograph No.12 shows one such contact.

(c) small portions of quartz-feldspar-biotite gneiss which have been changed to an aplitic composition; all gradations from gneiss to aplite occur. The third order folds previously developed in the gneiss are often visible in the aplite

The preferred orientation in the feldspar is usually parallel to the foliation of the gneiss; a slight discordance not exceeding 10 degrees has been recorded in some localities but this could be due to the fact that it is more difficult to record the orientation of the feldspars in comparison with the foliation. The preferred orientation of the feldspars ranges from 240 degrees to 320 degrees in the area of the Mt. Swan Granite; in the same area the foliation of the gneiss ranges from 260 degrees to 325 degrees. It is not always possible to match the regional trend of orientation and foliation and it is not possible to state that the preferred orientation of feldspars follows the regional trend of the gneiss.

Other facts to be considered in the origin of the Mt. Swan Granite are:

(a) no occurrence of inclusions (or unmetasomatised portions) of the quartz-muscovite schist and muscovite schist have been recorded in the granite. If these schists were intruded by granite the digestion has been complete. If the schists have been metasomatised then they have been completely made over. It would seem likely that the latter process would be the easier;

(b) large bands of hornblendite have been unaltered; their foliation parallels the preferred orientation of the feldspars in adjacent granite;

(c) epidote is abundant in some aplitic bands.

(d) the granite, the gneiss and the quartz-muscovite schist each have a well-developed system of almost horizontal joints.

(e) there are numerous pegmatites in the quartz-feldspar biotite gneiss; e.g., the small hill in photograph No.8 contains fourteen narrow pegmatites whose strikes all follow the changes in strike of the foliation in the gneiss. These pegmatites, and others in the same area, consist of quartz, muscovite, feldspar and tourmaline. The feldspar is always badly weathered and coarse; it has quite a different appearance to that in the many other pegmatites mapped on the Huckitta four-mile. These pegmatites may be of metamorphic origin and if this be the case then the case for a granite of metamorphic origin is strengthened.

The authors believe that the weight of field evidence favours a metamorphic origin for the Mt. Swan Granite. Such an origin could well account for the granite which was named the "Sainthill Grit" (Joklik 1955) and for the Marshall Granite mapped in 1957. Against this theory of origin for the Mt. Swan Granite are the fact that the authors believe the Jinka and Jervois Granites to be intrusive ones and that the Jinka, Jervois and Mt. Swan Granites are roughly the same age. Furthermore, age determinations, made by P.M. Hurley on samples of other granites, indicate that in much of Central Australia there was a period of granitic intrusion about 1400 million years ago.

Throughout the areas occupied by the Precambrian metamorphic and igneous rocks numerous pegmatites were mapped in 1958. These pegmatites, and those mapped in 1957, are described by Woolley (1959). He lists all pegmatites mapped, their strikes and mineral contents, the strike of the country rocks, details of mines and prospects and pegmatites which warrant further prospecting. The position of each pegmatite is plotted on maps whose scale is one mile to one inch. Woolley (loc.cit.) has analysed the strike of about 150 discordant pegmatites; this shows that there is a maximum ·a in the east-west direction, with two subsidiary maxima, one north-east and one north-west. If most of the pegmatites have been emplaced in fissures, then the analysis gives a lead to the directions of fissures produced by faulting.

SEDIMENTARY ROCKS

The mapping of the sedimentary rocks on the Huckitta sheet was completed and numerous sections were measured in them. Names have been proposed for several new formations and approval to use such names has been obtained from the Territories Committee on Stratigraphical Nomenclature. The following table gives the names and ages of formations discussed in following sections of this report.

Tertiary	
? Permian	
Devonian	Dulcie Sandstone
Cambro-Ordovician	Tomahawk Beds
Upper Cambrian	Arrinthrunga Formation
Middle Cambrian	Arthur Creek Beds
Lower Cambrian	Mt. Baldwin Formation
? Upper Proterozoic	Grant Bluff Formation
	Elyuah Formation
Upper Proterozoic	Mt. Cornish Formation

Mt. Cornish Formation (New name)

This is the name now given to the sequence of glacigene sediments partly mapped in 1957. The Mt. Cornish Formation is here named and defined as the sequence of blue-green siltstone containing boulders, cobbles and pebbles; of hard, laminated cyclic siltstone and sandstone; and of subordinate amounts of calcilutite, dolomite and coarse-grained arkose and quartz greywacke; the sequence rests unconformably on either Archaean metasediments or on Lower Proterozoic granite, and is overlain, probably unconformably, by the Oorabra Arkose.

The name is taken from Mt. Cornish (Lat.22 degrees 46 minutes S., Long. 136 degrees 29 minutes E.) which is capped by basal units of the Formation. The Formation crops out also in each of the Mopunga, Elyuah and Jervois Ranges and it is the oldest of the unmetamorphosed sedimentary formations in the Huckitta four-mile area. On aerial photographs the Formation has no distinguishing features; on the ground, scree of the Oorabra Arkose often obscures much of the Mt. Cornish Formation.

The sequence is exposed best in the vicinity of Mt. Cornish and the type section is located there. In this area the basal unconformity is well-exposed but the top of the Formation is masked by soil cover. The sequence measured in the type section, in descending order, is:

Soil cover
8 feet of hard, laminated, blue-green cyclic siltstone and fine sandstone;
26 feet of blue-green BOULDER BEDS (35% exposed);
13 feet concealed;
3½ " of green siltstone with "tillitic" texture; pebbles up to 1½ inches;
63½ feet concealed;
26 " of blue-green BOULDER BEDS (33% exposed;)
13 " concealed;
11½ " of hard, laminated, blue-green cyclic siltstone and fine sandstone; some coarser sandstone; a few pebbles up to 1 inch in size;
3½ feet of blue-green BOULDER BEDS;
3½ " concealed;
1½ " of green siltstone with "tillitic" texture;
3 " of blue-green BOULDER BEDS;
6 " concealed;
6 " of blue-green siltstone with "tillitic" texture, containing abundant pebbles;
6 feet concealed;
23 feet of blue-green BOULDER BEDS (45% exposed);
363 feet concealed;
7 feet of blue-green BOULDER BEDS (55% exposed);
3½ " concealed;
3½ " of blue-green siltstone with "tillitic" texture;
3 " of blue-green BOULDER BEDS; boulders range to 24 inches;
9 feet of poorly-outcropping blue-green siltstone with "tillitic" texture; laminated in part;
2 feet of blue-green BOULDER BEDS; boulders range to 15 inches;
36 feet of blue-green siltstone with "tillitic" texture; some pebbles and cobbles; (60% exposed);
4 feet of blue-green BOULDER BEDS;
16½ feet of blue-green siltstone with "tillitic" texture, containing some pebbles; (33% exposed);
63½ feet of blue-green BOULDER BEDS; boulders range to 18 inches; (60% exposed);

61 feet of poorly-outcropping blue-green siltstone with "tillitic" texture; some hard, laminated cyclic siltstone and fine sandstone;
192 feet of blue-green BOULDER BEDS; (50% exposed);
184 feet of blue-green BOULDER BEDS with some thin interbeds of hard, laminated, cyclic siltstone and fine sandstone; (50% exposed);
2 feet of white, medium-grained, medium-bedded sandstone;
5 feet of brown, medium-bedded dolomite;
13 feet of grey and purple, laminated to thin-bedded dolomite;
4 feet of purple, medium-grained, medium-bedded, poorly sorted sandstone;
1 foot of white, medium-grained, medium-bedded sandstone;
12 feet concealed;
½ " of white, medium-grained, medium-bedded sandstone;
23 feet concealed;
5 " of yellow and pink, thin to medium-bedded dolomite and calcilutite;
½ foot of pale brown, medium-bedded quartz-greywacke;
2 " concealed;
2 " of pale brown, medium-bedded quartz-greywacke;
4 " concealed;
½ " of thin-bedded quartz greywacke;
3½ " concealed;
4 " of coarse-grained, thin-bedded arkose unconformably overlying the Jervois Granite

1247 feet - thickness of Mt. Cornish Formation in type locality.

Features of interest in the beds of the type section of the Mt. Cornish Formation are:

(a) the "tillitic" texture of many beds. "Tillitic" texture is used here for a dominantly fine-grained ground-mass, usually green or blue-green in colour, containing numerous scattered fragments ranging in size from sand to boulders. In the section all of the boulder beds have this texture; the 'siltstone with "tillitic" texture' refers to those beds which contain only rare boulders and/or cobbles;

(b) the shape of the boulders. These are: well-rounded and polished, with concave surfaces also polished; wedge-shaped; pyramidal; kidney-shaped. Cobbles in the boulder beds are rarely faceted. Photographs 13 and 14 show portions of typical boulder beds in the type section;

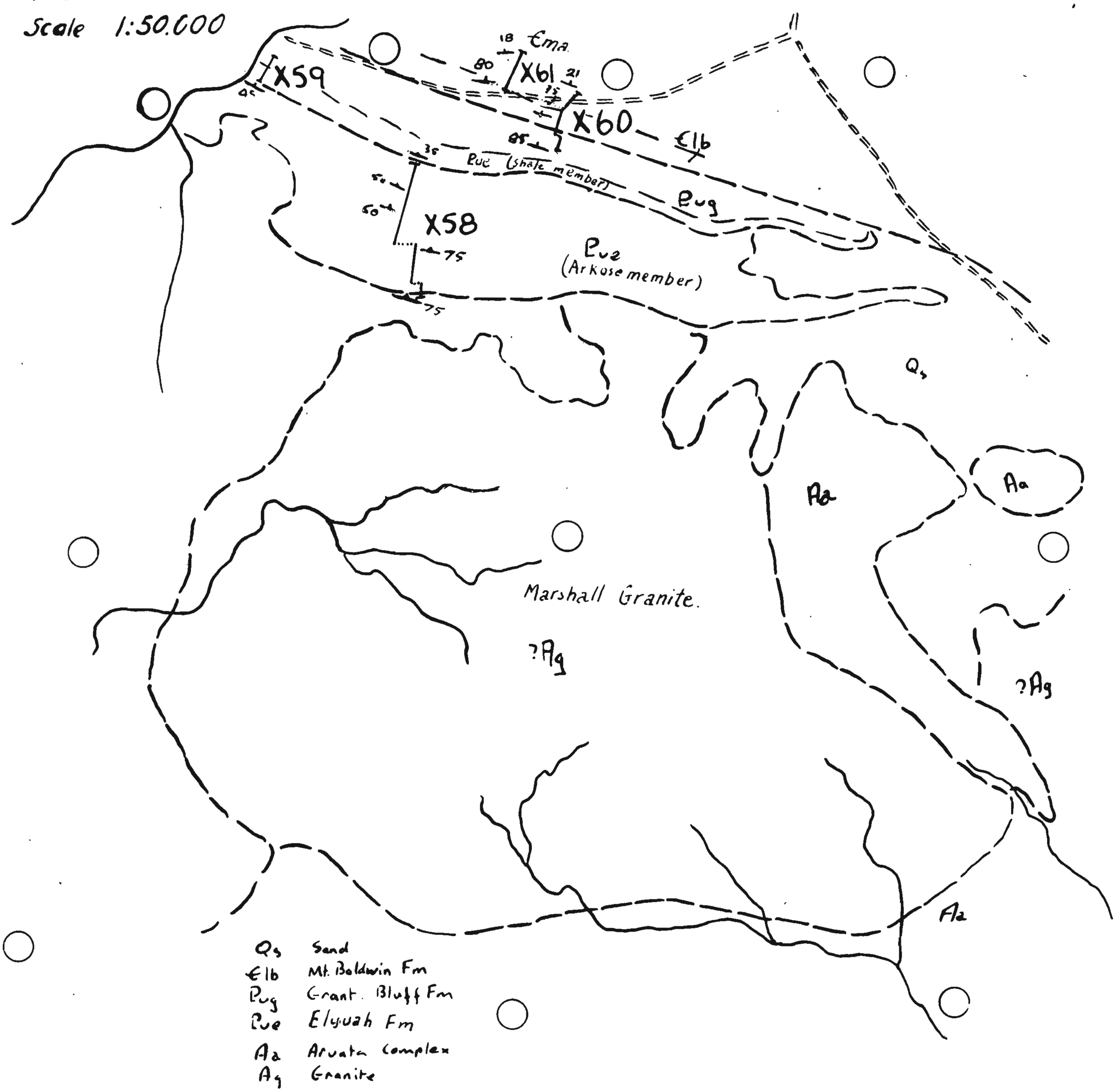
(c) many of the boulders and many of the cobbles are striated;

(d) the beds of "tillitic" texture show a rough bedding; impact structures have been observed under some boulders;

(e) the boulders and cobbles are of various types of Archaean gneiss, schist, metaquartzite and amphibolite, and of granite. The Archaean rocks of the area are so diverse in type, and all types are represented in the boulder beds, that it is impossible to record indubitable "foreign" boulders.

Muckitta Run 11-5193

FIG 7
Scale 1:50.000



(f) the cyclic siltstone and fine sandstone show little gradation between the laminae. The rare pebbles contained in the cyclic beds show impact structures in some cases. The cyclic beds show numerous minute faults (refer Photograph No. 15);

(g) there is no record of a glacial pavement at the basal unconformity.

The sequence in the vicinity of Mt. Cornish is very similar to a sequence of glacigene sediments reported by Noakes (1957, p.233) from the Field River area to the south-east. We have inspected the sequence recorded by Noakes.

The sequence at Mt. Cornish is similar in many aspects to those recorded previously from the Jervois and Elyuah Ranges (Smith et al, 1960) and to one mapped in the Mopunga Range during 1958. The authors believe that the evidence at Mt. Cornish strongly indicates a sequence of glacigene sediments; the boulder beds and the siltstone with "tillitic" texture indicate material released from floating ice and the cyclic sediments indicate varve deposition. The use of the term "tillitic" does not imply that the Mt. Cornish sequence is a ground moraine.

In the Mopunga Range a section (X58, Fig.7) was measured in the Mt. Cornish Formation. Here the sequence is 1040 feet thick and contains intervals of boulder beds. Much of the sequence is of greenish-grey arkose and brown, laminated siltstone. No indubitable "foreign" boulders were established. The sequence is overlain by the Oorabra Arkose but the nature of the contact could not be established.

The only locality where a ground moraine has been recorded is in the Elyuah Range, 2¼ miles north-north-east of Oorabra Rockholes. Here M.A. Condon has recorded the following sequence (Records 1958/106); thicknesses are estimated:

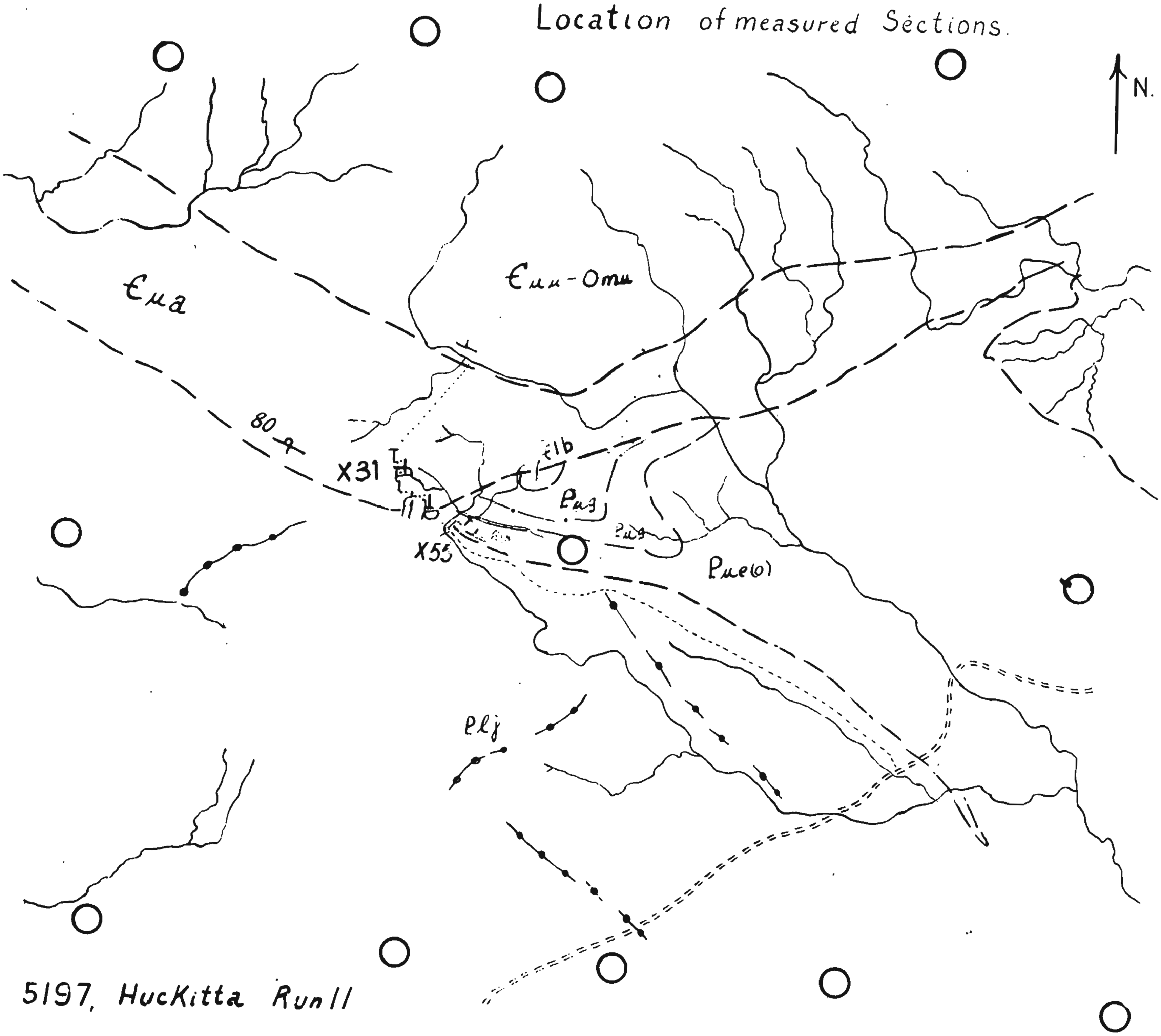
	Stratified siltstone and quartz greywacke overlying
25 feet	of unstratified boulder clay with boulders and cobbles of granite and metaquartzite and a large granite erratic 10' x 40' x 8' (ground moraine);
20 feet	of laminated, cyclic (varved) siltstone and claystone whose top surface is scoured and contorted;
3 feet	of unstratified pebble clay (ground moraine);
5 feet	of laminated, cyclic (varved) siltstone and claystone;
15 feet	of laminated, sandy (tillitic) siltstone;
10 feet	of unstratified boulder clay containing boulders and cobbles of granite and cobbles and pebbles of quartz and metaquartzite (ground moraine);
—	Decomposed coarse Jinka Granite
78 feet.	

A comparison of all sections measured during the whole survey of the Huckitta four-mile area is as follows:

Mt. Cornish area	X 81 (type section)	1250 feet
Jervois Range	X 20	80 "
Elyuah Range	X 1	40 "
" "	X 2	110 "
" "		78 "
Mopunga Range	X 58	1040 "

Fig.8.

Location of measured Sections.



5197, Huckitta Run II

Scale: 1:50,000 approx.

The age of the Mt. Cornish Formation is certainly Precambrian and it is believed to be Upper Proterozoic. The authors correlate it with the Areyonga Formation (Prichard and Quinlan, 1959), of the Western MacDonnell Ranges, which disconformably overlies the Bitter Springs Limestone. It is considered that the Mt. Cornish Formation may also be correlated with the Sturt Tillite of South Australia. Age relationships of the glacigene sediments reported by Noakes in the Field River area are not yet available.

The Elyuah Formation

This Formation was named and defined by Smith et al. (1960, unpubl). It consists of two members - an arkose member succeeded by a shale member. Joklik (1955, loc.cit. named the arkose member which crops out near Oorabra Rockholes the Oorabra Arkose.

In 1958, three additional sections were measured in the Arkose member; one of these, X55, was measured in the Oorabra Arkose and the others, namely X58 and X 62, were measured in the Mopunga Range. A comparison of the lithologies of X 55 and X 62 are shown on Fig. 10 and the locations of X 55, X 58 and X 62 are shown on Figs. 8, 7 and 9 respectively.

The variations in thickness of all sections measured in 1957 and 1958 in the arkose unit of the Elyuah Formation are shown in the following list:

Mopunga Range	X 62	530 feet	
" "	X 58	2460 "	
Elyuah "	X 1(type section)	83 "	(Oorabra Arkose)
" "	X 2	96 "	" "
	X 6	102 "	" "
	X 55	630 "	" "
Thring Creek	X 17	273 "	
Jervois Range	X 20	110 "	

In addition to the thicknesses quoted, Madigan (1932,b) recorded a thickness of 240 feet in the (present) Oorabra Arkose at a locality north-east of Oorabra Rockholes.

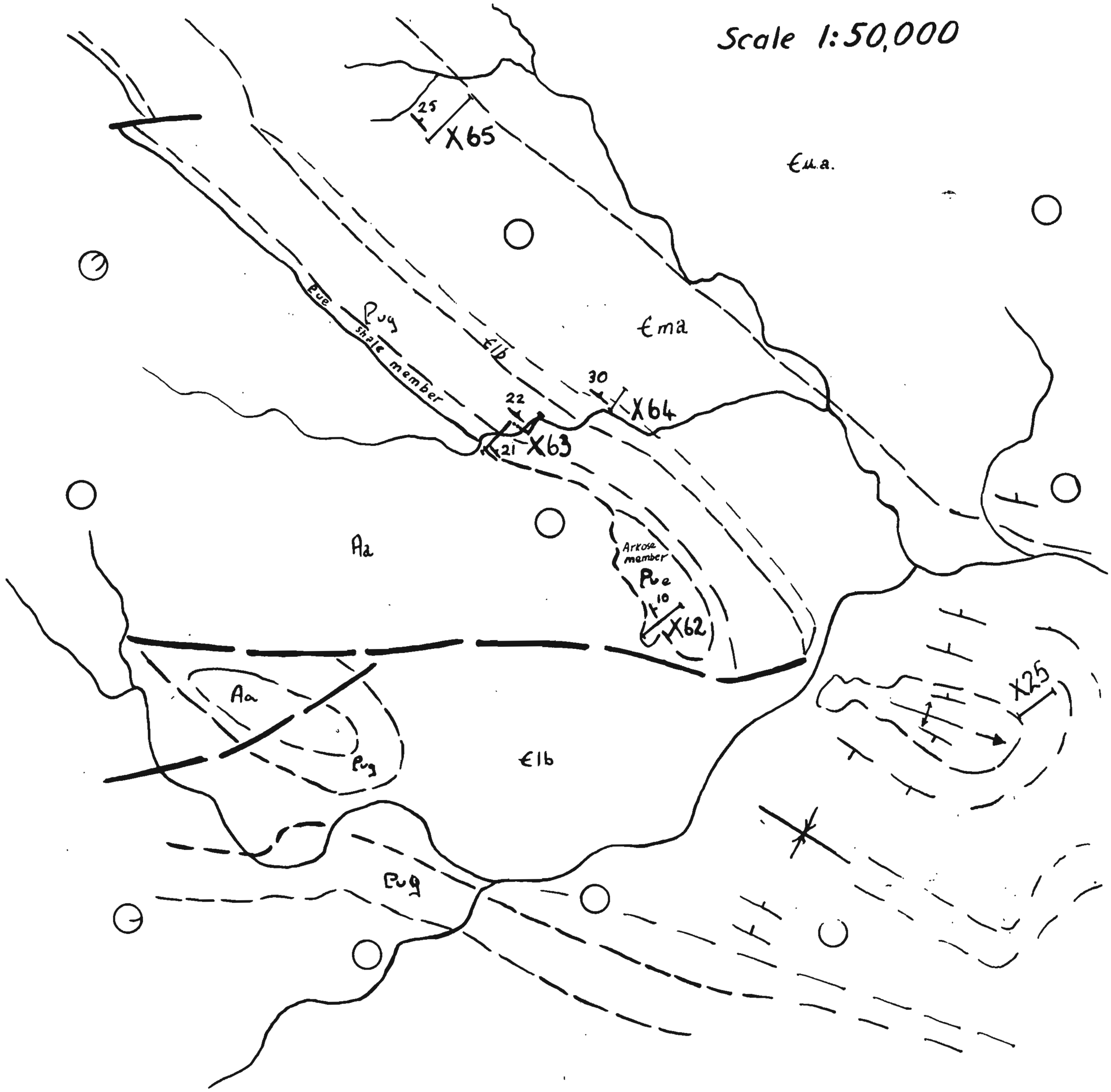
With the exception of X 17, all of the sections listed above have clearly-defined tops, being succeeded conformably by the shale member of the Elyuah Formation. The bases of the sections rest either on Precambrian and/or metamorphic rocks, or on the Mt. Cornish Formation. A disconformity is believed present at the contact between the Mt. Cornish Formation and the arkose member of the Elyuah Formation.

The range of thicknesses exhibited by the arkose of the Elyuah Formation is probably due in part to the configuration of the surface on which the arkose was deposited and in part to the source area and the direction of the currents. In the Elyuah Range some evidence is available for the direction of currents of deposition. This evidence is:

(a) In both sections X1 and X6 density-current stratification is well-exhibited by thin beds of green shale which are within the Oorabra Arkose. Asymmetric ripples on the top surface of this shale indicate a direction of current from the south-west.

FIG. 9

HUCKITTA RUN 10-5026



(b) Supporting evidence for this current direction is given by the thickness of sections measured in the Elyuah Range. X1, X 2 and X 6, and also the thickness of 240 feet recorded by Madigan (1932, loc.cit.) were measured on the north-eastern limb of a syncline; X 55 was measured on the south-western limb of this fold. At other localities on the south-western limb, visual estimates give thicknesses greatly in excess of those on the north-eastern limb.

In the Mopunga Range a similar situation may apply. Here X 58 is south-west of X 62 and X 58 is much closer to the outcrop area of the Marshall Granite. In the Jervois Range and in the area near Thring Creek no evidence of thickness variation is available because of limited areas of outcrop. About 10 miles east of Grant Bluff there are several steeply-dipping outcrops of arkose of the Elyuah Formation; in this area the thickness of the arkose has not been measured but it is estimated to be of the order of 300 feet.

Two additional sections of the shale member of the Elyuah Formation were measured in 1958. These sections, which were measured by D.R.G. Woolley, are X 59 and X 63, whose locations are shown on Figs. 7 and 9 respectively. Both sections are poorly-exposed in the rubble-covered backscarp of the Mopunga scarp. Both sections are 310 feet thick.

The Grant Bluff Formation

This formation was named and described by Smith et al. (1960, loc.cit.). During the 1958 field season, two additional sections were measured in it. Both are in the Mopunga Range and were measured by D.R.G. Woolley; the lithologies of these sections are shown on Fig.11. Fig.12 shows a comparison between all sections of the Grant Bluff measured on the Huckitta Four-Mile Sheet, and all sections of the shale member of the Elyuah Formation in the same area. In the Grant Bluff Formation, only X 59 and X 15 are complete sequences.

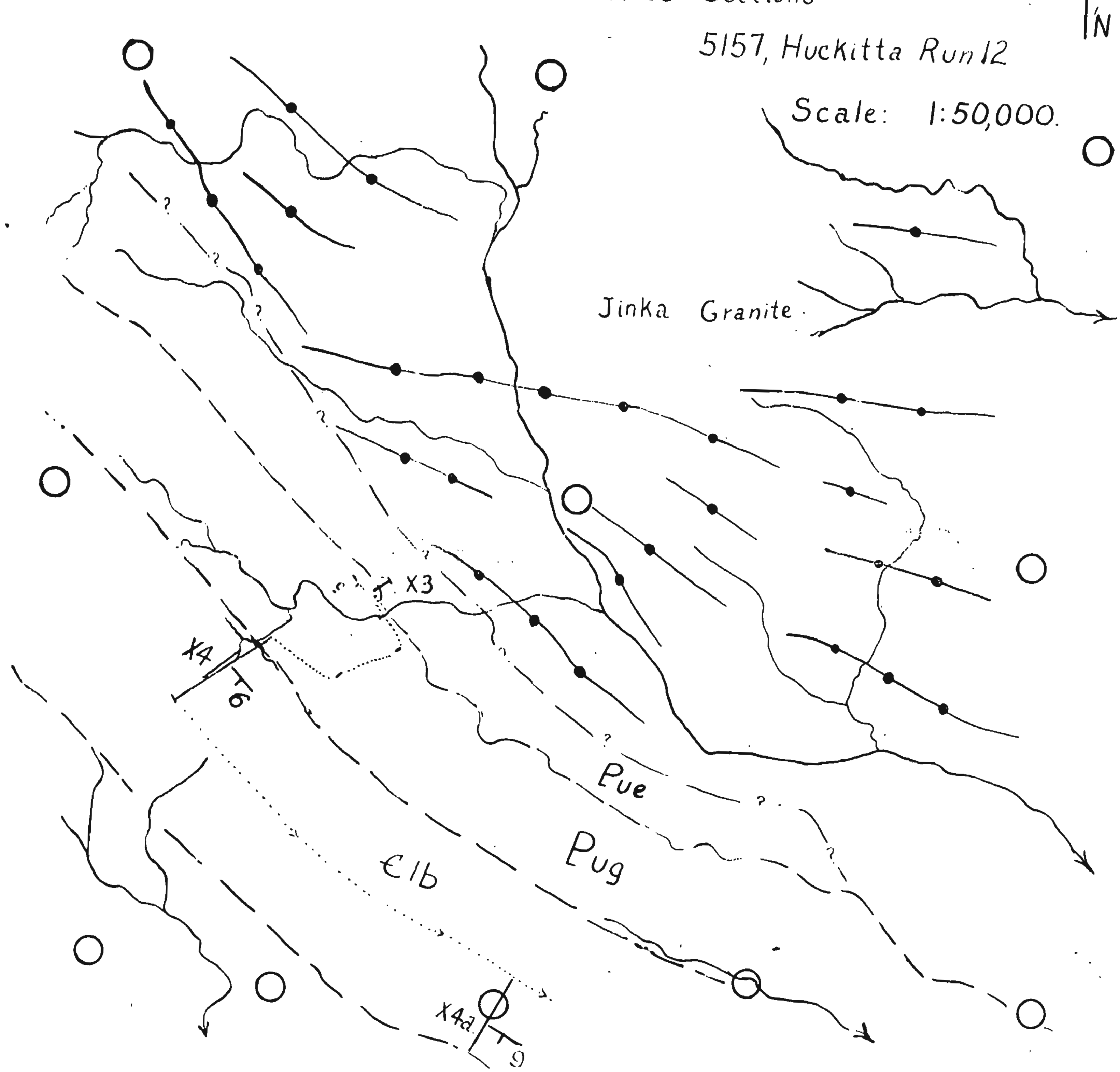
The age of the Grant Bluff Formation is indefinite; it is either Upper Proterozoic or Lower Cambrian, or it may range from Upper Proterozoic to Lower Cambrian. The presence of glauconite in the Formation may indicate a Lower Cambrian age, but some of the parts of the Formation which are glauconite-bearing contain also unidentified organic remains as well as tracks and worm trails, and these may be of Upper Proterozoic age. The algal form Collenia is contained in dolomite bands of the Formation but this does not indicate a definite Upper Proterozoic age because the same algal form has been collected from the Upper Cambrian Arrinthrunga Formation. In the absence of indubitable Lower Cambrian fossils, the authors refer to the age of the Grant Bluff Formation as ? Upper Proterozoic.

The Mt. Baldwin Formation

The Mt. Baldwin Formation was named and defined previously (Smith et al, 1959) but a type section was not recorded because some additional mapping was required in the area of the proposed type section in the Elyuah Range. The object of this additional mapping was to check whether beds containing shelly fossils (Sample H 41) were within the

Fig 13.

Location of measured Sections



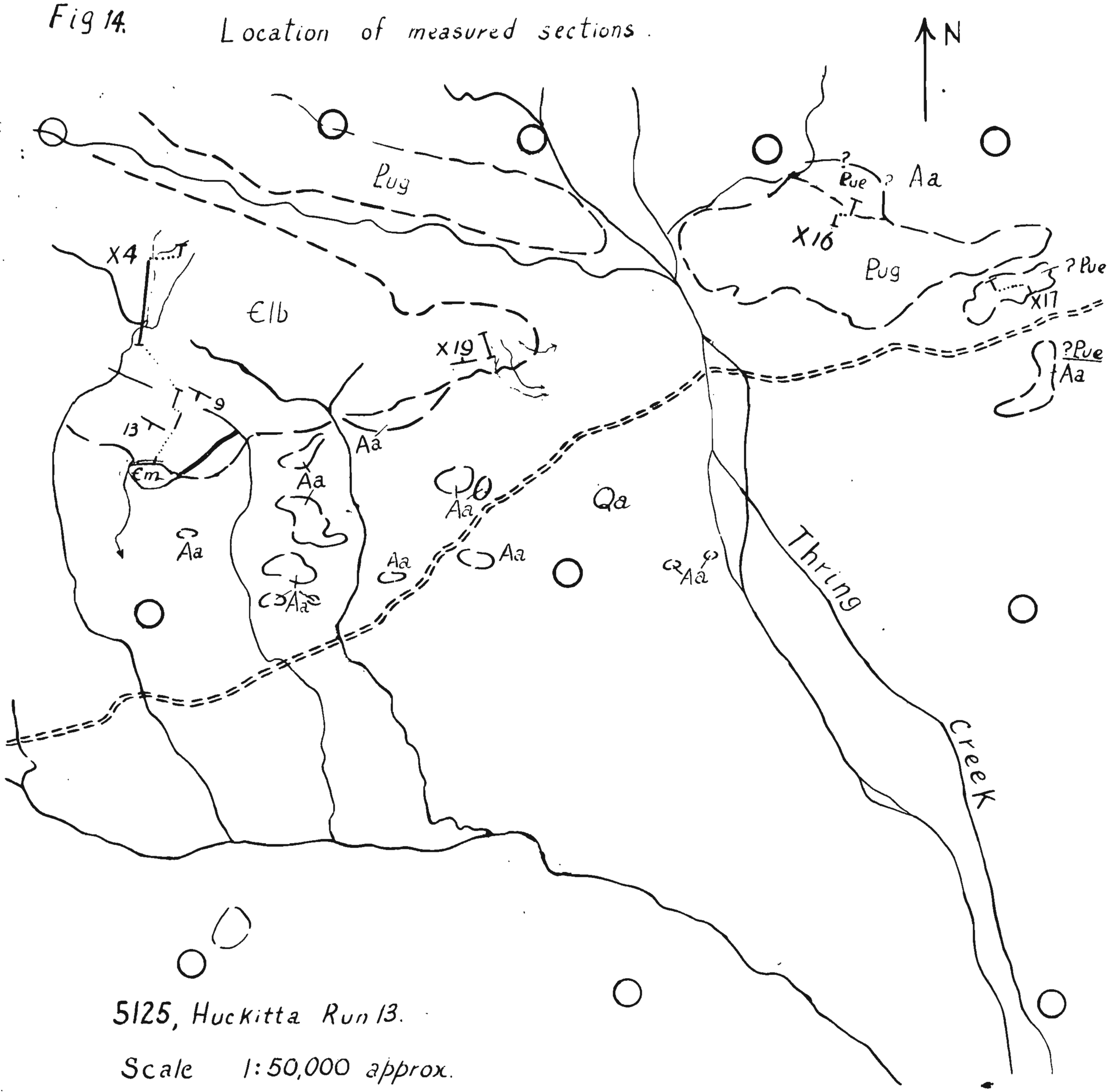
Mt. Baldwin Formation or above it. These checks were made in 1958 and confirmed that the fossiliferous beds were within the Formation. Additional fossils (Sample H103) were located; these are brachiopods and archaeocyathids and the age of the latter is Lower Cambrian (Opik and Gilbert-Tomlinson, personal communication).

The locality of the type section of the Mt. Baldwin Formation is shown in Figs. 13 & 14. At this locality, the section in descending order consists of:

Arthur Creek beds conformably overlying

42 feet of	poorly-outcropping, purple, flaggy, medium-grained micaceous quartz sandstone;
1 " "	purple, coarse-grained, laminated quartz sandstone;
10 " "	poorly-outcropping red-brown, flaggy, medium-grained, micaceous quartz sandstone;
3 " "	concealed;
25 feet of	dark red, flaggy, medium-grained, micaceous quartz greywacke;
67 " "	dark red, laminated, coarse-grained quartz sandstone with abundant mud pellets;
40 " "	concealed;
62 " "	poorly-outcropping, dark red, laminated, massive-weathering, coarse-grained quartz sandstone with ripple marks, worm trails and abundant mud pellets;
105 " "	mainly concealed; some near-outcrop of dark red, medium grained, cross-laminated micaceous quartz sandstone;
17 " "	yellow, micaceous greywacke;
32 "	concealed;
1 " "	grey, medium-grained quartz sandstone with ripple marks and mud pellets;
2 " "	light brown, medium-grained, micaceous quartz sandstone with ripple marks and abundant mud pellets;
2 " "	dark brown, ferruginised shale;
13 " "	poorly outcropping, firm, yellow limestone with some thin interbeds of red, flaggy medium-grained quartz sandstone;
3 " "	yellow and blue, firm, laminated, massive-weathering limestone; (archaeocyathids on this horizon to the north-west);
12 " "	yellow, firm, laminated limestone;
37 " "	poorly outcropping, flaggy, micaceous, medium-grained quartz sandstone with thin interbeds of red and yellow calcilutite;
13 " "	red, flaggy, micaceous quartz sandstone;
30 " "	dark chocolate, medium to coarse-grained, cross-bedded, silicified, micaceous quartz sandstone with ~~assymetric~~ asymmetric ripple marks;
5 " "	purple, hard, flaggy, coarse-grained, micaceous greywacke;
100 " "	purple, hard, coarse-grained, cross-bedded quartz greywacke with abundant ripple marks and mud pellets;
31 " "	dark red, hard, medium to coarse-grained, micaceous, cross-laminated quartz sandstone with some ripple marks; some beds "rolled into balls";
40 " "	concealed;
68 " "	dark red, medium-grained, cross-bedded, flaggy, micaceous quartz sandstone with ripple marks and mud pellets;

Fig 14. Location of measured sections.



5125, Huckitta Run 13.

Scale 1:50,000 approx.

3	feet of	dark red, flaggy, coarse-grained quartz greywacke;
16	" "	red, thin-bedded, cross-bedded, medium-grained, quartz sandstone;
5	" "	purple, laminated, massive-weathering, coarse-grained quartz sandstone;
35	" "	purplish-grey, coarse-grained, cross-bedded, silty quartz sandstone with numerous mud pellets;
17	" "	light purple, medium-grained, cross-bedded quartz sandstone; abundant mud pellets;
280	" "	concealed; debris of red shale and red quartz sandstone;
15	" "	dark red, laminated, massive-weathering medium-grained, hard quartz sandstone;
25	" "	red, hard, medium-grained quartz greywacke;
75	" "	red, laminated siltstone;
5	" "	red siltstone with a few thin beds of red, micaceous quartz sandstone showing efflorescence;
5	" "	red, laminated, hard, medium-grained, micaceous quartz sandstone; ripple-marked;
7	" "	soft, white (leached) micaceous siltstone with small lenses of red, medium-grained, micaceous quartz sandstone;
3½	" "	yellow, soft, laminated, medium-grained, micaceous greywacke;
½	" "	yellow, soft, laminated siltstone;
5	" "	yellow, soft, laminated, medium-grained, micaceous greywacke;
22	" "	red, flaggy, hard, micaceous quartz greywacke with ripple marks and worm trails; some thin beds of red shale;
1	" "	soft, green, friable coarse quartz greywacke;
6	" "	soft, yellow, laminated, micaceous siltstone;
1	" "	soft, yellowish-green, coarse to very coarse-grained quartz greywacke;
20	" "	red, coarse, laminated, micaceous quartz greywacke;
9	" "	yellowish-green, soft, coarse-grained friable quartz greywacke;
9	" "	yellow, soft, laminated, greywacke-siltstone (Sample No.Ha.129).
19	" "	yellow and purple, laminated, soft siltstone;
1	" "	yellowish-green, coarse-grained, friable greywacke;
10	" "	concealed;
2	" "	dark green, friable, fine greywacke-conglomerate;
4	" "	yellow, soft, laminated, micaceous siltstone;
5	" "	greenish-yellow, medium-grained, massive-weathering quartz greywacke; (Sample No. Ha.123)
		conformably overlying Grant Bluff Formation.

1384 feet - thickness of Mt. Baldwin Formation at the type locality.

The basal 89 feet of this type section of the Mt. Baldwin Formation consists of the transition beds between the Mt. Baldwin and Grant Bluff Formations. These transition beds do not usually crop out strongly and cannot be mapped as a separate formation although some units of them have been recognised at several localities in the

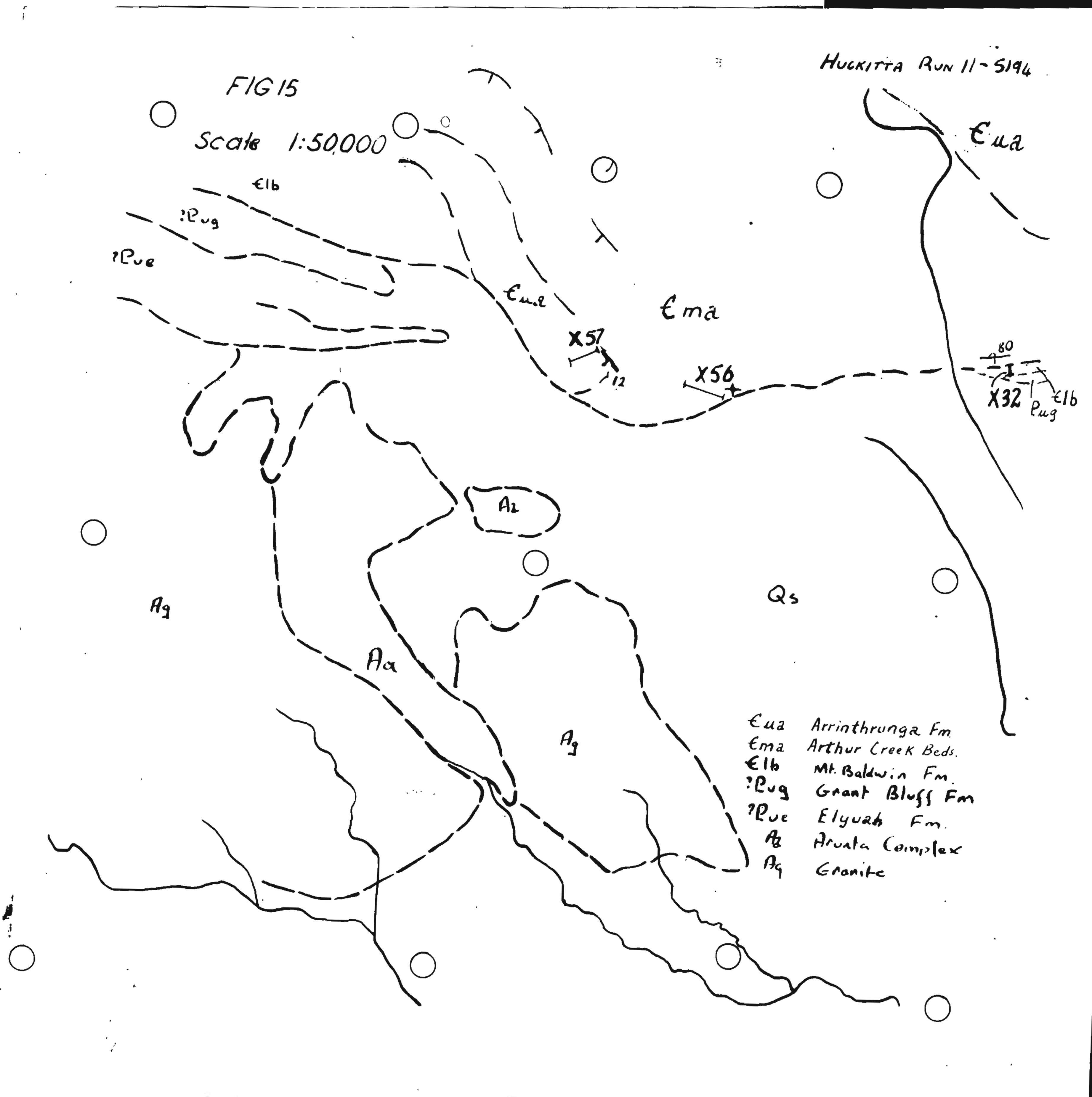


FIG 15
Scale 1:50,000
HUCKITTA RUN 11-5194
€ua
€lb
?Pug
?Pue
€ma
X57
12
X56
80
X32
€lb
Pug
Qs
Aa
Ag
€ua Arrinthrunga Fm.
€ma Arthur Creek Beds.
€lb Mt. Baldwin Fm.
?Pug Grant Bluff Fm
?Pue Elyuah Fm.
Aa Arunta Complex
Ag Granite

Mopunga, Elyuah and Jervois Ranges. Because the transition beds have more lithological affinities with the Mt. Baldwin Formation than with the Grant Bluff Formation they have been included in the former. Samples Ha 123 and 129 have been described previously (Smith et al., 1959).

In the type section of the Mt. Baldwin Formation the top of the Formation is placed at the top of the youngest bed of red or purple quartz sandstone which occurs in the sequence. In the type section this bed grades, within a short distance along strike, into purple calcilutite. No fossils have been located in the sequence immediately above the type section of the Mt. Baldwin Formation.

In the Jervois Range and in areas to the east of Grant Bluff the top of the Mt. Baldwin Formation is easy to place; in these localities the Formation is succeeded conformably by shales which contain a rich fauna of trilobites and brachiopods, and occasional archaeocyathids, of lower Middle Cambrian age (Opik and Tomlinson, personal communication.) In the Mopunga Range the top of the Mt. Baldwin is placed at the top of the youngest bed of red arenite or shale which occurs in the sequence of dominantly arenaceous rocks; some red arenites occur interbedded with carbonate rocks of the overlying sequence; they may belong to the Mt. Baldwin Formation, but they will be discussed in a later section of this report.

In the Mopunga Range two sections were measured in the Mt. Baldwin Formation; these are X 60 and X 64, whose locations are shown on Figs. 7 and 9. Thicknesses, measured by D.R.G. Woolley, are:

X 60	280 feet
X 64	115 feet

West of Oorabra Rockholes a section was measured in the Formation at a locality east of the Marshall River (refer Fig.15). Here the thickness, measured by K.G. Smith, is 405 feet.

In the Elyuah Range the thickness of the Formation increases markedly towards the south-east. Exposure in the northern portion of this range is insufficient for the measurement of sections but the increase towards the south-west is clearly visible on the ground. The only information available on this increase is given by sections X4 and X4a. (refer Figs. 13 & 14.) Here the thicknesses between the same parts of the Formation are:

X4 332 feet.(interval between 564 and 896 feet above base)
X4a 160 feet(interval above 564 feet).
The distance between the sections is about 3½ miles. Thus in this locality there is a divergence of about 50 feet per mile.

A comparison of all sections measured in the Mt. Baldwin Formation, as exposed on the Huckitta four-mile area, is as follows:

Mopunga Range	X 60	280	feet.	(complete)
" "	X 64	115	"	"
Marshall River	X 32	405	"	"
Elyuah Range	X 4a	724	"	"
" "	X 4	1384	"	"
" "	X 19	428	"	(incomplete)
Arthur Creek	X 21	2200	"	(complete)
" "	X 11	470	"	(incomplete)
Jervois Range	X 10	1200	"	(complete)
" "	X 5	680	"	"

The reason for the thin sections of the Formation in areas north-west of the Elyuah Range is believed due in part to the fact that the Mt. Baldwin Formation interfingers with the Arthur Creek Beds which in those areas are dominantly limestone or dolomite; thus as a mappable unit the Mt. Baldwin Formation does not persist in those areas.

The age of the Mt. Baldwin Formation is believed to be Lower Cambrian. The fossils in Sample H103 have not yet been determined fully but a preliminary examination places their age as Lower Cambrian (Opik and Tomlinson, personal communication). It is not impossible that these fossils belong to the lowest part of the Middle Cambrian, but in either case a Lower Cambrian age for the basal part of the Mt. Baldwin Formation would be indicated.

Arthur Creek Beds (New name)

In the eastern part of the Huckitta four-mile area the Mt. Baldwin Formation is overlain conformably by a sequence of shales, with some sandstone and limestone, containing a fauna of lower Middle Cambrian age. This sequence is overlain by a sequence of limestone and sandstone containing a fauna of upper Middle Cambrian age (Casey and Tomlinson, 1956). Therefore in this area it would be possible, despite poor outcrop, to define and name two formations (which might approximate to time-rock units). But in the western portion of the Huckitta four-mile area the Mt. Baldwin Formation is overlain conformably by a sequence of limestone and dolomite (fossiliferous) which, in turn is overlain by a poorly-outcropping sequence of limestone, sandstone, siltstone and chert in which only one fossil sample (H22) has been recorded. In both the eastern and the western area the Arrinthrunga Formation overlies the units described above.

In the western area the fossiliferous limestone and dolomite unit of the lower part of the sequence contains archaeocyathids and brachiopods (samples H104, H105, H106, H107 and H41) which are probably of the same (Lower Cambrian) age as Sample H103, obtained from the Mt. Baldwin Formation. In this western area the authors have recorded several localities where fossiliferous carbonate rocks contain thin interbeds of red quartz sandstone which is similar to the lithology of much of the type section of the Mt. Baldwin Formation and thus it is considered that part of these carbonate beds is the lateral equivalent of the upper part of that Formation.

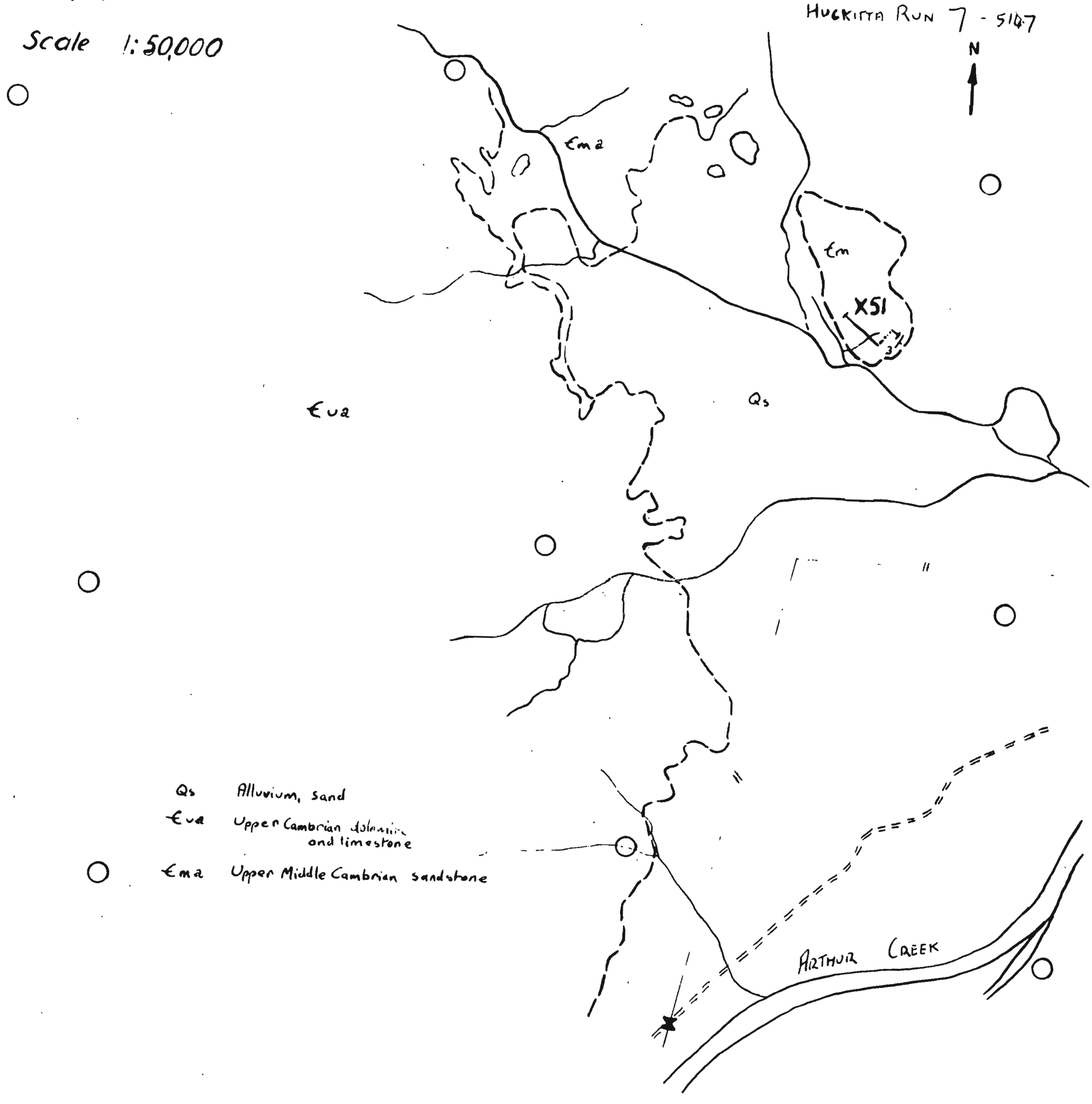
In the western area some of the carbonate rocks grade laterally to brown sandstone and greywacke; this occurs in both the upper and lower parts of the sequence. Thus formations are difficult to define and the lack of fossils which might be expected to be of Middle Cambrian age has led the authors to use the name "Arthur Creek Beds" for those rocks of Cambrian age which lie between the Mt. Baldwin Formation and the Arrinthrunga Formation.

The name is taken from Arthur Creek, which is a large stream flowing through part of the area of outcrop of the Cambrian sediments described above. Some estimates have been made of thickness in some areas, and some partial sections have been measured.

Partial sections from the eastern area were previously reported (Smith et al., 1960); these sections were measured in the shale, with some limestone and sandstone,

FIG. 16

Scale 1:50,000



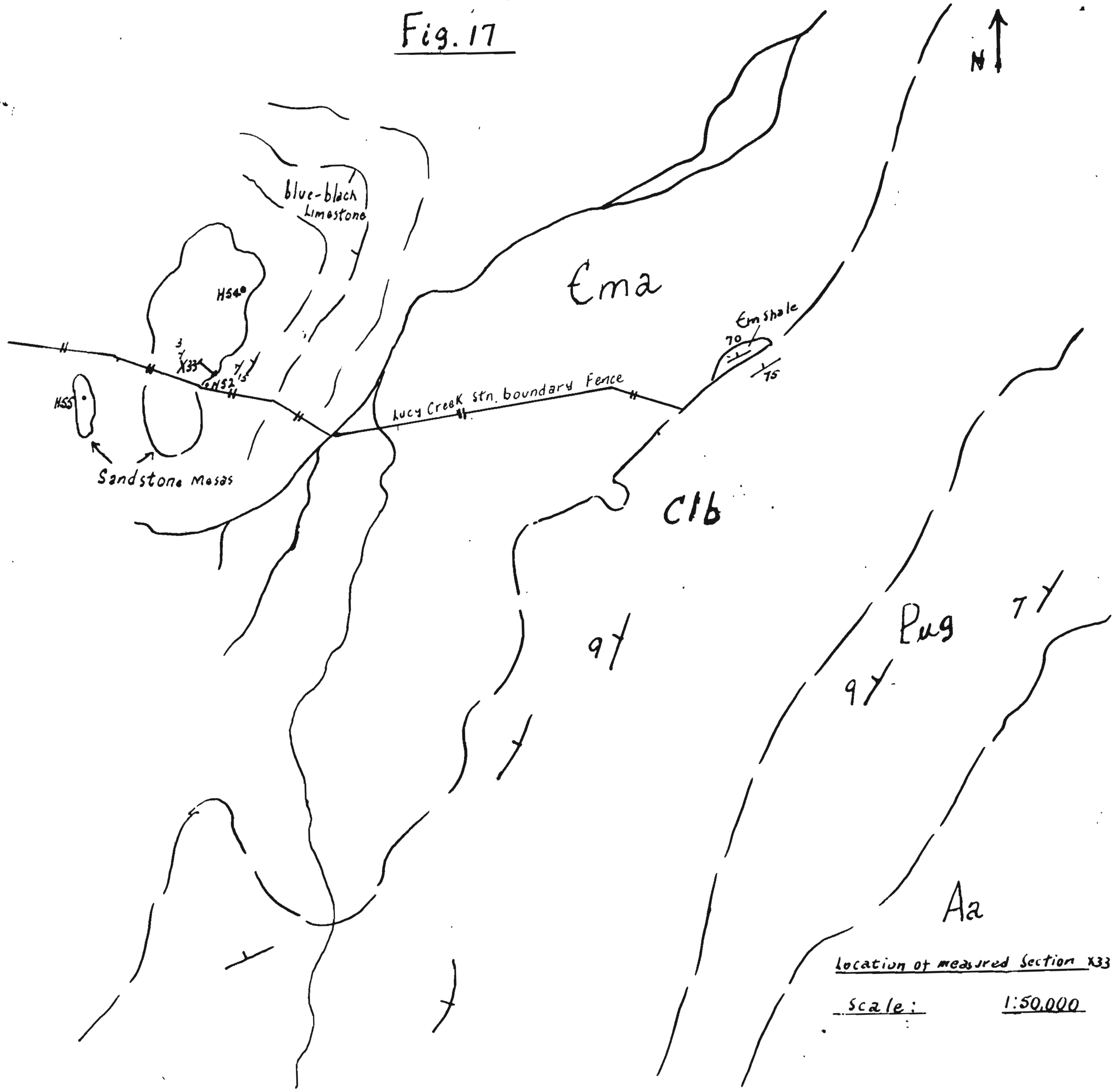
which conformably overlies the Mt. Baldwin Formation. This sequence was estimated to be of the order of 500 feet thick. Three sections have been measured in the limestone-sandstone sequence which succeeds the shales; none of the sections is complete. Details of these sections are:

X51, measured by D.R.G.W. at a locality about 3 miles south-south-east of No.7 Bore on Lucy Creek station. (Refer Fig.16). At this locality the section, in descending order, consists of -

11	feet	of	yellow, flaggy, medium-grained, well-sorted quartz sandstone;
1	"	"	botryoidal limonite;
44	"	"	yellowish-brown, medium-bedded, medium-grained brown quartz sandstone with 5% - 10% of argillaceous matrix;
18	"	"	concealed
2	"	"	cream, medium-grained, massive, poorly-sorted quartz sandstone;
12	"	"	white, fine-grained, thin-bedded, friable quartz sandstone; weathers dark brown;
12	"	"	dazzling white, fine-grained, quartz sandstone;
3	"	"	brown, laminated dolomite;
7	"	"	white, laminated, fine-grained quartz sandstone;
7	"	"	grey, fine-grained, medium-bedded, friable quartz sandstone which may have a carbonate cement and which contains small, inarticulate brachiopods;
5½	"	"	greenish-white, laminated to thin-bedded calcareous sandstone with inarticulate brachiopods;
11	"	"	greenish-grey, fine-grained, friable, calcareous sandstone with thin interbeds of dense blue limestone;
14	"	"	blue, thin-bedded, fine-grained limestone with inarticulate brachiopods (Sample H140) Sand cover;
158	feet		thickness of partial section.

X66 was measured by D.R.G.W. at a locality about 3 miles south-south-west of No.7 Bore on Lucy Creek station. At this locality the sequence, in descending

Fig. 17



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order, consists of:

Top of hill, which is capped by 64 feet of thick-bedded grey limestone of the Arrinthrunga Formation conformably overlying -

4 feet of		white, fine-grained, thin-bedded, well-sorted sandstone with a calcareous cement;
22	"	concealed;
34	" "	white, fine-grained, friable, porous quartz greywacke; up to 30% argillaceous matrix;
6	" "	white, fine-grained, friable, porous quartz sandstone containing brachiopods and trilobites; Sample H.137.
14	"	concealed;
7½	" "	white, medium-bedded, friable, porous sandstone with some lenses of hard calcarenite;
1	" "	white, fine-grained, thin-bedded, friable sandstone;
1	" "	medium-bedded, pale grey, sandy limestone;
½	" "	white, fine-grained, friable sandstone;
3	" "	white, tough, medium-bedded, fine-grained, well-sorted quartz sandstone;
2	" "	yellow, fine-grained, thin-bedded, friable quartz sandstone with ferruginous cement;
4	" "	white, medium-bedded, very friable, fine-grained quartz greywacke;
3	" "	white, massive, sandy limestone (this is a lens about 10 feet long, in white sandstone)
2	" "	grey, thin-bedded, friable calcareous sandstone;
___		Soil cover

104 feet thickness of partial section.

The fauna contained in Sample H137 from this section is of uppermost Middle Cambrian age (A.A. Opik, personal communication). Thus the upper boundary of the Arthur Creek Beds is, in this locality, very close to the time boundary between Middle and Upper Cambrian.

X 33 was measured by K.G.S. at a locality about three miles south of No.2 Bore on Lucy Creek station (Refer Fig.17) At this locality the sequence, in descending order, consists of:

Top of Hill

70 feet of		buff and yellow, medium-bedded, medium-grained sandstone with ? calcareous cement;
1 " "		grey, dense limestone containing brachiopods and trilobites;
8 " "		buff and yellow, medium-bedded, fine-grained calcareous sandstone; this is on the stratigraphic horizon of Sample H54;
17 " "		laminated to thin-bedded, grey and pink calcilutite;
20 " "		dark grey, platy, cross-bedded, sandy limestone containing brachiopods;
43 " "		yellow, soft, micaceous greywacke;
		Soil cover
159 feet		thickness of partial section.

Sample H54, obtained about 350 yards north of the section line of X33, contains the trilobite Asthenopsis, of upper Middle Cambrian age.

Sections X 51, 66 and 33 each show dominantly sandstone beds; these crop out as usually brown mesas in the area between No.7 Bore on Lucy Creek station and the longitude of the road crossing of Arthur Creek on the Marshall Bore Lucy Creek Homestead road. Similar sandstone has not been observed west of this stream crossing, and no fossils of upper Middle Cambrian age have been located to the west.

About ½ mile west of the locality of X 33 blue, flaggy limestone has been observed to grade laterally into yellow-brown medium-grained sandstone which contains the upper Middle Cambrian trilobite Dorypyge. Some gradation is observed also in X66 and it is considered possible that the sandstones in the mesas represent large lenses in a carbonate sequence rather than a reasonably continuous sandstone unit.

In the eastern area the sequences outlined in X33, 51 and 66 are underlain by blue, fossiliferous limestone which crops out poorly; measurable parts of the limestone sequence seldom exceed 20 feet. It is estimated that the thickness of this limestone does not exceed 250 feet. The fossils contained are of middle Middle Cambrian age (J. Gilbert Tomlinson, personal communication).

In the western area there are discontinuous outcrops of the Arthur Creek beds between the crossing at Arthur Creek and the longitude of Mt. Sainthill and there are poor but continuous outcrops in the Elyuah Range. Fossils have been obtained at several localities; the most noteworthy one located in 1958 was Sample H107. This sample contains archaeocyathids and was obtained either at, or very near to, the locality from which Madigan (1932,b) reported ? archaeocyathids. The party's identification was confirmed in the field by A.A. Opik (personal communication)

In the Arthur Creek Beds of the Elyuah Range no measurements of thickness were obtained. Fossil sample H41, of brachiopods and tubular organisms, occur 26 feet above the local top of the Mt. Baldwin Formation but the succeeding beds do not crop out well. An estimated 500 feet of section occurs between the Mt. Baldwin Formation and the base of the Arrinthrunga Formation in this locality. The lithology of the Arthur Creek Beds includes soft, yellow, calcareous greywacke, brown calcilutite, brown sandy dolomite, blue sandy limestone, silicified shale, and ferruginous beds which may be weathered limestone. The contact with the overlying Arrinthrunga Formation is not visible.

Two miles east of Point Spring, Casey and Gilbert Tomlinson (1956) obtained fossils (Sample No.H4) of Middle Cambrian age from laminated, blue-black limestone; this limestone is underlain by silicified, buff-coloured shale which contains agnostids. The sequence has not been measured at this locality but it is estimated to be of the order of 400 feet thick. Some two miles further to the east, fossils of lower Middle Cambrian age (Sample H48) occur near the base of a poorly-outcropping sequence of shale, calcareous sandstone and blue limestone; Sample H48 was obtained within an estimated 20 feet stratigraphically above the top of the Mt. Baldwin Formation. At this locality the thickness of the Arthur Creek Beds was not measured.

From about 2 miles west of the locality of H107 to the north-western tip of the Mopunga Range the Arthur Creek Beds consist of a sequence of dolomite, limestone, chert, shale, greywacke and sandstone. From the north-western tip of the Mopunga Range to the western boundary of the Huckitta four-mile area the Arthur Creek Beds do not crop out, as far as is known; however, some of the lithology has been reported from water bores, e.g. Ilkyra Bore.

The strongest outcrops of the Beds between the north-western ends of the Elyuah and Mopunga Ranges consist of limestones and dolomites. A formation of thin-bedded blue and grey limestones and/or grey and brown dolomite can be traced for several miles on aerial photographs; this unit of carbonate rocks underlies the Arrinthrunga Formation (also of Carbonate rocks). Although no real criteria for distinguishing the two units can be listed, the boundary can be placed fairly accurately after field work has established the relative stratigraphical positions of the units.

No complete sections were measured in the Arthur Creek Beds in the area under discussion, but several partial sections were obtained. Details of these are:

X25, whose location is shown on Fig.9, was measured by K.G.S. This sequence is in the lower part of the Arthur Creek Beds and, in descending order, consists of:

Soil cover		
40	feet of	medium-bedded, brown, sandy dolomite with some glauconite;
4	" "	pink and brown, massive-weathering, glauconitic dolomite with abundant archaeocyathids and some brachiopods; (Sample H104);
12	"	concealed;
5	" "	pink, sandy, medium-bedded dolomite;
61	"	(C/Forward)

61 feet (B/Forward)

25	feet of	red-brown, flaggy, medium-grained quartz sandstone, with ripple marks and salt crystals;
22	" "	bluish-grey and pink flaggy limestone with numerous fragmentary archaeocyathids;
2	" "	pink, cross-laminated limestone;
5	" "	yellow-brown, massive-weathering limestone;
20	" "	poorly-outcropping, flaggy, yellow limestone with some ? fragmentary archaeocyathids;
27	" "	mauve, medium-bedded limestone with abundant Collenia whose diameter ranges from 1 to 9 inches, and some fragmentary archaeocyathids;
19	" "	pink and yellow, laminated, massive-weathering, cross-laminated, firm limestone with abundant fragmentary archaeocyathids and some stylolites;
2½	" "	purple limestone with abundant quartz grains whose size ranges from 1 to 5 mm.;
20	" "	poorly-outcropping, finely laminated purple limestone with abundant chert nodules;
1	" "	purple limestone with abundant sand grains; most of the grains are in the 1-2 mm size range but some are 3 mm.;
22	" "	poorly-outcropping, finely laminated, purple limestone with abundant chert nodules, and algae; slump structures;
4	" "	finely-laminated, purple limestone;
32	" "	concealed;
21	" "	poorly-outcropping, finely-laminated, purple limestone containing sporadic sand grains; numerous slump structures;
39	" "	concealed; some debris of purple limestone; Mt. Baldwin Formation;

322 feet thickness of partial section.

X56, whose location is shown on Fig.15, has been measured by D.R.G.W. This section is through limestone beds in the upper part of the Arthur Creek Beds. The sequence is incomplete, but contains 190 feet of interbedded grey and cream limestone and laminated, chocolate-coloured micaceous calcarenites and chocolate-coloured calcilutite.

It is estimated that the full sequence of similar lithology in this area is 600 feet thick. Beneath this thickness is a sequence of poorly-outcropping glauconitic brown and cream dolomite containing archaeocyathids (Sample H105).

Section X61, located about 2 miles south of X25 (refer Fig.7), has been measured by D.R.G.W. This section begins at the top of the Mt. Baldwin Formation and is measured through the same beds as are in X25, but continues to the top of a sandstone unit in which Casey and Gilbert-Tomlinson (loc.cit.) recorded brachiopods. The thickness recorded in X61 is 430 feet, consisting of 20% concealed ground, 2% sandstone, 4% pelite and 74% dolarenite, dolomite and dolomitic limestone. The section is incomplete. It includes, in the interval from 180 to 198 feet above the base, abundant <u>Collenia</u>; no other fossils were located in the section.

X64 and X65, located north-west of X25 (refer Fig.7) were measured by D.R.G.W. The base of the Arthur Creek Beds is available in X64 and the top of them in X65; but there is an unmeasured interval between the top of X64 and the base of X65. In this interval there are very poor outcrops of leached siltstone and red-brown sandstone; reversals of dips have been observed and it is impossible to give a reliable estimate of thickness. If there were no dip reversals the thickness would be of the order of 600 feet; therefore the best that can be said is that the thickness of the unmeasured interval does not exceed 600 feet.

X64 is 153 feetthick and consists of about 50% of cream, grey and pink dolomite and dolomitic limestone; the remainder of the section is concealed ground. About ½ mile to the north-west, archaeocyathids and brachiopods were located in a brown, sandy, glauconitic dolomite which is on the strike of the top beds of X64. (Sample H106).

X65 is 450 feet thick and consists of: 53% of grey purple and pink dolomite, sandy dolomite and limestone; 9% of friable, brown, medium-grained micaceous quartz sandstone; 38% concealed ground. No fossils were recorded in this section.

A summary of the available evidence on thickness and lithology of the Arthur Creek Beds in the western area is as follows:

(a) in section X56, 190 feet of limestone and/or dolomite, interbedded with red, micaceous calcarenites and calcilutites, has been measured; this sequence is underlain by an estimated 400 feet of similar lithology, plus an unknown thickness of dolomite containing fossils (Sample H105).

(b) X25 contains 320 feet of dominantly carbonate rocks which are fossiliferous (Sample H104); these are succeeded by an unmeasured sequence of poorly outcropping sandstone, chert and carbonate rocks.

(c) X61 contains the same sequence as X25, plus an additional 100 feet of carbonate rock and 10 feet of sandstone; this sandstone is at the base of a sequence of sandstone,chert and limestone which, towards its top, has a distinct white pattern on aerial photographs and which grades into the basal portion of the 600 feet of carbonate rocks as measured and estimated in (a). Casey and Tomlinson (1956,p63-64) estimated a thickness of 200 feet between the top of the fossiliferous sandstone at H22 and the first grey limestone in a younger part of the sequence. Therefore it is considered that the full sequence in the area of X61 has a thickness of the order of 1000 feet.

(d) X64 and X65 have a combined thickness of 600 feet and the two sections are separated by a stratigraphic interval which is estimated to be less than 600 feet thick. Therefore a thickness of the order of 1000 feet may reasonably be inferred for the sequence in this area.

In the eastern area of outcrop the Arthur Creek Beds contain some lithologies and faunas identical with those in much of the strata penetrated by the Cherry Creek Bore on Ammaroo station, which is about 100 miles north-west of the Jervois Range. In 1956 this bore was drilled in the Sandover Beds (named by Opik, 1956) and wet gas was encountered in the bore.

In the western area of outcrop the lithologies and faunas similar to those of the Sandover Beds are not present (except in a small area 2 miles east of Point Spring) but it is believed that beds of equivalent age are represented by some of the lithologies described above. The determination of the age of the fossils in Samples H104, 105 and 106 will be of considerable use in determining those parts of the sequence where additional fossils may be sought.

The Arrinthrunga Formation (New name)

The Arrinthrunga Formation is here named, and defined as the sequence of dolomite, limestone and dolomitic limestone with interbedded sandstone and green siltstone which lies stratigraphically between the Arthur Creek Beds below and the Tomahawk Beds above.

The name is taken from Arrinthrunga Creek, a tributary of Arthur Creek. In the banks of Arrinthrunga Creek the Formation is well-exposed but the section is incomplete; therefore the type section is located about 1½ miles north-west of Oorabra Rockholes. The Eurowie Sandstone Member crops out in the eastern portion of the Huckitta four-mile area; in this area the full section of the Arrinthrunga Formation cannot be measured and therefore it is impossible to locate a type section of the Formation in an area where the Eurowie Sandstone Member can be included.

The Arrinthrunga Formation has a wide distribution; it is exposed in a narrow, steeply-dipping belt which runs from a point about 5 miles south-east of Mt. Ultim to a locality about 3 miles east of Point Spring. To the north and north-east of Point Spring the Formation crops out over a wide area in which the dips are usually low and where the Formation is usually exposed in small hills. Also in this area there are extensive plains underlain by the Formation.

The locality of the type section of the Arrinthrunga Formation is shown in Fig.8. Here the sequence has been measured by K.G.S.; in descending order it consists of:

Grey, fossiliferous quartz sandstone, with interbedded green siltstone, of the Tomahawk Beds conformably overlying -

15 feet of grey, medium-grained calcareous sandstone with lenses of sandy limestone and thin interbeds of white (leached) and green siltstone, poorly-outcropping;

125 " " poorly-outcropping grey and brown, medium-bedded, cross-bedded sandy dolomite with a few thin interbeds of medium-grained brown sandstone;

44 " " grey, coarse-grained, thin-bedded, ? calcareous sandstone with some thin interbeds of coarsely crystalline, brown dolomite;

8 " " grey, medium-bedded. sandy, crystalline limestone;

25 " " brown, medium-bedded, finely crystalline dolomite, with some beds, up to 1 foot, of grey micaceous siltstone;

7 " " brown, hard, laminated, finely-crystalline dolomite;

9 " " brown, hard, medium-bedded, finely-crystalline dolomite;

8 " " poorly-outcropping, hard, fine-grained, cross-laminated, micaceous sandstone;

21 " " grey (brown weathering), thin-bedded, crystalline limestone;

7 " " soft, grey siltstone;

10 " " grey, thin-bedded, crystalline limestone;

71 " " blue and buff, massive-weathering, thick-bedded limestone with some laminated, buff limestone; numerous random calcite veins;

3½ " " blue, massive-weathering limestone with chert fragments;

½ " " brown, coarse-grained, subrounded-quartz sandstone with a carbonate cement;

3 feet of brown, coarse-grained, cross-laminated quartz sandstone;

3 " " blue, massive-weathering, dense limestone;

1½ " " brown, coarse-grained, micaceous sandstone;

18½ " " blue and brown, massive-weathering, thick-bedded oolitic limestone and dolomitic limestone;

10 " " yellow, purple and blue, flaggy dolomite and limestone;

1 " " blue, flaggy, oolitic limestone; Sample;

5 " " purple and yellow, flaggy dolomite;

54 " " blue, massive-weathering, oolitic limestone with numerous, random calcite veins; oolites are in lenses and are up to 2 mm in diameter;

4	feet	of	purple, massive-weathering dolomite;
19	"	"	purple, massive weathering, thick-bedded, oolitic limestone and dolomite;
18	"	"	poorly-outcropping, brown, coarse-grained, micaceous sandstone;
1	"	"	dark-brown, flaggy dolomite;
29	"	"	brown, coarse-grained, cross-laminated quartz sandstone with numerous mud pellets;
5	"	"	brown, coarse-grained, hard sandstone with lenses of yellow, crystalline dolomite;
12	"	"	yellow, soft, fine-grained sandy dolomite;
7	"	"	yellow, hard, laminated dolomite;
21	"	"	poorly-outcropping, buff, oolitic dolomite;
3	"	"	blue, oolitic limestone; oolites to 4 mm.
1½	"	"	buff, finely-crystalline dolomite;
4½	"	"	cream, flaggy, fine-grained, micaceous sandstone;
3	"	"	blue, crystalline, medium-bedded limestone;
3	"	"	two-tone, massive-weathering limestone with algae;
12	"	"	blue-grey oolitic limestone; some beds of flaggy blue-grey limestone without oolites;
17	"	"	blue-grey, medium-bedded, crystalline limestone with lenses of oolites;
7	"	"	blue-grey, medium-bedded limestone with numerous oolites;
18	"	"	blue-black, medium-bedded, fine-grained limestone; a 6 inch band of oolites 9 feet above the base of the interval;
2	"	"	buff, sandy limestone;
4	"	"	blue-black, massive-weathering, oolitic limestone with abundant oolites;
7	"	"	buff, sandy limestone with 1 foot of blue-black limestone with 1 foot of blue-black limestone 4 feet above the base of the interval;
10	"	"	brown, flaggy, sandy limestone;
21	"	"	blue-black, thin-bedded, crystalline limestone with a few oolites; abundant random calcite veins and a few fragments of silica;
8	"	"	buff, hard, massive-weathering dolomite;
8	"	"	blue-grey, crystalline limestone;
12	"	"	blue and purple, medium-bedded coarsely-crystalline limestone;

17	feet	of	blue, thin-bedded, oolitic limestone (oolites of 1 mm) with numerous silica fragments and random calcite veins;
36	"	"	poorly-outcropping, massive-weathering, blue and brown crystalline dolomite;
6	"		concealed;
2	"	"	blue, oolitic limestone; oolites 1 mm in diameter; Sample;
8	"	"	blue-grey, medium-bedded, oolitic limestone;
1	"	"	brown, oolitic dolomite;
6	"	"	blue, coarsely-crystalline limestone;
6	"	"	concealed;
2	"	"	grey, oolitic limestone; oolites are 1 mm in size;
8	"	"	blue-grey, laminated, massive-weathering, oolitic limestone; oolites are very fine-grained;
5	"	"	poorly-outcropping, flaggy, blue limestone;
5	"	"	blue-grey limestone with sporadic oolites and abundant silica fragments;
10	"	"	grey-blue limestone;
5	"	"	purple and grey two-tone dolomite with many fragments of silica;
17	"	"	poorly-outcropping grey and purple dolomite;
7	"	"	purple, massive-weathering, coarsely-crystalline limestone with abundant random, calcite veins;
12	"	"	flaggy, blue limestone with abundant silica fragments on the weathered surface;
7	"	"	blue, flaggy, crystalline limestone with 1 foot of chocolate-coloured dolomite 3 feet above the base of the interval;
9	"	"	blue, massive-weathering limestone with numerous random calcite veins and abundant silica fragments on the weathered surface;
13	"	"	flaggy, two-tone limestone;
16	"	"	yellow, medium-bedded, two-tone dolomite;
35	"	"	grey, two-tone, medium-bedded, crystalline dolomite with 2 feet of grey, coarsely-crystalline limestone containing numerous chert fragments at 16 feet above the base of the interval;
28	"	"	yellow and grey, hard, medium-bedded two-tone dolomite;
29	"	"	blue-grey, crystalline, medium-bedded limestone with numerous chert fragments;

2	feet of	yellow, flaggy dolomite;
17	" "	poorly-outcropping, yellow, coarse-grained sandstone with lenses of yellow dolomite;
		Soil cover.
1007	feet	thickness of type section of the Arrinthrunga Formation. (X31).

The type section is incomplete, but it is estimated that it is very nearly the full section.

The relationship between the Arrinthrunga Formation and underlying rocks shows considerable variation. In the locality of X66 the Arrinthrunga Formation conformably overlies the Arthur Creek Beds. Apparent conformity, (based on dip evidence) exists between the Arrinthrunga Formation and the Arthur Creek Beds at the locality of H4 (two miles east of Point Spring) and in several localities to the south-west, west and north-west of Huckitta homestead. One mile east of the Lucy Creek aerodrome the Arringthrunga Formation is in contact with a coquinite containing fossils of lower Middle Cambrian age; four miles west of this locality the Arrinthrunga Formation overlies blue-black limestone of a higher unit of the Arthur Creek Beds. At least one of these two contacts may be faulted. Between Point Spring and the locality of the type section of the Arrinthrunga Formation the Formation rests unconformably on each of the following:

(i) the Jinka Granite
(ii) the Mt. Cornish Formation
((iii) the Mt. Baldwin Formation
(iv) the basal part of the Arthur Creek Beds
(v) Archaean metasediments.

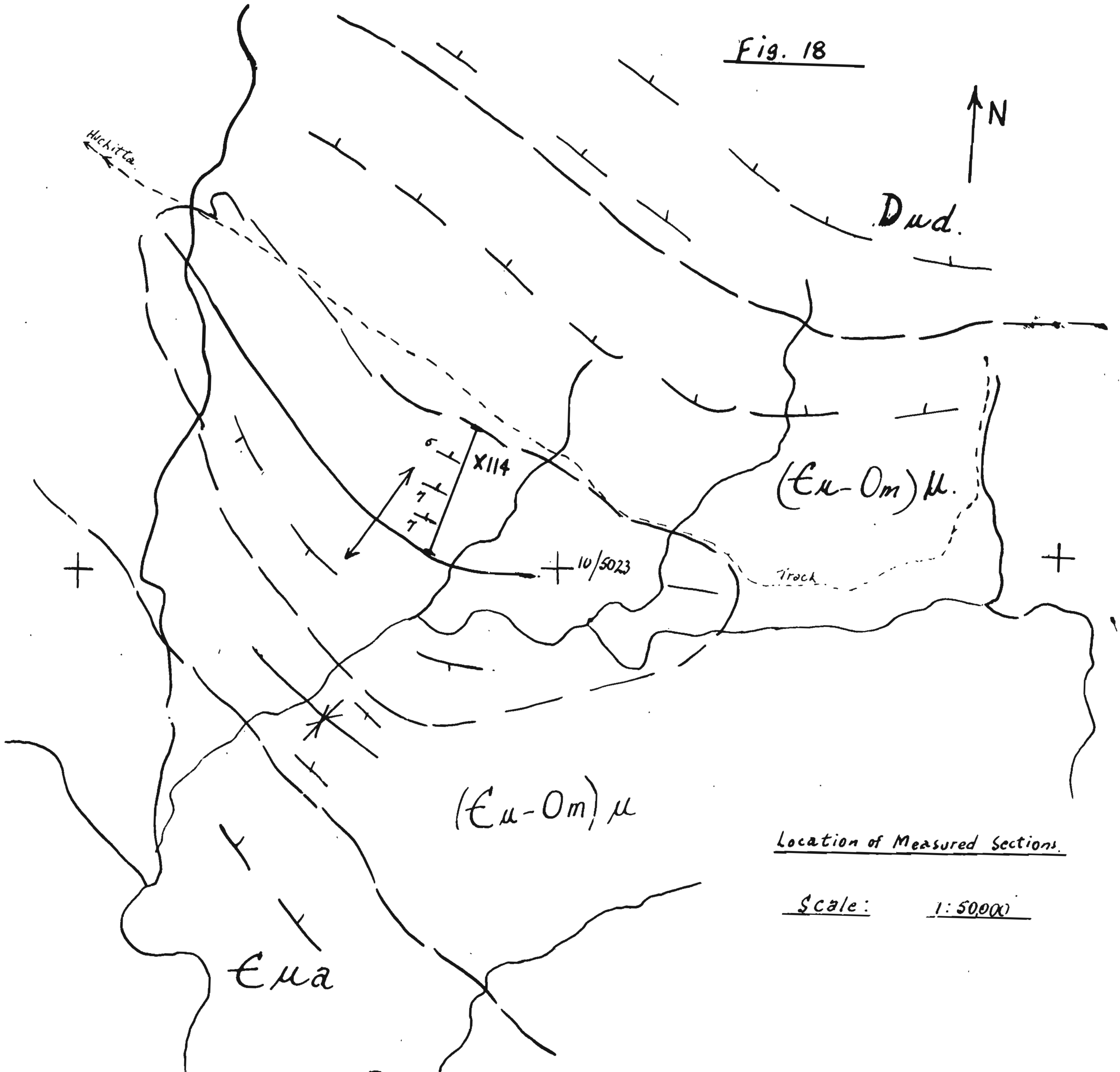
<u>The Eurowie Sandstone Member</u>, X...

As shown in the type section of the Formation, there are numerous beds of quartz sandstone interbedded with, and lensing into, carbonate rocks. These usually do not crop out strongly. But in the extensive area where the Formation crops out to the north and north-east of Arthur Creek there are several low, extensive hills of sandstone which is within the upper quarter of the Arrinthrunga Formation. This sandstone is named the Eurowie Sandstone Member. The name is taken from Eurowie stockyard; good outcrops of the member occur immediately to the east of this yard.

The member has a widespread area of outcrop, mainly on the flank of a broad anticline in the Arrinthrunga Formation. Dips in the Member are always very irregular and no reliable type section has been measured. The thickness of the Member is estimated to range from 50 to 100 feet. The Member is dominantly a medium-grained quartz sandstone; there are some beds of fine-grained sandstone and of siltstone near the base. In part, the Member is very dolomitic, and locally contains some mica. It is thin-bedded and sometimes laminated. Fresh exposures are white in colour but generally the Member is weathered to a dark red colour which gives a dark pattern on aerial photographs.

The Member shows many features indicative of deposition in shallow water; amongst these are ripple marks,

Fig. 18



Location of Measured Sections.

Scale: 1:50,000

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cross-bedding (on a small scale), mud cracks and mud-pellets. The most distinctive feature is the presence of pseudomorphs after halite; these are very well developed and consist of hollow-faced cubes in which dolomite or domomitic sandstone provide the pseudomorphic material.

Variations in the lithology of the Member have been observed, mainly in the area north and north-west of Lucy Creek. Here there is some medium-grained quartz greywacke, arkosic sandstone, clean quartz sandstone and laminated siltstone which has weathered to a tough, white cherty rock.

The base of the Eurowie Sandstone Member usually shows a sharp contact with the underlying limestone and dolomite of the Formation. The top of the Member usually shows a gradation to the overlying beds of the Formation; lateral gradation of the upper beds of the Member into dolomite has been observed also.

The Eurowie Sandstone Member occurs in the upper quarter of the Arrinthrunga Formation, and it may have accumulated as sand bars in a basin which is thought to have restricted circulation of water. Although the type section of the Formation shows limestone dominant over dolomite, the relative proportions of these two carbonate rocks fluctuate rapidly and in general there is more dolomite in the Formation than the type section would suggest.

The Arringthrunga Formation contains abundant algae and a reef of colonial algae is well-exposed in the Bed of Eurowie Creek (refer Photograph No.16). The diameters of individual colonies in this locality range to 7 feet; the colonies are gently domed and individual algae grow in positions normal to the doming. Similar reefs have been seen in a stream bed on the southern side of the road from Lucy Creek homestead to No.3 Bore on Lucy Creek station. At this locality the diameter of individual domes ranges to 4 feet.

In the north-eastern portion of the Huckitta four-mile area the outcrop of the Arringhrunga Formation does not permit the measurement of sections which may approximate the full thickness of the Formation. In several places along streams about 100 feet of the Formation is well-exposed, e.g., At Ilgulla Waterhole on Lucy Creek. In the steeply-dipping belt of carbonate rocks in the western portion of the four-mile sheet more of the Formation is exposed. Section X114, whose location is shown on Fig.18, a partial section has been measured by K. Gough. At this location a thickness of 815 feet of dolomite and oolitic limestone, with interbedded sandstone, was recorded. A partial section, X57, in the lower part of the Formation, was measured by D.R.G.W. At this locality (refer Fig.15) a thickness of 280 feet of dolomite, brecciated dolomite, oolitic limestone and thin beds of sandstone were recorded.

Two partial sections X8, of 865 feet, and X13, of 895 feet, were previously reported (Smith et al.1960).

The thicknesses recorded in X8, X13, X31 and X114 indicate that the thickness of the Arrinthrunga Formation is of the order of 1000 feet.

The only place where shelly fossils were located in the Formation is at a locality one mile west of Eurowie yard. Here fragmentary trilobites and brachiopods were recorded but they are unidentifiable. The age of the

Formation must therefore be determined by its stratigraphic position. The age of the top, fossiliferous sediments of the Arthur Creek Beds is reliably established as uppermost Middle Cambrian; the age of the lower fossiliferous beds in the Tomahawk Beds is Upper Cambrian (at H24) (Casey and Tomlinson, 1956). Therefore the age of the Arrinthrunga Formation is Upper Cambrian; the base of the Formation may be of Middle Cambrian age but the boundary between the Arrinthrunga Formation and the topmost Arthur Creek Beds is very close to the boundary between middle and upper Cambrian.

The Arrinthrunga Formation is the sequence previously regarded as being Eo-Cambrian in age (Casey and Tomlinson, 1956); a correction of this has been given previously (Smith et al., 1960). Sprigg, (1958) regarded the Formation as of ? Lower Cambrian age and in a stratigraphic column in the publication he showed what is actually the Arrinthrunga Formation to be beneath fossiliferous Middle Cambrian sediments (our Arthur Creek Beds). The present authors cannot agree with that interpretation and regard the Upper Cambrian age of the Arrinthrunga Formation as unequivocal.

Tomahawk Beds (New name)

The sediments in the Dulcie Range were investigated by Tindale (1931), Hossfeld (1954), Madigan (1932,b) Joklik (1955) and Casey (1956). Tindale, Hossfeld and Madigan each reported the discovery of fossils of Ordovician age in the slopes of the Dulcie Range. Tindale measured and described a sequence 800 feet thick near Mt. Ultim, and a sketch of the sequence is given in Fig.5, p.36 of his published work. He referred briefly to this sequence as the "Mt. Ultim series". Hossfeld used the name "Dulcie series" for Tindale's sequence. Each of Tindale, Hossfeld and Madigan regarded the sequence as being of Ordovician age.

Joklik (1955) named the "Dulcie Sandstone", of ? Ordovician age; he stated (p.35) 'The Dulcie Sandstone, which is here named after its excellent outcrops in the Dulcie Range, is flatly bedded, and forms gentle basin and dome structures'. This description, with regard to the excellence of the outcrop and the structure, clearly fits the sandstone which caps the Dulcie Range (refer the top 100 feet of sandstone in Tindale's Fig.5, p.36) but by inference Joklik included the fossiliferous sandstone of the Range, below the sandstone cap, in his Dulcie Sandstone. Neither Tindale, Hossfeld, Madigan nor Joklik reported fossils from the sandstone which caps the Dulcie Range.

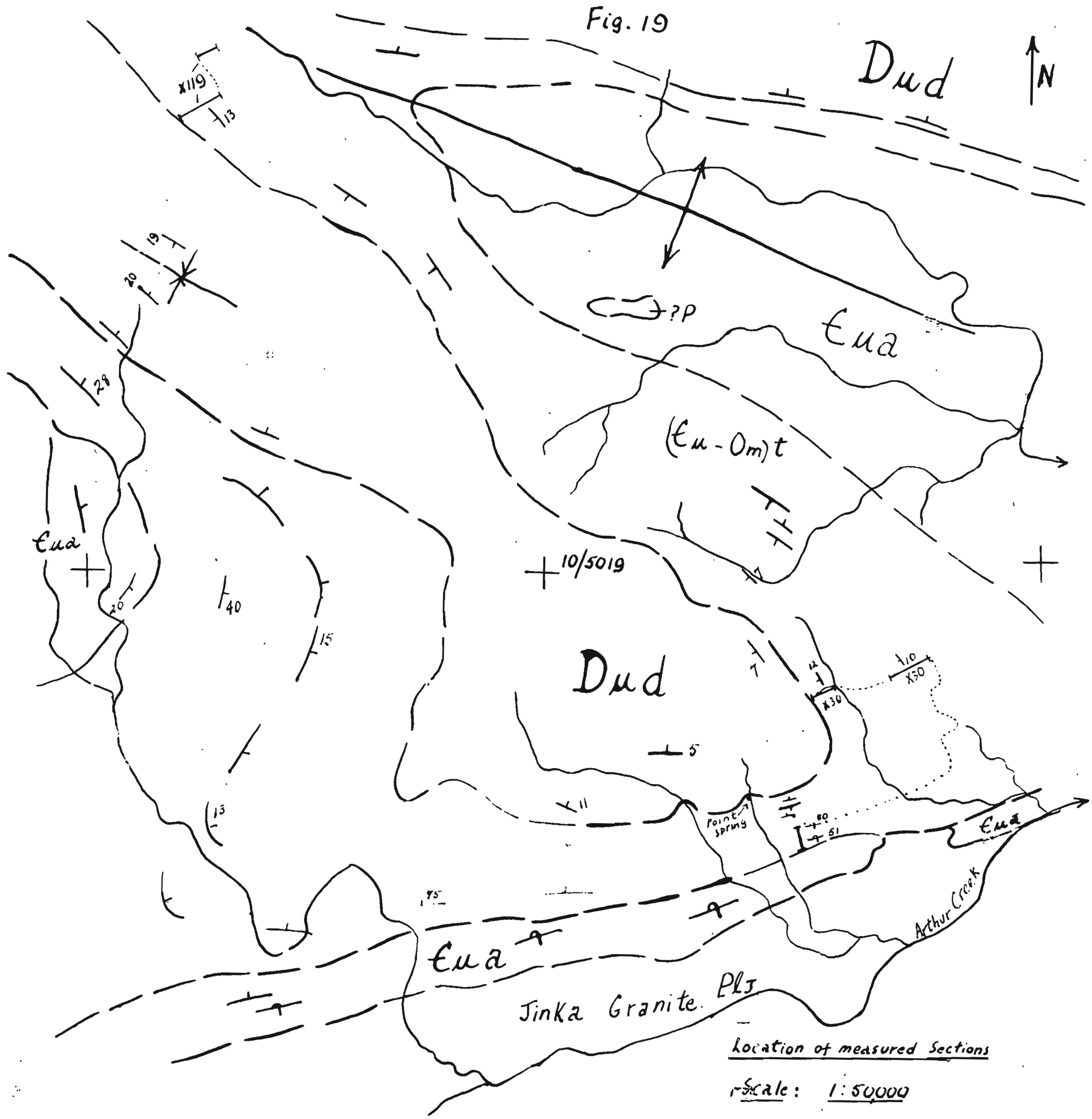
Casey (1956) discovered fossils of Upper Cambrian age in "the lower topographical levels of the Dulcie Range" - Casey & Tomlinson, (1956, p.61) and therefore the Ordovician age of the "Mt. Ultim series" "Dulcie series" "Dulcie sandstone" became suspect in part.

Field work in 1958 established the following:

(a) the Upper Cambrian and Ordovician sediments in the Dulcie Range area are in continuous sequence, with perhaps some disconformities.

(b) there is a regional unconformity at the base of the plateau-forming sandstone which caps the Dulcie Range. Proof of the unconformity is provided by -

Fig. 19



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(1) at several localities near the base of the capping sandstone the scree contains blocks of conglomerate which include fragments of fossiliferous Ordovician sandstone.

(2) the surface of the topmost fossiliferous Ordovician sandstone near Mt. Ultim is serrated.

(3) the measurement of sections shows that up to 700 feet of the Ordovician sequence is absent from some localities; this absence cannot be attributed to faulting.

(4) fossils discovered in the capping sandstone have been determined by Hills (1959) as fragments of the placoderm Bothriolepis sp., of Upper Devonian age.

Therefore none of the nomenclature of Tindale, Hossfeld and Joklik is acceptable because the sequence includes two formations, of Cambro-Ordovician and Devonian age respectively, which are separated by an unconformity. New nomenclature is necessary and the authors will now use the name "Tomahawk Beds" for the Cambro-Ordovician sequence and will restrict "Dulcie Sandstone" to the Upper Devonian sandstone which caps the Dulcie Range.

The Tomahawk Beds are here named, and defined as the sequence of richly fossiliferous sandstone, quartz greywacke, green mudstone, green siltstone, ferruginous sandstone, oolitic ironstone, dark brown dolomite and limestone, which conformably overlies the Arrinthrunga Formation and which is separated from the Dulcie Sandstone above by an unconformity.

In a section, (X30), in the Point Spring area (refer Fig.19), the Tomahawk Beds, in descending order, consist of:

Strongly-outcropping Dulcie Sandstone unconformably overlying:

185 feet	-	concealed; debris of Dulcie Sandstone and of angular conglomerate with fragments of fossiliferous Ordovician sandstone; 135 feet above the base of the interval near-outcrop of red siltstone and of purple quartz sandstone;
65 "	"	concealed; debris of dark-green fossiliferous dolomite, fossiliferous green mudstone and grey, cross-laminated fossiliferous sandstone; debris of Dulcie Sandstone in the top 20 feet of this interval;
½ "		of coarse-grained, dark-red, ferruginous sandstone with some small lenses of brown dolomite;
49 "		concealed;
1 "		of green mudstone; fossiliferous;
2 "	"	dark-red, coarse-grained, subrounded, ferruginous sandstone;
20 "	"	poorly-outcropping green mudstone with some lenses of very coarse-grained sand; fossiliferous;
2 "	"	greenish-brown mudstone with some lenses of medium and coarse-grained sand;

1	foot	of	dark-red, coarse-grained ferruginous sandstone;
4	"	"	green siltstone;
3	"	"	dark-red, coarse-grained, ferruginous sandstone; (Sample No.Ha248A.)
2½	"	"	green mudstone; fossiliferous;
2½	"	"	light-green sandstone with some lenses of red ferruginous sandstone and some clots of greenish-brown mudstone;
4	"	"	green mudstone with some thin (2 inch) bands of dark-red, ferruginous sandstone;
28	"	"	mainly concealed; some poor outcrop of green siltstone;
26	"	"	grey, glauconitic, soft, porous, medium-grained calcareous sandstone; fossiliferous;
13	"	"	concealed;
15	"	"	coarse-grained, friable, cross-bedded, medium-bedded sandstone which grades laterally into light-brown dolomite;
8	"	"	poorly-outcropping grey and brown sandstone with pelecypods;
1	"	"	dark-brown, coarsely-crystalline dolomite;
15	"	"	grey, medium-grained, thin to medium-bedded, cross-bedded, subrounded to subangular quartz sandstone with worm-tracks;
1	"	"	brownish-grey, coarsely crystalline dolomite; lenticular;
5	"	"	medium-grained, thin to medium-bedded, cross-bedded, friable, subrounded, fairly well sorted sandstone;
17	"	"	medium-grained, laminated to thin and medium-bedded, cross-bedded, subrounded to sub-angular quartz sandstone with mud pellets and ripple marks; forms a strong bench; contains much "pipe rock" and some worm trails;
55	"	"	white to grey, friable, medium-grained, thin bedded, poorly-sorted sandstone; fossiliferous;
10	"	"	grey (brown weathering) coarsely-crystalline medium-bedded to massive dolomite; cross-bedded in part;
2	"	"	medium-bedded, cross-bedded, dolomitic sandstone;
31	"	"	poorly-outcropping, white, friable, medium-grained, subrounded, fairly well-sorted sandstone;
10	"	"	brown, medium-bedded to massive, coarsely-crystalline dolomite; forms strong bench;
4	"	"	dark-brown to black, medium-bedded, poorly outcropping coarsely-crystalline dolomite;

1	foot of	fine-grained, laminated, glauconitic, micaceous sandstone;
1	" "	brown, massive, coarsely-crystalline, sandy dolomite;
1	" "	poorly-outcropping, laminated, fine-grained white sandstone;
1	" "	poorly-outcropping, grey-brown, thin-bedded, cross-bedded sandy dolomite;
2	" "	medium-bedded, sandy dolomite-breccia;
3	" "	poorly-outcropping, medium-grained, friable sandstone;
1	" "	medium-bedded, sandy breccia of dolomite fragments in calcarenite;
3	" "	poorly-outcropping thin to medium-bedded, calcareous sandstone with thin calcarenite;
6	" "	dark-brown, massive, coarsely crystalline dolomite;
27	"	concealed;
1	" "	laminated, soft, micaceous, glauconitic siltstone;
9	" "	dark-brown, massive-weathering, cross-laminated, sandy dolomite;
26	" "	poorly-outcropping, grey, sideritic calcarenite;
2	" "	grey, massive-weathering, coarsely-crystalline limestone; fossiliferous;
11	" "	poorly-outcropping, grey, medium-grained, thin-bedded sandstone with thin bands of laminated green siltstone;
1	" "	grey, massive-weathering limestone crowded with brachiopods;
6	" "	grey, flaggy, cross-bedded limestone;
9	" "	poorly-outcropping grey limestone;
4	" "	grey-brown, medium-grained, thin-bedded calcarenite;
4	" "	grey, coarsely-crystalline limestone with numerous brachiopods;
15	" "	poorly-outcropping grey calcarenite;
5	" "	brown and grey, cross-laminated, sandy dolomite;
28	" "	grey, medium-grained, cross-laminated calcarenite;
3	" "	grey, cross-laminated sandy limestone with numerous fragmentary brachiopods;
21	" "	poorly-outcropping, grey, medium-grained, thin-bedded sandstone;

4 feet of		grey-brown, hard, sandy limestone crowded with brachiopods;
36 "	"	grey, medium-grained, cross-laminated, glauconitic sandstone; fossiliferous;
14 "	"	poorly-outcropping, dark-brown, thin-bedded massive-weathering dolomite;
3 "	"	brown, laminated, massive-weathering, sandy dolomite; forms a prominent band;
82 "	"	poorly-outcropping, grey, medium-grained, glauconitic sandstone with thin-bedded sandy, glauconitic limestone;
11 "	"	grey, soft, porous, medium-grained, glauconitic sandstone;
13 "	"	poorly-outcropping, green, micaceous, laminated siltstone with some thin beds of soft, grey, medium-grained, glauconitic sandstone; fossiliferous;
12 "	"	grey, firm, medium-grained, thin-bedded glauconitic sandstone with interbedded green, micaceous siltstone; fossiliferous;
14 "	"	green, laminated siltstone with interbeds of grey, thin-bedded, medium-grained, glauconitic sandstone; fossiliferous;
53 "	"	mainly concealed; few poor outcrops of green siltstone;
		conformably overlying the Arrinthrunga Formation.

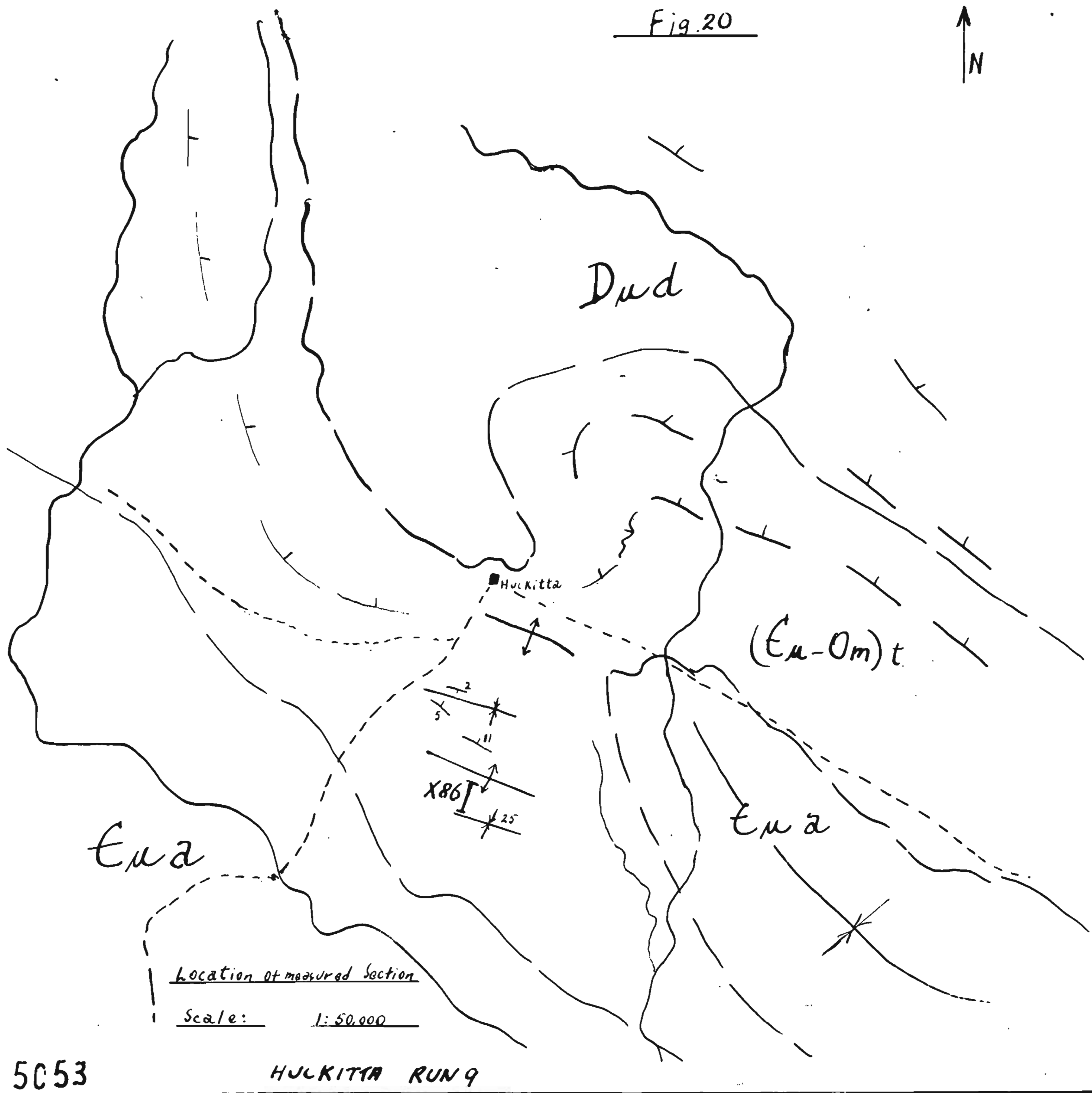
1015 feet thickness of Tomahawk Beds

In the reference section the interval from 592 feet to 1015 feet above the base of the Formation was measured in the steep scarp of the Dulcie Range; here outcrop generally is poor but there are many fossils in the scree of the scarp. Many fossiliferous samples were collected in the scree along the line of the section. There are no reversals of slope at this locality, and therefore the stratigraphic intervals in which the samples were collected fix the lowermost sequential position of the fossils contained in the samples; collections were made over the following intervals in the reference section:

7th interval.	895'	to	1000'	above	base.	Sample	H 102.
6th "	830'	"	895'	"	"	"	H 101
5th "	765'	"	830'	"	"	"	H 81
4th "	713'	"	755'	"	"	"	H 82
3rd "	693'	"	713'	"	"	"	H 83
2nd "	646'	"	693'	"	"	"	H 84
1st "	592'	"	646'	"	"	"	H 85, H 86.

The lithologies of the reference section are roughly divisible into five units which are:

(a) 830' - 1015'; mainly concealed; some red siltstone and some purplish quartz sandstone;



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(b) 646' - 830'; green-brown mudstone, ferruginous sandstone, green siltstone, dark-brown dolomite, some grey sandstone;

(c) 386' - 646'; grey and brown sandstone with sandy brown dolomite;

(d) 185' - 386'; dark-brown dolomite, grey limestone and some grey sandstone;

(e) 0' - 185'; grey sandstone with thin green siltstone.

The unit (d) is a strongly-outcropping one which can be traced from a locality two miles east of Point Spring to beyond Mt. Ultim, via the southern foothills of the Dulcie Range. Thus this unit provides a convenient stratigraphic marker and it has been used as a base for the measurement of some partial sections. The unit is always very tightly folded and it provides also some useful information on the degree of repetition by folding of beds in the lower parts of the Tomahawk Beds, e.g., Casey and Gilbert Tomlinson (1956, p.64) quote a thickness of about 1000 feet of Upper Cambrian Sandstone at the location of H24 but the present authors estimate that this thickness does not exceed 250 feet because the unit (d) indicates that the sequence at this locality is very highly folded.

Dolomite bands in units (b) and (c) also give good indications of the degree of folding. Some of these bands occur in the sequence described and measured by Tindale (1931) near Mt. Ultim; the authors consider that the 700 feet measured beneath the 100 feet of Dulcie Sandstone is excessive because of repetition by folding.

The ferruginous sandstone in unit (b) has been observed in several localities between Point Spring and Mt. Ultim; it has a red or dark red colour and is clearly visible on the ground.

Section X118, whose locality is shown on Fig.19, was measured by K. Gough. This section begins at the top of a sandy dolomite which is 592 feet above the base of X30. The thickness recorded in X118 is 450 feet; the comparable part of X30 is 423 feet thick, but the relative positions of the base of the Dulcie Sandstone are unknown. Another partial section, X119, was measured by K. Gough in the same beds as X118 and the top 423 feet of X30. The thickness recorded in X119 is 453 feet. Both X118 and X119 show pipe rock which is not exposed in the comparable portion of X30.

At a locality some two miles south of Huckitta station homestead a section, X86, has been measured by R.R.V. The section is incomplete; it is above the carbonate unit (d) and below the unit (b) which, in the vicinity of Huckitta homestead contains ferruginous sandstone beds (Sample Ha350). X86 was measured on the north limb of a syncline; its location is shown on Fig.20.

At this locality, the sequence in descending order consists of:

Top of hill

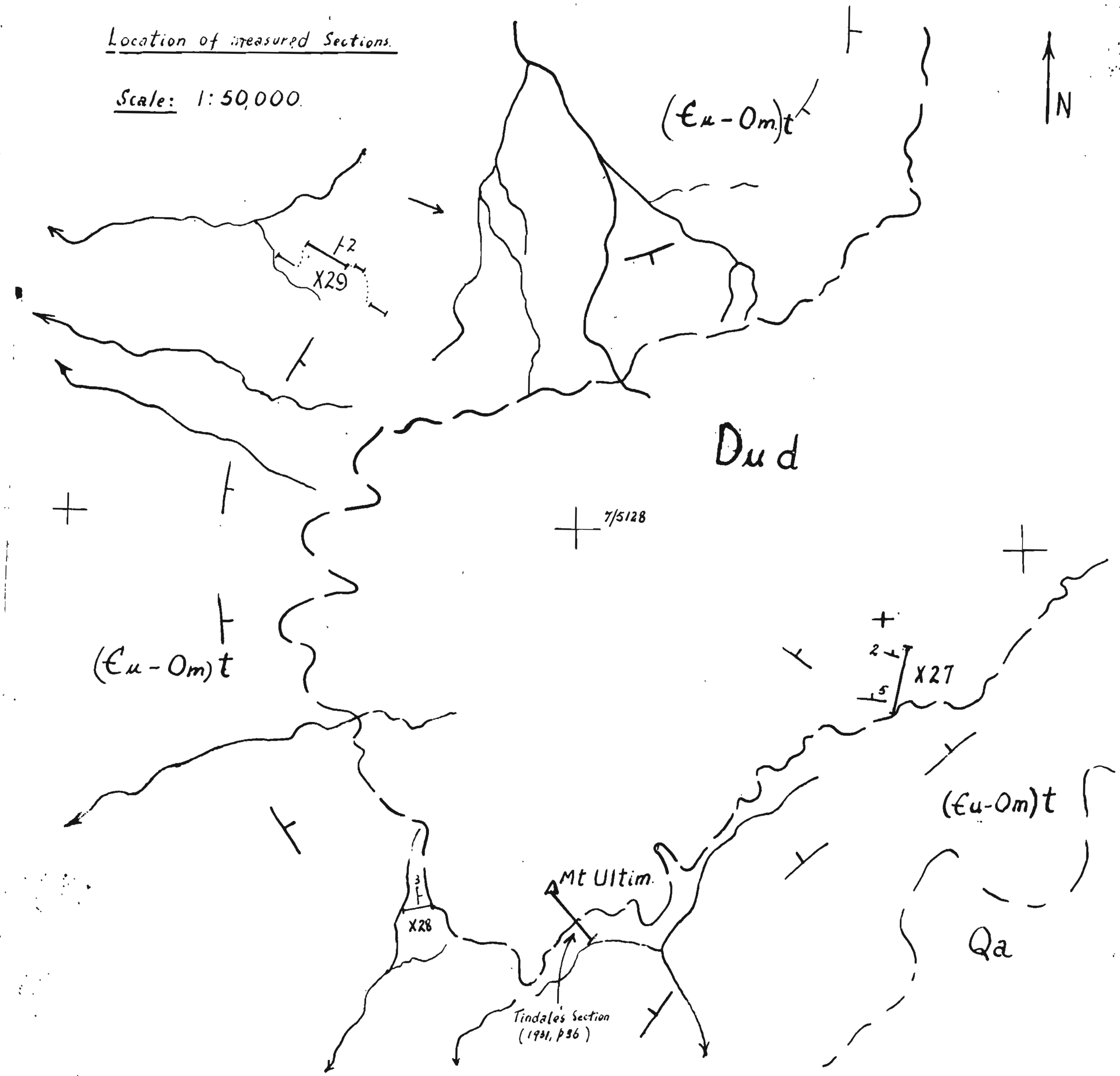
11 feet of hard, laminated to thin-bedded and medium-bedded, cross-bedded sandstone showing slickensides;

14 " " poorly-outcropping, soft, friable, laminated sandstone;

Fig. 21

Location of measured Sections.

Scale: 1:50,000



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5	feet	of	brown, medium-bedded, cross-bedded sandstone with worm trails;
44	"	"	soft, friable, laminated, kaolinitic sandstone;
5	"	"	hard, medium-grained, medium-bedded, brown and white kaolinitic sandstone with slickensides; some pipe rock;
17	"	"	brown weathering, friable, kaolinitic sandstone with some pipe rock;
30	"	"	poorly-outcropping, white, cross-laminated, friable, subrounded sandstone;
13	"	"	silicified, laminated to thin-bedded, cross bedded, white sandstone;
11	"	"	poorly-outcropping, friable, medium-bedded, medium-grained sandstone;
12	"	"	poorly-outcropping, cross-laminated, friable, silicified, glauconitic sandstone;
7	"	"	coarsely-crystalline, glauconitic, sandy dolomite, cross-bedded in part;
2	"	"	glauconitic sandstone;
4	"	"	medium-grained, medium-bedded, friable sandstone;
6	"	"	hard, medium-grained, medium-bedded, glauconitic sandstone;
21	"	"	poorly-outcropping, medium-grained, medium-bedded, cross-bedded, glauconitic, micaceous sandstone;
11	"	"	medium-grained, thin-bedded, glauconitic sandstone;
1	"	"	medium-bedded, glauconitic dolomite;
4	"	"	medium-grained, laminated, glauconitic sandstone;
18	"	"	medium-grained, thin to medium-bedded, friable, well-sorted, glauconitic sandstone; fossiliferous; (Sample H94);
13	"	"	glauconitic; dolomite, sandstone, siltstone and dolomite breccia, thin to medium-bedded;
22	"	"	medium-grained, thin to medium-bedded, friable, well-sorted, glauconitic sandstone with laminae of siltstone;
284	feet		thickness of part section X86.

Near Mt. Ultim a section, X28, was measured by K.G.S.; this section, whose location is shown on Fig.21, has no scree to obscure the top beds in the sequence and thus a good contact with the Dulcie Sandstone is available;

the section has its base at the top of the carbonate unit (d). In descending order, K28 consists of:

Strongly-outcropping Dulcie Sandstone unconformably overlying:

25 feet of		hard, medium-grained, pipe rock;
50 "	"	light-red, coarse-grained, well-rounded, ferruginous sandstone; crowded with fossils;
18 "	"	dark-brown, coarsely-crystalline sandy dolomite with interbeds and gradations of friable, coarse-grained, cross-bedded, dolomitic sandstone; fossiliferous;
12 "	"	grey, cross-laminated, medium-grained, calcareous sandstone; green silt debris observed in the interval but does not crop out;
3 "	"	hard, brown, cross-bedded, sandy dolomite; fossiliferous;
50 "	"	grey, cross-bedded, medium-grained, calcareous sandstone with worm-trails and fossils; debris of green siltstone;
1 "	"	hard, brown, glauconitic, sandy limestone;
5 "	"	grey, medium-grained, calcareous sandstone;
1 "	"	hard, brown, coarsely-crystalline, glauconitic sandy limestone;
14 "	"	poorly-outcropping, grey, calcareous sandstone; fossiliferous;
1 "	"	hard, brown, crystalline dolomite;
44 "	"	poorly-outcropping, fine to medium-grained, grey, micaceous calcareous sandstone with small fossils and abundant trails;
2 "	"	hard, brown, crystalline, sandy dolomite; (top of prominent bench)
34 "	"	poorly-outcropping, grey, medium-grained, cross-laminated, subangular, calcareous sandstone with debris of green silt; abundant trails;
3 "	"	hard, brown, crystalline, sandy dolomite; few small fossils; forms prominent bench;
8 "	"	white, medium-grained, calcareous sandstone with abundant trails;
2 "	"	concealed;
3 "	"	green, laminated, micaceous siltstone;
29 "	"	poorly-outcropping, fine to medium-grained, cross-bedded, grey calcareous sandstone with some thin (1 foot) bands of hard, brown dolomite and abundant debris of green siltstone; abundant trails;

FIG. 22

Scale 1:50,000

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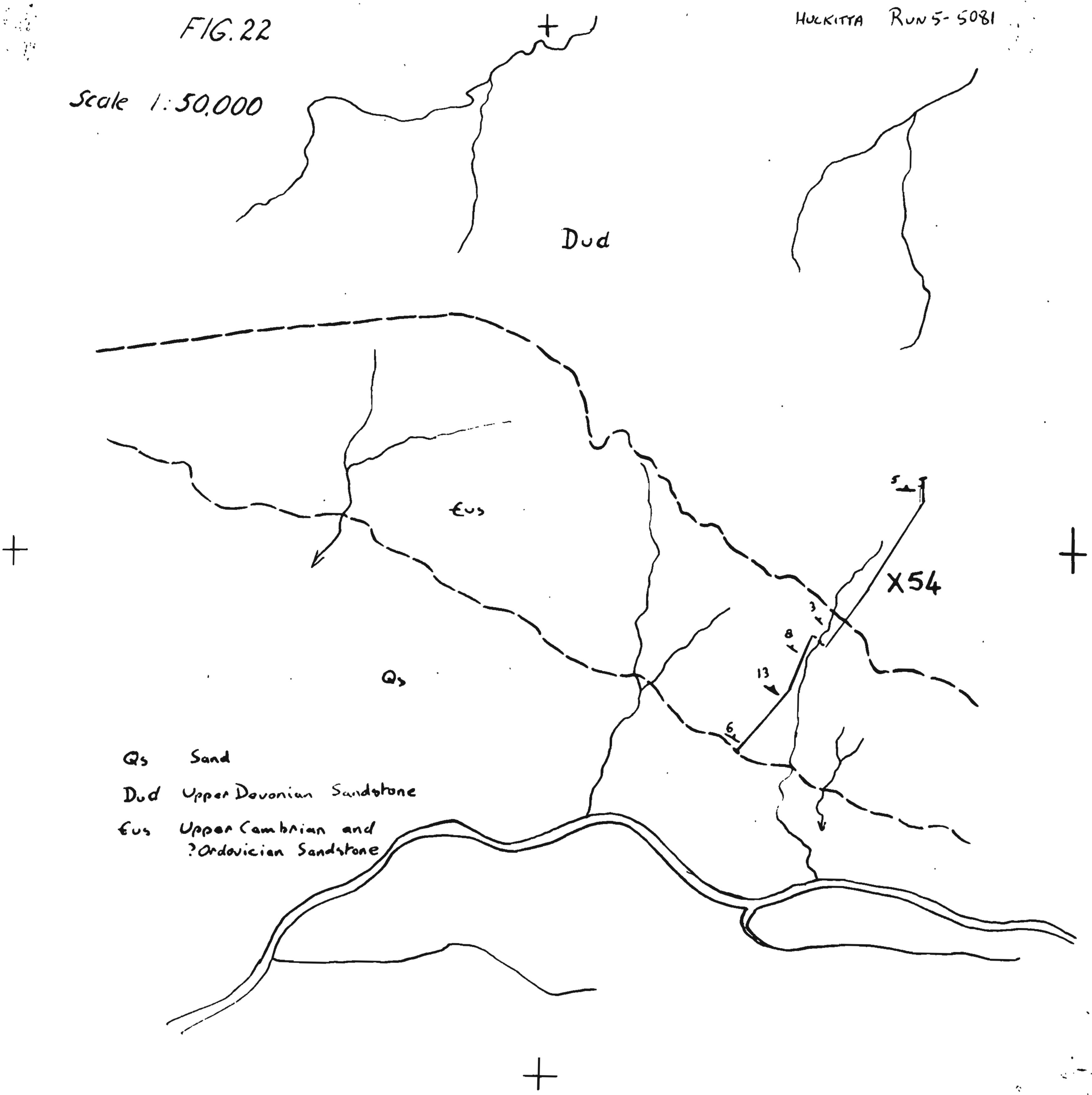


Qs Sand

Dud Upper Devonian Sandstone

€us Upper Cambrian and ?Ordovician Sandstone

11 feet of strongly-outcropping, grey, soft, angular, medium-grained, friable, glauconitic quartz sandstone; ripple-marked;

5 " " green, laminated, micaceous siltstone;

6 " " grey, soft, medium-grained, ripple-marked, micaceous, calcareous greywacke with abundant trails; thin interbeds of green, micaceous siltstone;

25 " " brown, medium-grained, cross-bedded sandstone with ripple-marks; (N.B. this thickness of 25 feet is estimated; folding is very tight); carbonate unit of (d) conformably underlying

352 feet thickness of partial section X28

Photograph No.17 shows the beds in the interval 276 feet to 352 feet above the base of X28.

X29, whose location is shown on Fig.21, was measured by K.G.S.; this section is in the beds above the carbonate unit (d) but it is incomplete. A thickness of 339 feet was recorded from the top of the basal sandstone unit of X28 to the top exposure which is estimated to be within 10 feet stratigraphically below the base of the Dulcie Sandstone. The lithology of X29 is dominantly of grey sandstone and dark-brown dolomite, with some green siltstone and some pipe rock. The ferruginous sandstone was not recorded in the section.

Section X54, whose location is shown in Fig.22, has been measured by D.R.G.W. Here the thickness of the Tomahawk Beds is 740 feet, consisting mainly of fossiliferous quartz sandstone and quartz greywacke, with some pipe rock and a little thin-bedded dolomite. The base of the sequence is not exposed but there are good exposures of the Dulcie Sandstone at the top of the section. The unit (d) has not been recorded in this sequence. The sandstone and greywacke are highly fossiliferous.

No measurements of the thickness of the Tomahawk Beds have been made on the eastern and northern sides of the Dulcie Range. The sequence consists mainly of sandstone in the lower part, with sandstone and interbedded brown dolomite in the upper portion. The sequence is generally highly fossiliferous, and pipe rock is a common feature.

In the north-eastern part of the Huckitta four-mile sheet the Tomahawk Beds do not appear to extend into the Ordovician; the only fossils obtained from this area are of upper upper Cambrian age (Opik and Tomlinson, personal communication). In this area too, the Formation contains sometimes a large proportion of limestone into which sandstone grades laterally.

Two sections, X52 and X53, whose locations are shown on Figs. 23 and 24, have been measured by D.R.G.W. X53, in descending order, consists of:

Top of hill

21	feet	of	thin-bedded, weathered sandstone;
55	"	"	pale brown, soft, laminated to thin-bedded, quartz greywacke with some thin bands of intra-formational conglomerate (weathered limestone ?);
6	"	"	medium-grained, soft, poorly-sorted quartz sandstone;
10	"	"	laminated white and brown, buff to pink, micaceous quartz greywacke;
11	"		concealed;
4	"	"	buff, soft, friable, laminated to thin-bedded quartz sandstone;
7	"	"	buff, porous, coarse-grained, well-sorted, thin to medium-bedded quartz sandstone;
9	"	"	white, soft, friable, porous, thin-bedded quartz sandstone;
¼	"	"	hard, pink, well-sorted sandstone;
24	"	"	yellow-weathering, thin-bedded, fine to medium-grained quartz greywacke;
39	"	"	white (when fresh), laminated to thin-bedded, fine to medium-grained, soft, friable quartz greywacke;
16	"	"	buff, thin to medium-bedded, friable quartz sandstone;
30	"	"	white, friable, quartz sandstone with thick interbeds of grey limestone;
232	feet	thickness of partial section X53	

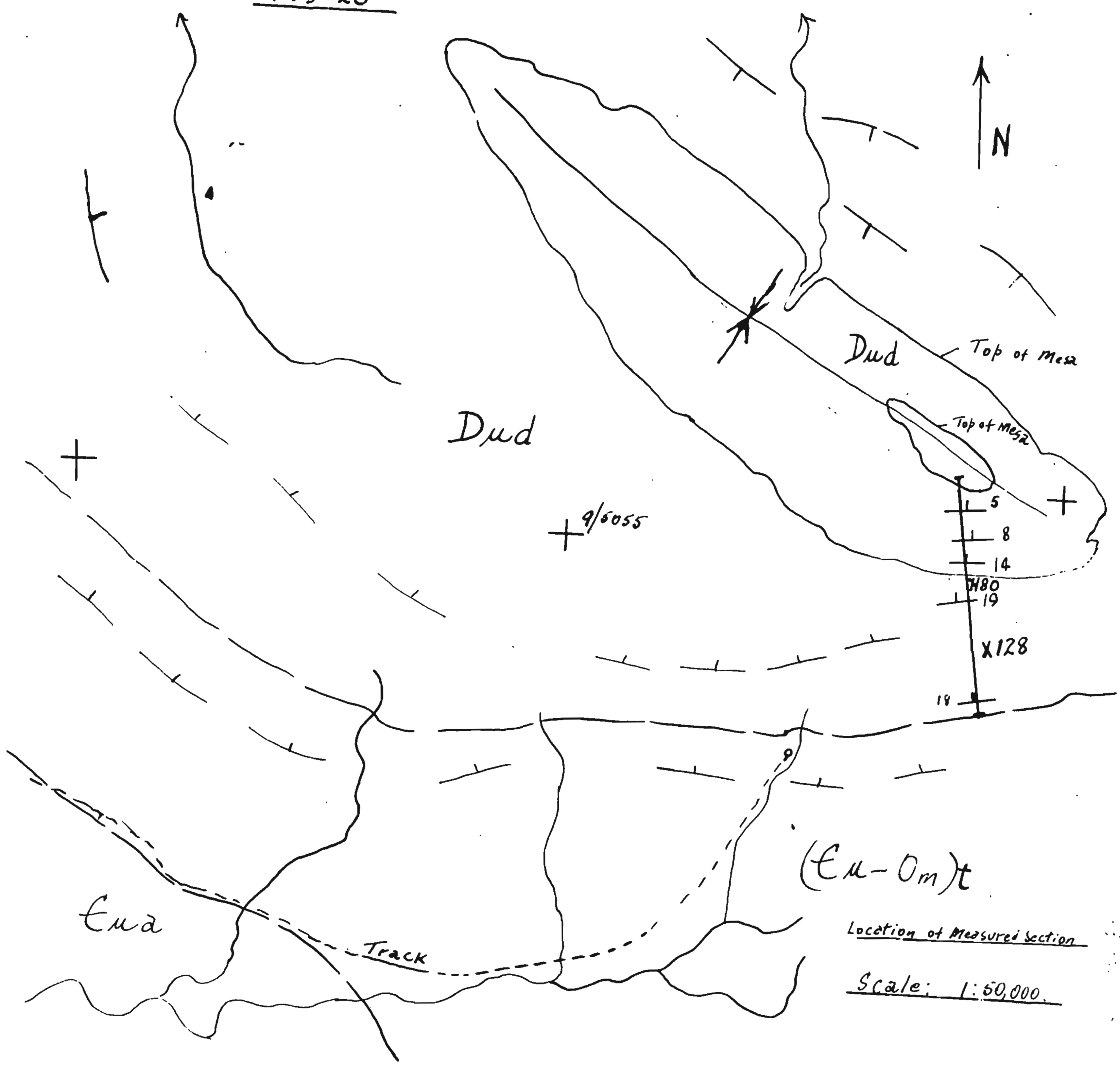
Section X52, whose thickness is 263 feet, consists of 77% carbonate rock; 23% of the section is concealed ground.

The age of the Tomahawk Beds ranges from upper Upper Cambrian to Middle Ordovician (Miss J. Gilbert-Tomlinson, personal communication). The most systematic collection of fossils is from the type section (X30) but there are several collections from other localities. Palaeontological work on these fossils is in progress; to show the unconformity between the Tomahawk Beds and the overlying Dulcie Sandstone in the best light it is necessary to locate more fossils from several localities in the foothills and scarp of the Dulcie Range and to fix the position of each collection in a measured section.

The Dulcie Sandstone

The name "Dulcie Sandstone" is here re-defined to apply to the sequence of strongly-cross-bedded, clean to silty quartz sandstone, with some sporadic beds of pebble conglomerate, and some calcareous, silty, sandstone containing Upper Devonian placoderms , which lies unconformably above the Tomahawk Beds.

Fig. 25



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HUCKITTA RUN 9

The name was taken (Joklik, 1955) from the Dulcie Range, which is capped by excellent outcrops of the Dulcie Sandstone. The distribution of the Formation is confined to the Dulcie Range.

The type section of the Dulcie Sandstone is located about 8 miles east of Huckitta station homestead. A track, suitable for four-wheeled drive vehicles only, leads from the homestead to within $\frac{3}{4}$ mile of the base of the type section. The locality of the type section is shown in Fig.25. At this locality, the section, measured by K. Gough, in descending order consists of:

Top of mesa

18	feet	of	white, medium-grained quartz sandstone;
5	"	"	poorly-sorted, sub-angular to sub-rounded quartz pebbles, in a matrix of soft, white mudstone;
16	"		concealed;
6	"	"	white, medium-grained quartz sandstone with abundant kaolin;
23	"	"	white, medium-grained, cross-bedded quartz sandstone with abundant interstitial kaolin and sporadic pebbles;
46	"	"	concealed;
22	"	"	white, medium-grained, strongly cross-bedded quartz sandstone with abundant interstitial kaolin;
113	"		concealed;
115	"	"	poorly-outcropping, porous quartz sandstone with sporadic pebbles;
81	"		concealed;
92	"	"	white, medium-grained, strongly cross-bedded kaolinitic sandstone; <u>Bothriolepis</u> sp. occurs in the interval between 30 and 55 feet above the base of the interval;
11	"	"	white, micaceous siltstone; some soft, compact light-grey mudstone;
62	"	"	concealed;
23	"	"	light-grey, medium-grained, subangular, kaolinitic sandstone;
37	"		concealed;
29	"	"	poorly-outcropping, soft, poorly-consolidated kaolinitic pebble conglomerate;
69	"	"	medium-grained, very kaolinitic sandstone with some stringers of pebble conglomerate;; cross-bedded; Sample Ha 540.
196	"	"	white, friable, medium-grained, subangular quartz sandstone;
23	"	"	light-grey, medium-grained, kaolinitic sandstone;

127 feet of		poorly-outcropping, white, medium-grained quartz sandstone with abundant kaolin;
12	" "	white, medium-grained, cross-bedded quartz sandstone with abundant interstitial kaolin;
178	" "	mainly concealed; a few small outcrops of sandstone;
63	" "	white, fine-grained, strongly cross-bedded sandstone with abundant interstitial kaolin;
140	" "	mainly concealed; some small outcrops of fine conglomerate;
115	" "	medium-grained, white, subangular quartz sandstone with abundant interstitial kaolin; some stringers of fine conglomerate; strongly cross-bedded;
40	" "	white, medium-grained, strongly cross-bedded quartz sandstone with abundant interstitial kaolin; some thin stringers of coarse, well-rounded quartz grains;
138	"	concealed;
34	" "	white, medium-grained, strongly cross-bedded quartz sandstone with abundant interstitial kaolin; some thin bands of pebble conglomerate;
164 feet of		white, friable, medium-grained quartz sandstone with interstitial kaolin in the upper half of the interval; strongly cross-bedded;
40	" "	white, well-sorted, medium-grained, hard, porous, strongly cross-bedded quartz sandstone with interstitial kaolin;
———		Soil and scree cover over Ordovician sediments;
2070 feet		thickness of type section of the Dulcie Sandstone.

This section is the thickest available, according to aerial photograph interpretation. Over many square miles to the north of Huckitta station homestead the headwaters of Ooratippra and Mistake Creeks drain from a mesa which is estimated to be stratigraphically about three-quarters of the way up the section; the top quarter of the type thickness occurs only in the vicinity of the type section. Usually only the lower half of the sequence crops out.

The specimens of Bothriolepis sp. were obtained from near the base of a prominent mesa; the silty fraction in the beds of this mesa have a pronounced white colour on aerial photographs; the mesa drained by the headwaters of the Ooratippra and Mistake Creeks has this white colour in its sides and is about on the same stratigraphic level as the mesa from which the placoderms were obtained. A similar, smaller mesa, in the same stratigraphic position, is located about three miles west of Picton Spring. Both mesas may yield fossils, if examined.

Three other partial sections have been measured in the Dulcie Sandstone; these are:

X 121, measured by K. Gough. This sequence is 706 feet thick and it consists of white, medium-grained, quartz sandstone with some sporadic beds of pebble conglomerate; the beds are strongly cross-bedded, for the most part.

X54, whose location is shown on Fig.22, has been measured by D.R.G.W. This sequence is 489 feet thick and consists of medium to coarse-grained, well-sorted (usually) white and buff, strongly cross-bedded quartz sandstone with about 90 feet of thin-bedded, soft, white ? calcareous quartz greywacke at the top of the section. This sequence is in the lower part of the Dulcie Sandstone.

X27, whose locality is shown on Fig.21, has been measured by K.G.S. Here the sequence is 310 feet thick and consists of 310 feet of clean, friable, strongly cross-bedded, sub-rounded, medium to coarse-grained quartz sandstone with some silty, cross-bedded quartz sandstone in the top 100 feet of the section. This section is incomplete and is in the lower part of the Dulcie Sandstone.

Summary of Thickness of Formations

The following table gives a summary of the thickness of Formations in several areas; the thickness is given for those Formations which are, in some places at least, believed to be in continuous sequence.

	AREA		
	Mopunga Range to Dulcie Range	Elyuah Range	Jervois Range and west
Tomahawk Beds	750 (estimated)	Not present	Not present
Arrinthrunga	1000 (estimated)	865'	Not measured
Arthur Creek Beds	1000 (estimated)	500 (estimated)	1000 (estimated)
Mt. Baldwin	300	1380	1200
Grant Bluff	730	530	530
Elyuah	530	250	380
	4310'	3525'	3110' plus

These thicknesses vary according to the figures quoted for the Elyuah Formation, and in the Elyuah Range they vary according to the quote for the Mt. Baldwin Formation, which thickens to the south-west. The estimates are not entirely unmeasured, e.g., in the area between the Mopunga and Dulcie Ranges a thickness of a partial section (X114) has been recorded as 815 feet. Likewise, the estimate of the Tomahawk Beds is based partly on measured portions of the Formation.

UN-NAMED FORMATION OF ? PERMIAN AGE

In a long valley, about 2½ miles north of Point Spring there occurs a small mesa, about 150 feet high, composed of deeply-weathered silty, medium to coarse-grained sandstone which contains numerous pebbles and cobbles of quartz and angular blocks, up to 15 inches, of unfossiliferous, silicified quartz sandstone. This formation rests unconformably on the Arrinthrunga Formation and is well below the topographic level of the Dulcie Range top in this locality. The formation bears no resemblance to Tertiary outcrops of the Huckitta four-mile area and it is the only outcrop of its type on the Huckitta four-mile sheet. The dips are about 15 degrees to the south-west, near the base of the mesa, and they flatten out near the top. Some rolling dips have been observed. The thickness is estimated to be of the order of 200 feet. The most likely age of this sequence is Permian. The authors correlate it with the Tarlton Formation (Condon and Smith, 1959), which is a sequence of thin moraines and fluvio-glacials, of ? Permian age, exposed near Tarlton Downs homestead and in localities to the east and in Queensland.

STRUCTURE IN UPPER PROTEROZOIC AND PALAEOZOIC ROCKS

The structure is dominated by several major folds whose axes trend west-north-west; superimposed on these are numerous minor folds whose axes also trend west-north-west mainly, but which have random directions when the folds are in incompetent beds. A subsidiary structural line has a north-east trend.

Folding and faulting movements have affected the Dulcie Sandstone; the age of the tectonic movements is unknown. The authors envisage two periods of tectonism, one post-Ordovician and one post-Upper Devonian (the small outcrops of the Mt. Cornish Formation are thought to have been folded in the post-Ordovician period, and not in a third, older period). However, it is difficult in the field to observe the actual results of the post-Ordovician folding as compared with the post-Devonian one. The fold axes of the Tomahawk Beds are parallel to those of the Dulcie Sandstone. Angular differences in dip between the Tomahawk Beds and the Dulcie Sandstone are difficult to observe because of either a cover of scree or the strongly cross-bedded nature of the Dulcie Sandstone. In areas e.g. near Mt. Ultim, where scree cover is usually slight, the Tomahawk Beds decrease in dip as one proceeds up the slope towards the Dulcie Sandstone. This decrease is observed also in the angle of pitch of minor folds in the dark-brown dolomite beds which are well-exposed in the slopes in this area. It is considered that the Dulcie Sandstone was deposited on a surface which contained many gently-dipping mesas of sediments of the Tomahawk Beds of various stratigraphic levels. The strongest folding movement occurred in the post-Devonian period.

The most important folds are a broad syncline in the Dulcie Range, a complementary anticline in the area drained by Eurowie and Tomahawk Creeks and a broad anticline in the north-eastern part of the four-mile sheet. These are broad folds with a slight degree of pitch to the north-west; they are complicated by smaller parallel folds within each major fold, and by numerous minor folds, particularly in the Arrinthrunga Formation and Tomahawk Beds, with random directions of fold axes.

In the western portion of the Huckitta four-mile area the carbonate rocks of the Arthur Creek Beds and of the Arrinthrunga Formation are intensely folded; such folds are probably an accentuation of slump folds by normal folding movements. Some large domes and synclines are mappable in these carbonate rocks. In localities where it has been folded against a buttress of Jinka Granite the

Arrinthrunga Formation (and older Formations, when present) is overturned. The carbonate rocks of the lower part of the Tomahawk Beds illustrate well the degree of folding in that Formation, away from the scarp of the Dulcie Range.

Major faults in the area trend north-west. They are most marked in the Archaean rocks and in the Lower Proterozoic grantites, where they are usually expressed as large quartz 'blows'. On continuations of these trends into the unmetamorphosed sedimentary rocks, some zones of steep dips may represent the surface expressions of the faults. Near Lucy Creek homestead the structures in the Arthur Creek Beds and in the Arrinthrunga Formation indicate a fault in some places, a monocline in others. It is probable that a fault in the basement occurs in this locality. The available surface information indicates that the eastern side is downthrown.

? TERTIARY ROCKS

In the valleys of the Plenty River and of the Frazer and Bonya Creeks there are erosional residuals of chalcedony and limestone, underlain in places by clastic sediments ranging from coarse sandstone to clay. Madigan (1932, p.97) named the Arltungan Beds and described them as consisting of "beds of sands, clays, gravels and limestone, unconsolidated except for the 'duricrust', and flat-lying or gently-dipping in conformity with an older land surface". The localities cited by Madigan were in the plains of Paddy's Hole (near Arltunga Battery) and the Todd, Hale and Plenty Rivers. Madigan's description of the Plenty River area (p99) clearly includes a sequence from a prominent hill near the site of the new (1957) Plenty River Airstrip but the present authors consider that Madigan included some material derived from deep-weathering of the underlying (Archaean) rock at the base of the hill.

The authors make a slight change in the name "Arltungan", to conform with the principles of the Code of Stratigraphic Nomenclature, and rename the sequence the Arltunga Beds. The term "Beds" is preferred to Formation because outcrop of the sequence is not widespread on the Huckitta four-mile sheet (although the hills are usually higher than elsewhere) and not all of the lithologies described by Madigan are present. The authors are convinced that the sequence on the Huckitta four-mile sheet are similar to part of the sequence described at other localities, but it is not considered advisable to locate a type section in the Huckitta area for a sequence which is not a proven Formation.

In the Huckitta four-mile area the dominant lithology of the Arltunga Beds is a vuggy chalcedony, with relict patches of silicified limestone in the cavities. It is crudely and massively bedded, and grades downwards into limestone with layers, nodules and veins of chalcedony, and into grey or white limestone. The limestone is unstratified (R.R.V. personal opinion); it generally presents a brecciated or pellety appearance, but is sometimes of uniform texture. The major part of the limestone has been silicified after deposition. The lowest limestone beds are generally travertinous and incorporate ferruginous impurities from the underlying, weathered surface.

The Beds in the Plenty River area are usually 35 - 40 feet thick. In the Bonya Creek area the thickness ranges from 3-35 feet. South of Dneiper homestead the Beds form an extensive plateau. In this area R.R.V. has measured several sections in the Beds. Details of these sections are:

Top of hill

6 feet of	chalcedony, with patches and layers of silicified limestone;
11 " "	concealed; rubble of grey, silicified limestone;
6 " "	vuggy chalcedony with patches of silicified grey limestone;
10 " "	vuggy chalcedony, thick-bedded to massive, with patches of grey limestone;
4 " "	chalcedonic grey limestone; medium to thick-bedded;
25 "	concealed; chalcedonic grey limestone thrown up from rabbits' burrows;
7 " "	concealed; rubble of silicified grey limestone and chalcedonic grey limestone;
3 " "	brecciated grey limestone, unstratified, with minor amounts of chalcedony;
9 "	concealed; rubble of white and grey limestone;
2 " "	brecciated grey limestone with nodules and layers of chalcedony;
1 " "	pink and white travertine with fragments of ferruginous material;
6 "	concealed;
2 " "	uncemented, pisolitic ironstone;
—	Archaean gneiss;
92 feet	thickness of section

X 83 was measured $\frac{3}{4}$ mile north of X 82. The same chalcedony bed forms the top of both sections, i.e., 69 feet above the base of the composite section, X82 and X84 described above. X83, in descending order, consists of:

Top of hill

7 feet of	vuggy chalcedony with patches of grey limestone;
4 " "	chalcedonic grey limestone;
2 " "	brecciated grey limestone;
6 " "	pink, earthy, ferruginous ? soil; cemented by travertine;
2 " "	concealed;
1 " "	pink, earthy, ferruginous ? soil; cemented in part by travertine;

16 feet concealed;

27 " of unstratified, pisolitic ironstone; Archaean gneiss

---

65 feet thickness of part section

The main outcrop of clastic sediments of the Arltunga Beds is in an area of less than ¼ square mile, some 7 miles east-south-east of Black Point. A thin capping of chalcedony has protected the sediments at the northern end of this area. X88, measured in this area, consists of (descending order):

Top of rise

3	feet of	chalcedony;
15	" "	concealed; much wash of gypsiferous blue clay;
3	feet "	? calcareous sandstone; coarse, illsorted, poorly-stratified, subrounded;
10	" "	micaceous shale; variegated red, yellow and white;
1	" "	yellow, micaceous siltstone;
10	"	concealed; rubble of yellow, red and grey limestone;
		Archaean gneiss.
42	feet	thickness of partial section.

In the Huckitta area no fossils have been located in the Arltunga Beds. Similar deposits south of Paddy's Hole Plain and on the Hale Plain contain fresh-water gastropods (Madigan, 1932 b, p98) which are regarded as being either of Pleistocene or Pliocene age. In Queensland similar fossils have been discovered in similar deposits in the valley of the Burke River (Casey et al. 1959).

Madigan (1932,b,p97) noted that the deposits appeared to be remnants of older valley fills in the present watercourses. Similar conditions are postulated for the Noranside Limestone (Casey et al., 1959) in the Burke River valley, Western Queensland, and for the Austral Downs Limestone in the valley of the Georgina River (R.J. Paten, personal communication). The mode of deposition is not clear but may have been in a lake or series of lakes along the older courses of the present-day drainage.

ECONOMIC GEOLOGY

COPPER

The detailed study of the Jervois Copper mines and environs was continued by J.A. Robertson. This work is reported in Records 1959/103.

No additional copper prospects were located during the 1959 regional mapping.

ECONOMIC GEOLOGY

MICA

Mapping of pegmatites continued in 1958 and some which warrant further prospecting were observed. A report on all of the pegmatites mapped on the Huckitta four-mile sheet has been prepared by D.R.G. Woolley (Records 1959/88).

IRON

In the upper part of the Mt. Ultim Formation some beds of ferruginous sandstone and of oolitic ironstone were observed at numerous localities. Sample Ha 248A, from the type section of the Tomahawk Beds, assayed 39% Fe_2O_3. (Assay by A. McClure). A report on the occurrences of ironstone has been prepared by R.R.Vine (Records 1959/102).

WATER

Some additional bores were drilled by landholders and by the Northern Territory Administration under its "Drought Relief" scheme. The latter were on both Lucy Creek and Ooratippra stations, and were in either the Tomahawk Beds (Ooratippra) or the Arrinthrunga Formation (Lucy Creek). In the north-eastern area of the four-mile sheet the outcrops of the Arrinthrunga Formation are generally low and rolling and therefore the restriction of localities caused by hills (Smith et al. 1959) does not apply in this area. The necessities for bore-siting in this area include the provision of sufficient (not less than 400 feet) thickness of dolomite of the Arrinthrunga Formation under the projected site. The blue limestone of the Arthur Creek Beds is better avoided, and limestone of the Arrinthrunga Formation is generally not suitable. One bore in the Tomahawk Beds (site selected by N.O. Jones) was successful; this bore penetrated the lower, sandy part of the Formation.

Messrs. Webb Bros. drilled several successful bores on sites selected by themselves and one unsuccessful bore (selected also by themselves) drilled into Archaean rocks. This unsuccessful bore penetrated 158 feet of soil on the bank of the Marshall River; a successful bore penetrated 202 feet of soil and was also located on the bank of the Marshall River. Another successful bore was drilled into the Arthur Creek beds west of Huckitta homestead; at 190 feet this bore yielded 900 gallons per hour from a thin band of chert. Ferruginous limestone fragments were obtained at a depth of 144 feet in this bore. A third successful bore yielded 1200 gallons per hour from 20 feet of clean, friable, pink sandstone in the Mt. Baldwin Formation. The bore began in alternating limestone and calcarenite of the Arthur Creek Beds and reached a total depth of 372 feet.

OIL

The Arthur Creek beds represent a thickness of the order of 1000 feet, of fossiliferous rocks including blue-black limestone which gives an odour of hydrogen sulphide when struck. The surface structures include domes and basins but these have little closure in the area of outcrop. No traces of gas or of oil have been reported from water bores in the Arrinthrunga Formation but if the structures represented by surface exposures of this

Formation are reflected in the Arthur Creek Beds, a structural trap worth investigating may be the probable monocline to the northwest of Lucy Creek Homestead; another may be the broad anticline in the north-east of the Huckitta sheet.

The sediments of the Tomahawk Beds are highly fossiliferous but the sequence does not include any reasonably thick siltstone which may act as a cap rock. The indefinite geological history of the unit between the time of its deposition and the beginning of deposition of Dulcie Sandstone does not enhance the prospects of the Tomahawk Beds.

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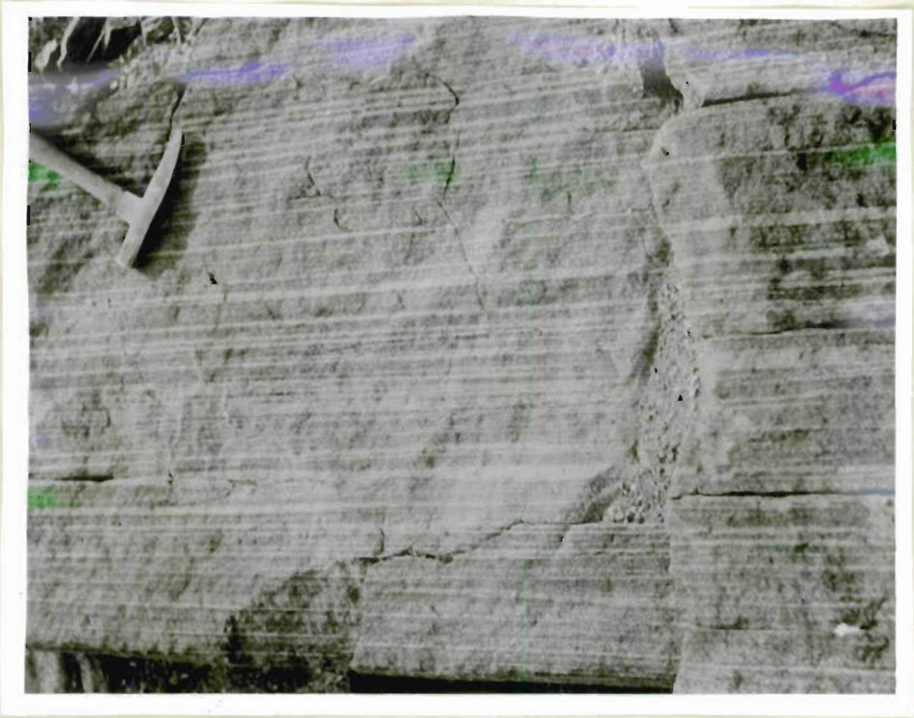
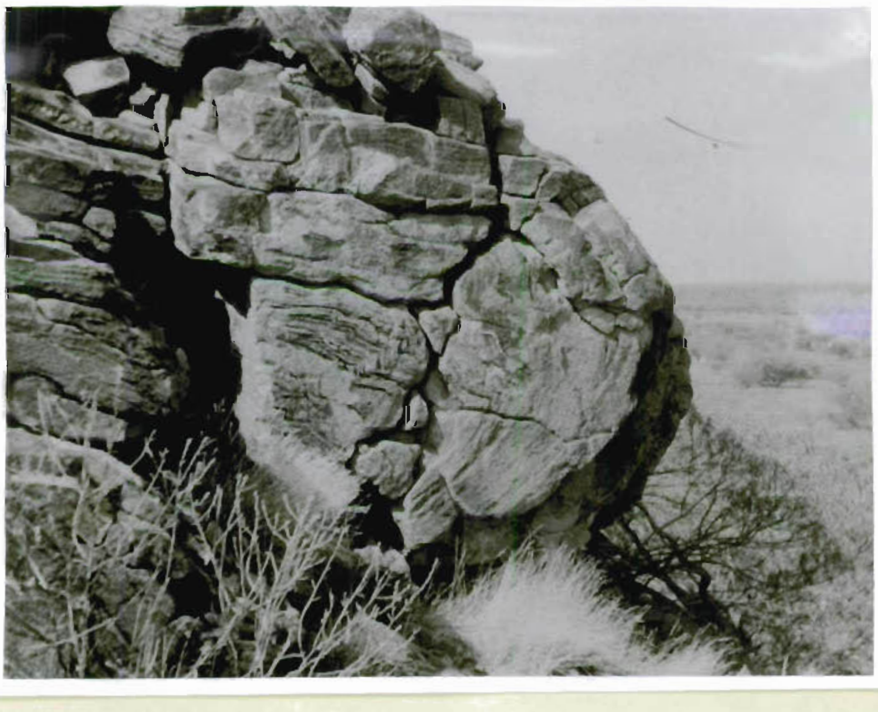


No. 1. Gneiss, with alternating layers of feldspar and quartzo-feldspathic minerals.

No. 2. Second order fold in quartz-feldspar-biotite gneiss.

No. 3. Ridge of quartz-feldspar gneiss (?Cadney Gneiss); looking south-east.



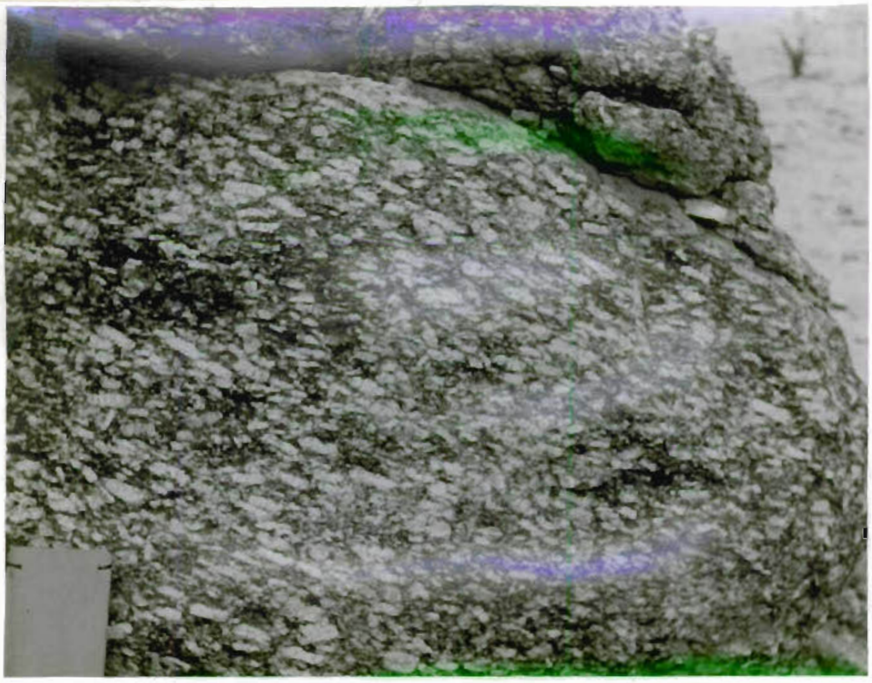
No. 4. Second order fold in southern end of outcrop shown in Photograph No. 3.

No. 5. b-axis lineation developed in gneiss.

No. 6. Folding in b-axis lineation of gneiss in Photograph No. 5. Joints produced in folding movement are shown. Looking south at the north limb of a west-trending anticline.

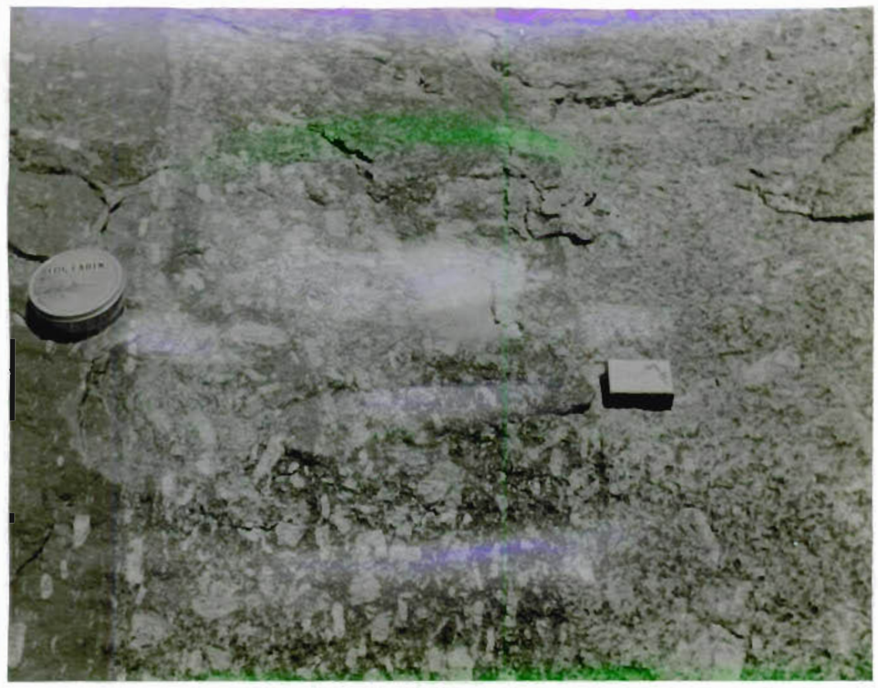
No. 7. Quartz-feldspar-biotite gneiss, Mt. Swan area.

No. 8. Quartz-feldspar-biotite gneiss, Mt. Swan area.

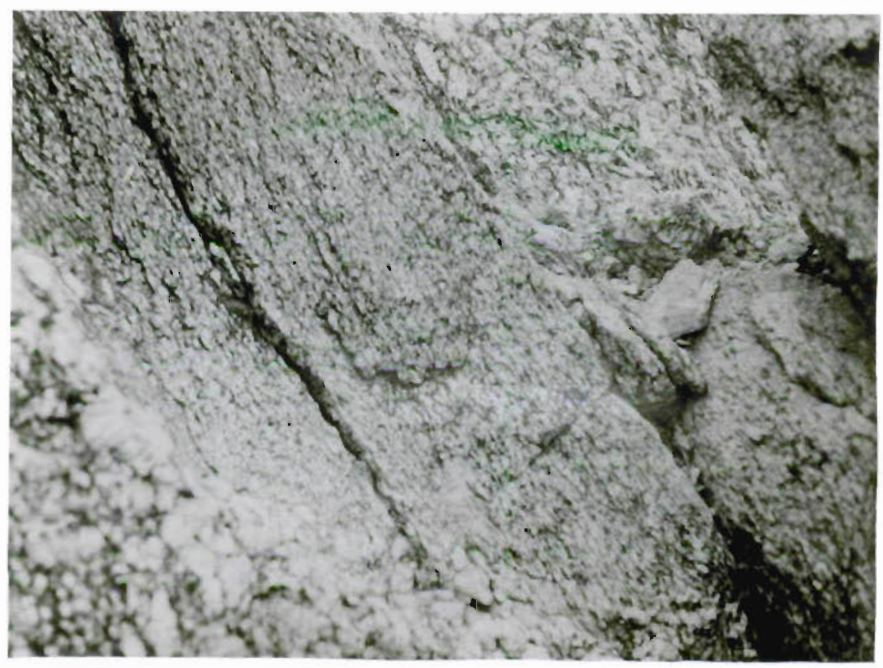


No. 9. Typical Mt. Swan Granite.

No. 10. Two generations of feldspar in gneiss, Mt. Swan area.



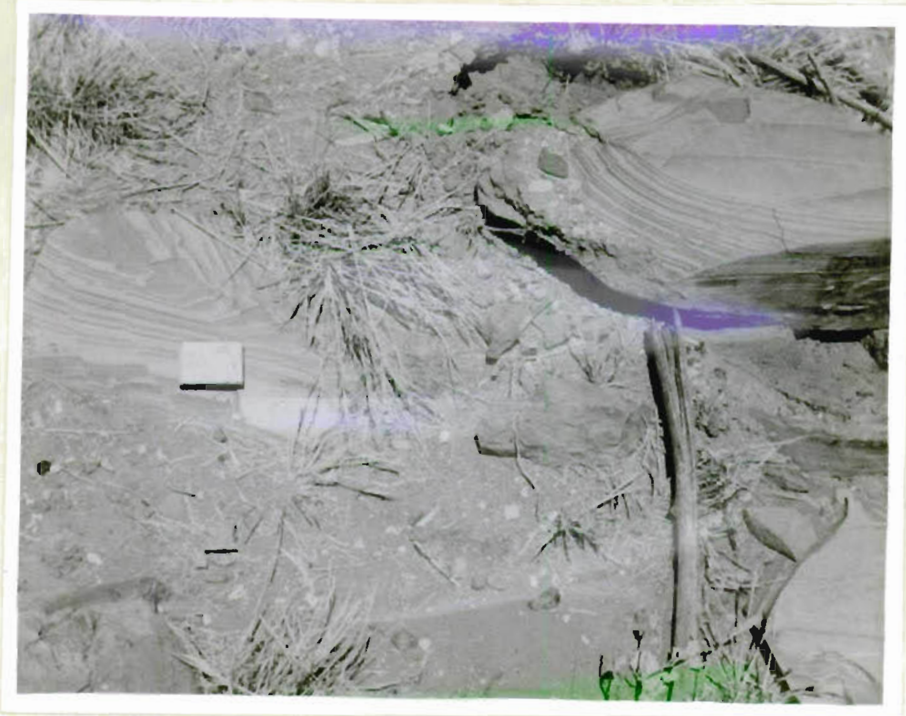
No. 11. Gneiss, intermediate zone, granite (from left to right); Mt. Swan area.



No. 12. Gneiss in Mt. Swan Granite. (Gneiss is in centre of photograph).

No. 13. Boulder bed, Mt. Cornish Formation.

No. 14. Boulder Bed, Mt. Cornish Formation.



No. 15. Cyclic siltstone and fine sandstone (varves), Mt. Cornish Formation. Numerous minute faults shown

No. 16. Colonial algae, Eurowie Creek.

No.17. Typical outcrop of the Tomahawk Beds, with the Dulcie Sandstone above. X28 measured, in part, on hill in foreground. Dark bands are dolomite and limestone. Small outcrop of Dulcie Sandstone at the top of the hill.

No.18. Typical folding in dolomites of the Tomahawk Beds Looking north-west up a valley north of Point Spring.

No. 19. Typical folding in dolomite of the Mt. Ultim Formation. In same valley as Photograph No. 18. Dulcie Sandstor on both sides of the photograph.

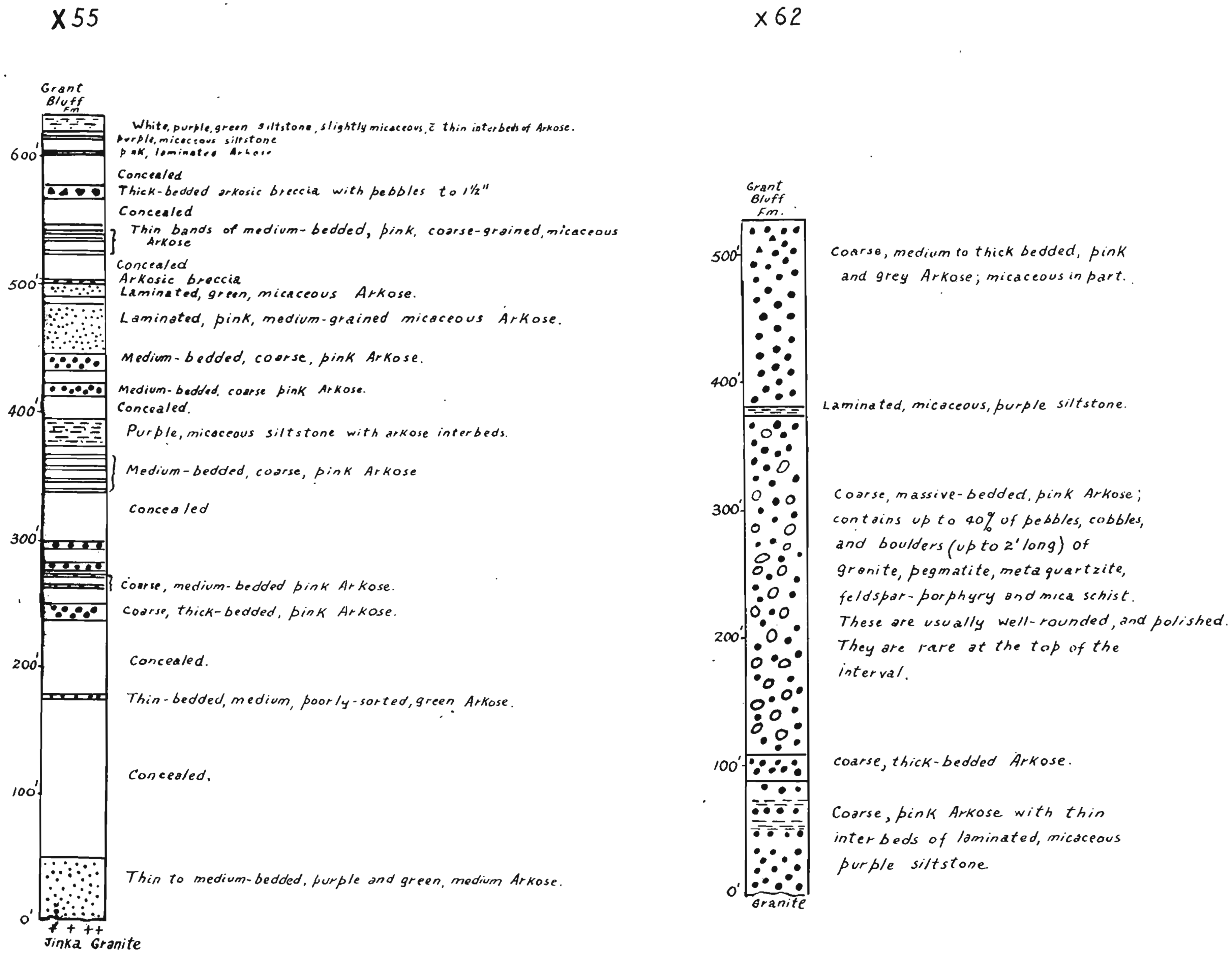


Fig. 10

Comparison of Sections of the Oorabra Arkose (X55) and other arkose of the Elyuah Formation.

Vertical Scale:

Photo Locations:

X55 5197, Huckitta Run 11.

X62 5026, Huckitta, Run 10.

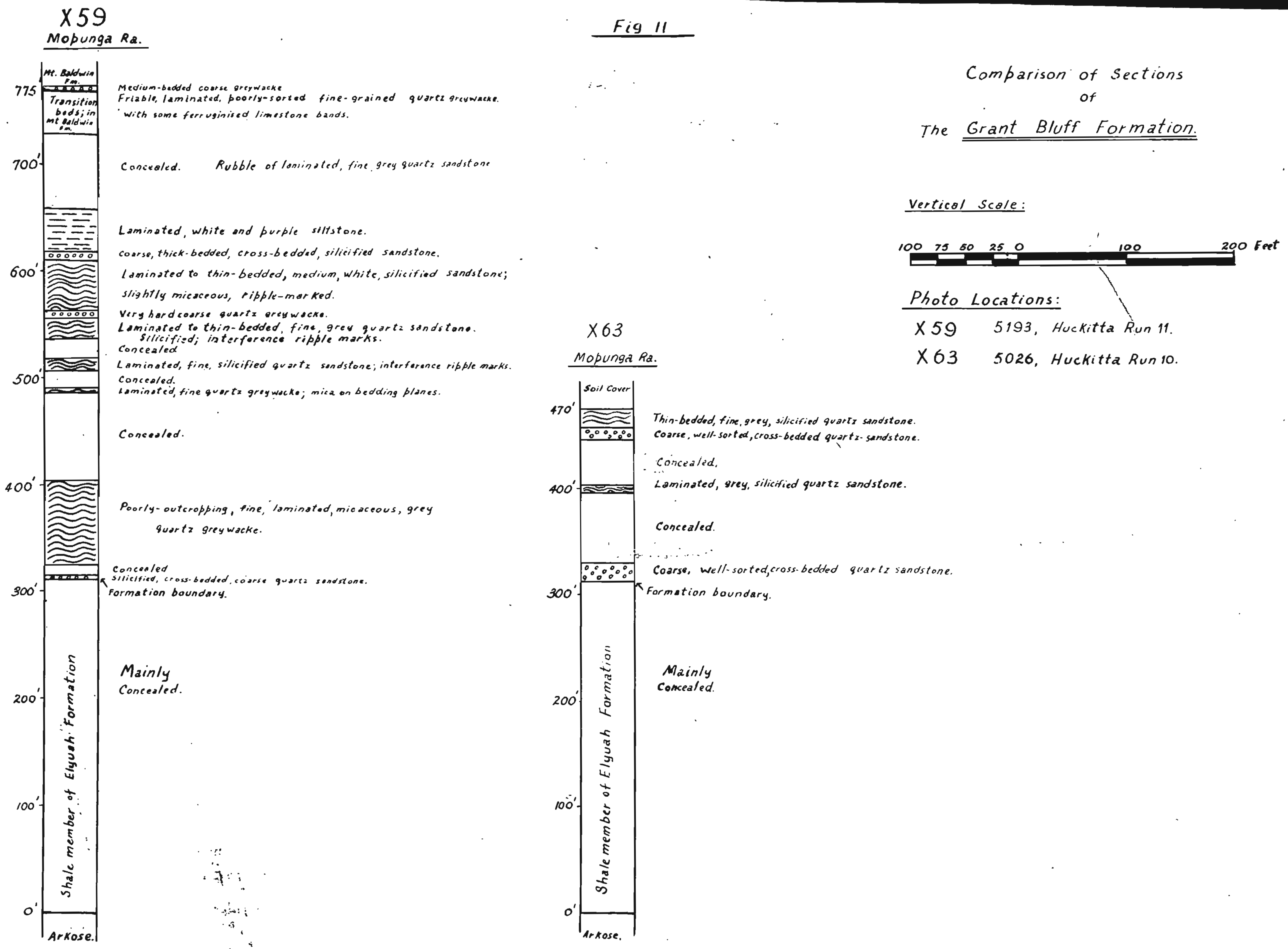


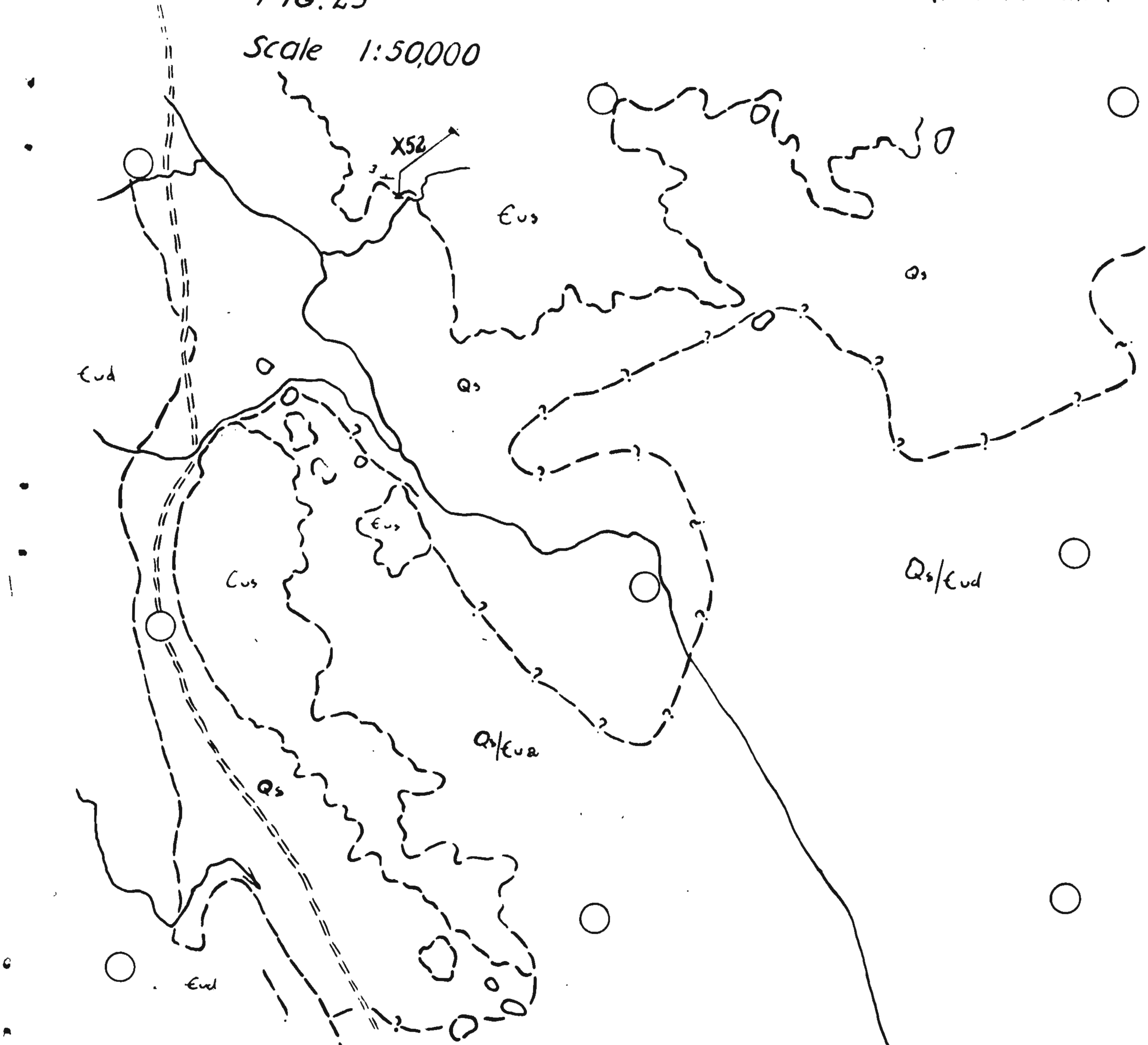
Fig 11

Comparison of Sections of The Grant Bluff Formation.

HULKIITA RUN 1 - 5121

FIG. 23

Scale 1:50,000



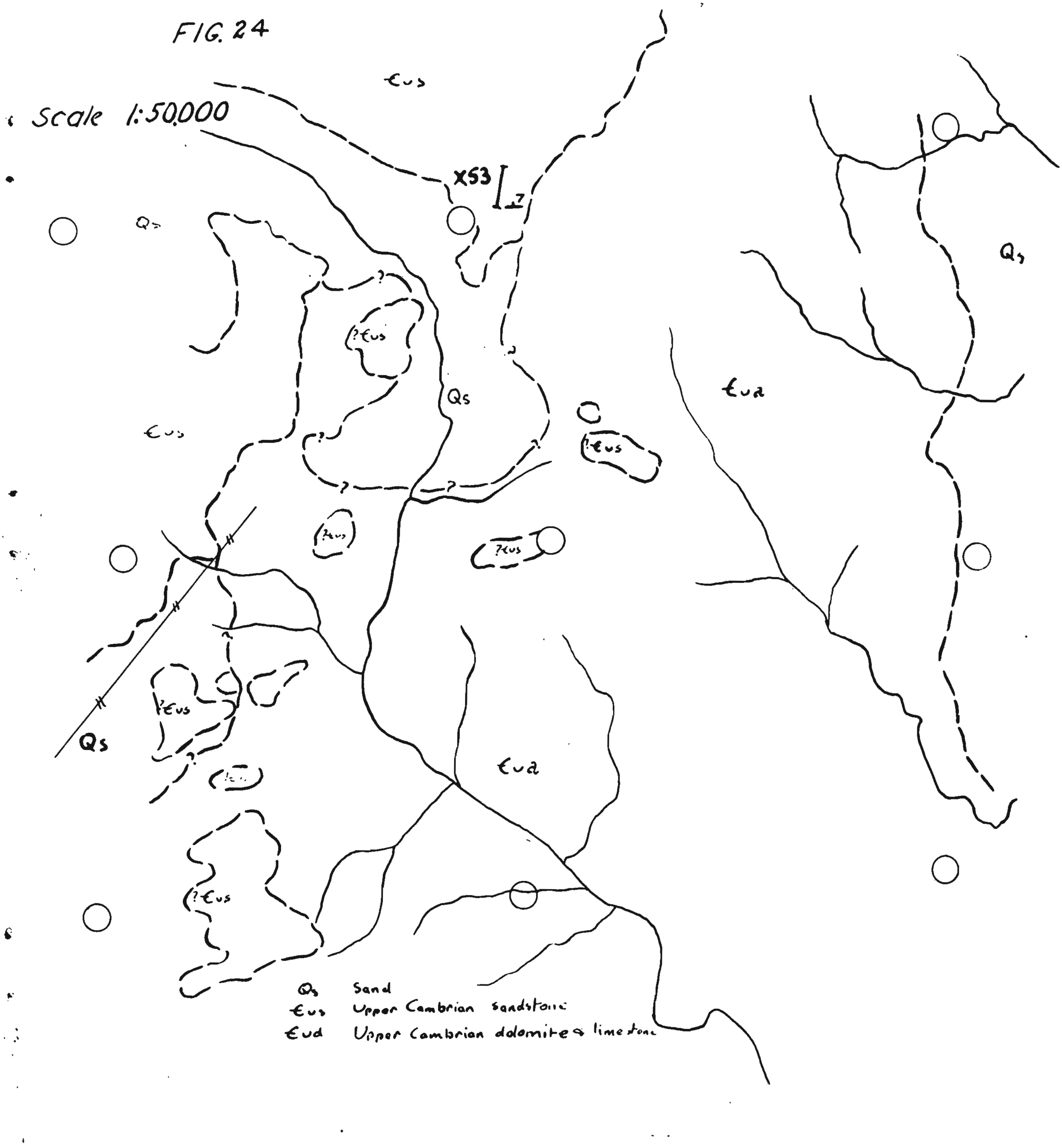
Qs Sand

Єus Upper Cambrian sandstone and limestone

Єud Upper Cambrian dolomite and limestone

HUCKITTA RUN 1 - 5123

FIG. 24



AUSTRALIA 1:253,000

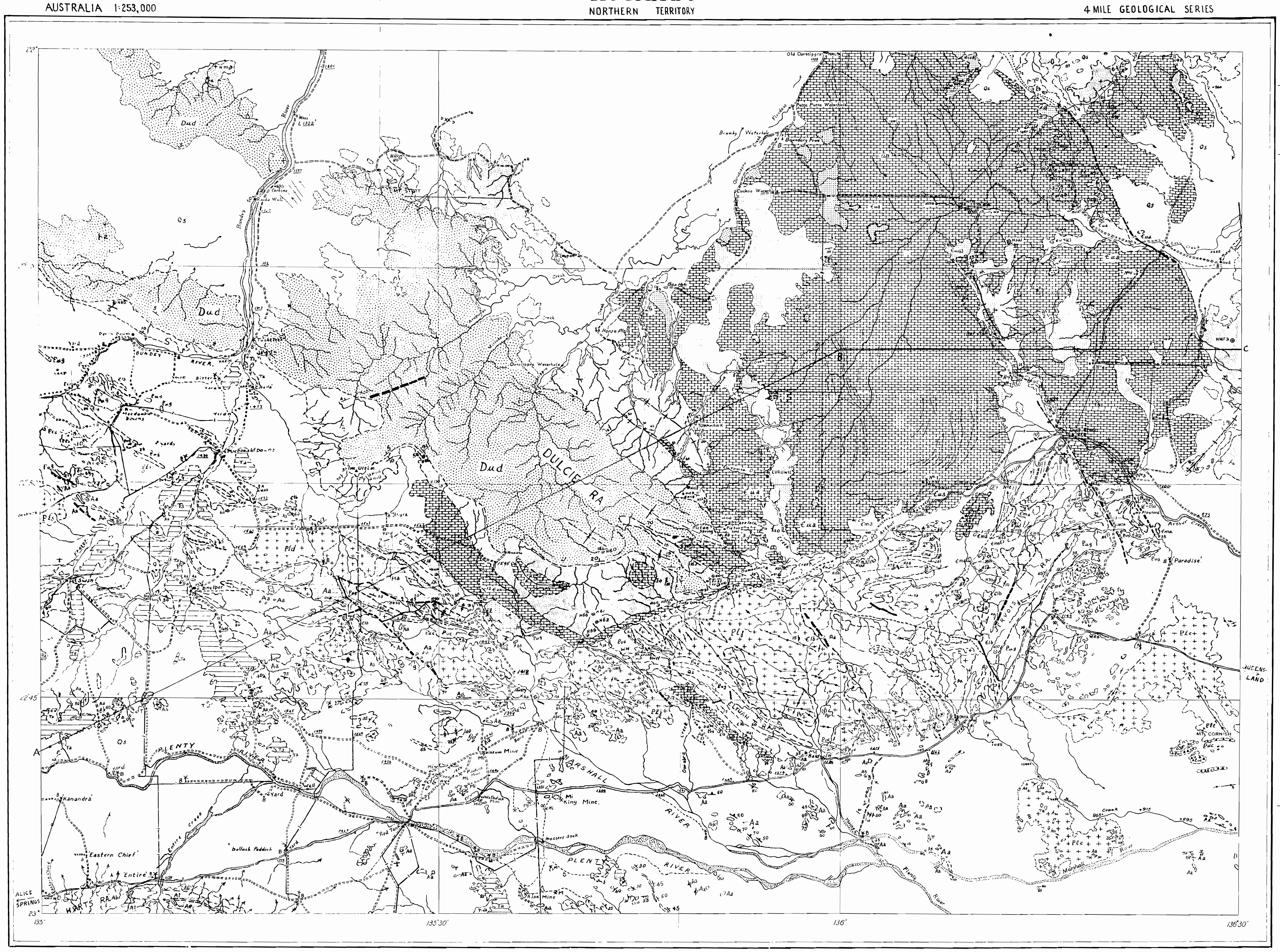
HUCKITTA

NORTHERN TERRITORY

4 MILE GEOLOGICAL SERIES

Reference

Barometric spot height
Levelled spot height
Wind pump
Water bore
Dry water bore
Tank
Water hole
Spring
Well
Yard
Dam
Homstead
Air field
Main road
Track
Track suitable for 4-wheel drive vehicles only



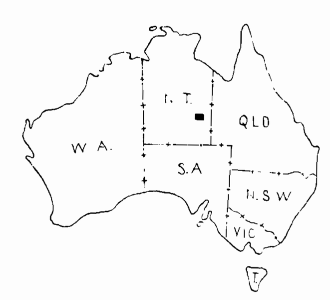
CAINOZOIC	QUATERNARY		Qs — Undifferentiated soil, sand, and alluvium
	TERTIARY	Altunga Beds	Ta — Silicified limestone, sandstone
		UNCONFORMITY	
PALAEOZOIC	PERMIAN	Tarlton Formation	Pt — Silty quartz sandstone with numerous boulders and angular blocks of quartzite
		UNCONFORMITY	
	DEVONIAN	Dulcie Sandstone	Dud — Quartz sandstone with some silty calcareous sandstone. Contains fossil fish
		UNCONFORMITY	
	CAMBRIAN	Tomahawk Beds	(Є-O)c — Calcareous sandstone, green siltstone, brown dolomite, grey limestone, oolitic iron beds, ferruginous sandstone, sandy dolomite, purple siltstone; richly fossiliferous.
		Arrinthrunga Formation	Єua — Brown massive dolomite, yellow flaggy dolomite, blue and purple oolitic limestone. Thin interbeds of siltstone and sandstone.
		Eurowie Sandstone Mem.	Єuae — Brown quartz sandstone with halite pseudomorphs
		Arthur Creek Beds	Єma — Buff shale, laminated blue-black limestone with lenses of calcareous sandstone; richly fossiliferous. Ferugenous shale, dolomite.
		? UNCONFORMITY	
		Mt Baldwin Formation	Єℓb — Red quartz sandstone, grey quartz greywake, red dolomite siltstone. Dolomite with Archaeocyathids
PRE-CAMBRIAN	UPPER PROT.	Grant Bluff Formation	Pug — Grey quartz sandstone with tracks and trails, gypsiferous siltstone, brown dolomite, with Collenia
		UNCONFORMITY	
		Elyuah Formation	Pue — Arkose, green and red shale
		UNCONFORMITY	
		Mt Cornish Formation	Puc — Boulder beds, green siltstone with "clastic" texture, cyclic green siltstone and fine sandstone
		IGNEOUS ROCKS	
	LOWER PROT.	Jervois Granite	Pℓe
		Jinka Granite	Pℓj
		Marshall Granite	Pℓm
		Dneiper Granite	Pℓd
		Mt Swan Granite	Pℓs
			Ad — Basic intrusives
		Metamorphics	
	ARCHAEAN	Arunta Complex: Brady Gneiss	Ab
		Irindina Gneiss	Ai
		Entia Gneiss	Ae
			Aa — Undifferentiated gneiss, schist, metaquartzite

Geology by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base compiled by the Division of National Mapping, Department of National Development. Levelled spot heights by Department of the Interior. Air photography by RAAF, vertical coverage at scale 1:46,000

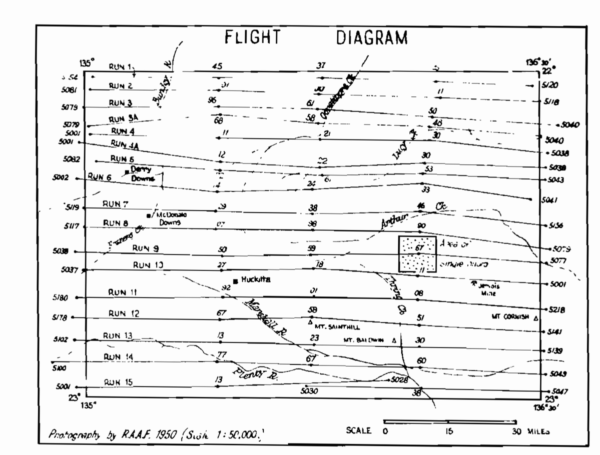
INDEX TO ADJOINING SHEETS
Showing Magnetic Declination

BARROW CREEK	ELKEDRA	SANDOVER RIVER
ALCOOTA	HUCKITTA	TOBERMORY
ALICE SPRINGS	ILLOGWA CREEK	HAY RIVER

Scale
4 Miles to 1 Inch



Geology by K.G. Smith, J.W. Smith, D.R. Woolley, J.M. Pulley, R.R. Vine, K. Gough, 1957-58 and G.F. Joklik 1955



Section ABC

Vertical Exaggeration 10.56