THE GEOLOGY OF THE PROTEROZOIC AND CAMBRIAN OF THE EMU BORE AREA, FLINDERS RANGES, SOUTH AUSTRALIA.

BY

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ERRATA

Page 2: fourth line from bottom: confomable should read conformable.

Page 5: fourth line of third paragraph: fissle should read fissile.

Page 8: sixth line: lense should read lens.

Page I4: seventh line: posses should read possess;
eighth line: texture should read structure.

Page I7: eighth line of second paragraph: diapir-effected should read diapir-affected.

Page 24: first line of last paragraph: riable should read viable.

Page 27: reference omitted from GENERAL REFERENCES:
Krauskopf, K.B., I967. Introduction to Geochemistry; McGraw-Hill: 262-266.

ABSTRACT

Mapping in the Emu Bore Area has disclosed hitherto unmapped Parachilna Formation and Billy Creek Formation as well as a diapiric body.

The entire Upper Proterozoic to Upper Lower Cambrian sequence is a shallow water one marked by periods of transgression and regression which has resulted in the deposition of limestones and red beds.

The Lower Cambrian rocks consist entirely of limestones as opposed to those in the type section in Wilkawillina Gorge where clastic units are included.

INTRODUCTION

The area mapped is on the eastern edge of the Flinders Ranges and lies approximately 85 miles N.E. of Hawker.

The campsite was situated about 3 to 4 miles west of Kempes Dam. Rough tracks lead from Martins Well Homestead to Kempes Dam, a distance of about 25 miles. These tracks are impassable in wet weather and on several occasions it was necessary to leave the main track at Kempes Bore to reach the campsite. The water from Kempes Bore was undrinkable so fresh water was obtained from Martins Well Homestead.

The fieldwork was done in March, from April to May, and in August.

Access to the Emu Bore Area each day was gained by riding across country on a trail bike, a distance of five to six miles.

The relief in the Emu Bore Area was moderate to steep in places and the trail bike could generally be ridden to within easy reach of most parts of the area.

Vegetation was sparse and consisted mainly of grasses and low bushes with very few large trees.

Outcrop was moderate to poor and this often made mapping difficult; boundaries and faults were walked where possible. A stratigraphic section of about 3,000 ft. was measured using a 100 ft. tape and applying trigonometric corrections for topography.

Laboratory work consisted of map drafting, thin section making, staining of thin sections and rock chips, some photographic work and descriptions of thin sections.

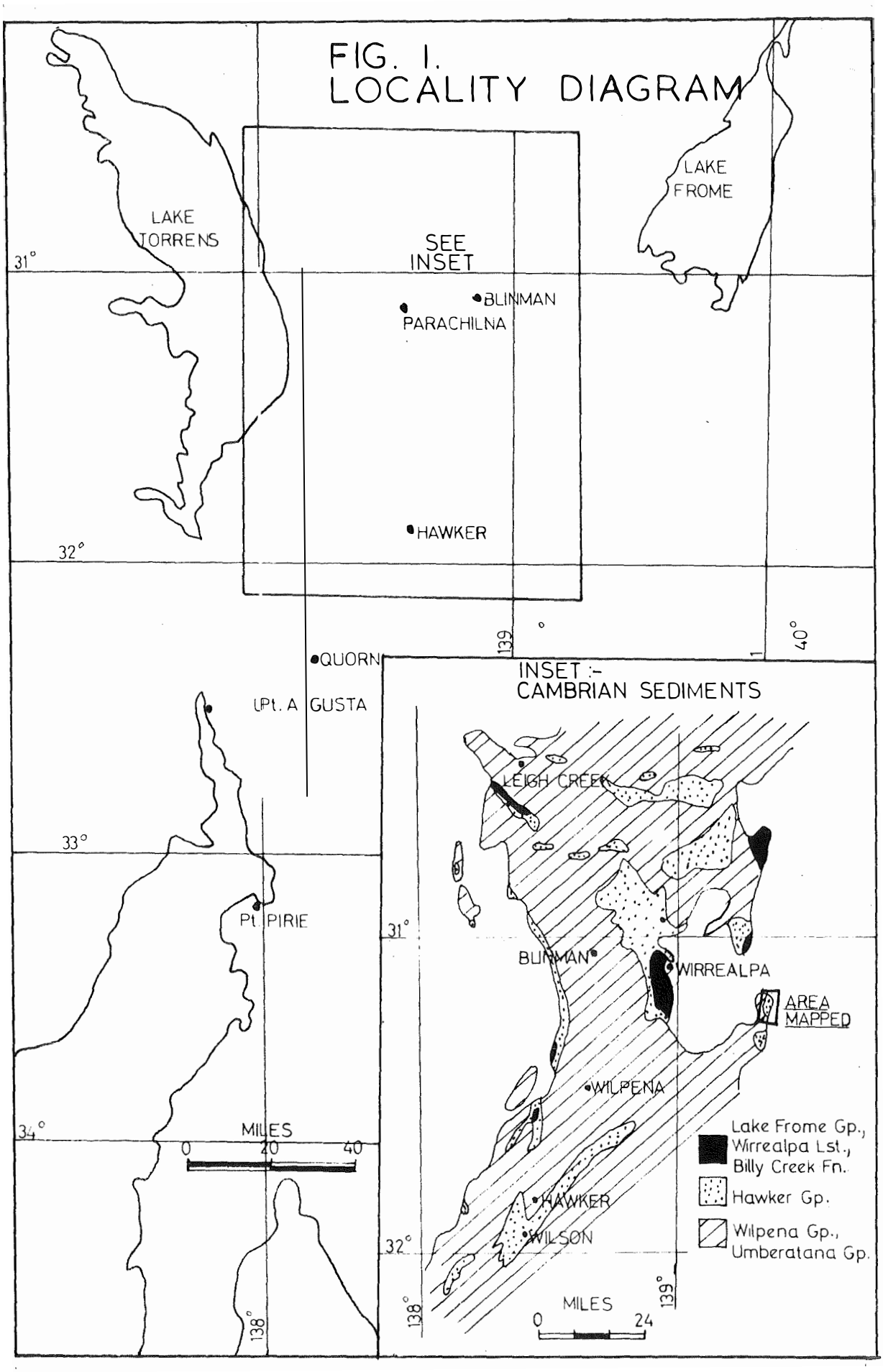


FIG. 1.
LOCALITY DIAGRAM
LAKE TORRENS
LAKE FROME
SEE INSET
BLINMAN
PARACHILNA
HAWKER
QUORN
Pt. AUGUSTA
Pt. PIRIE
31°
32°
33°
34°
139°
140°
138°
MILES
0 20 40
INSET :-
CAMBRIAN SEDIMENTS
LEIGH CREEK
BLINMAN
WIRREALPA
AREA MAPPED
WILPENA
HAWKER
WILSON
Lake Frome Gp., Wirrealpa Lst., Billy Creek Fn.
Hawker Gp.
Wilpena Gp., Umberatana Gp.
MILES
0 24

Particular attention was paid to the carbonates of the Wonoka Formation and the Wilkawillina Limestone.

Some time was spent examining ~~of rock~~ type sections of the Upper Proterozoic rocks in Brachina Gorge and the type section of the Lower and Middle Cambrian as found in Mount Billy Creek.

The region has been previously mapped by the S.A. Mines Department (Dalgarno and Johnson, 1963 & 1964) and by Kennecot Explorations.

Geochemical work had been done by both Kennecot and Delhi Minerals.

REGIONAL GEOLOGY

The sediments in the Emu Bore Area were deposited in the Adelaide Geosyncline and vary in age from Upper Proterozoic to Middle Cambrian.

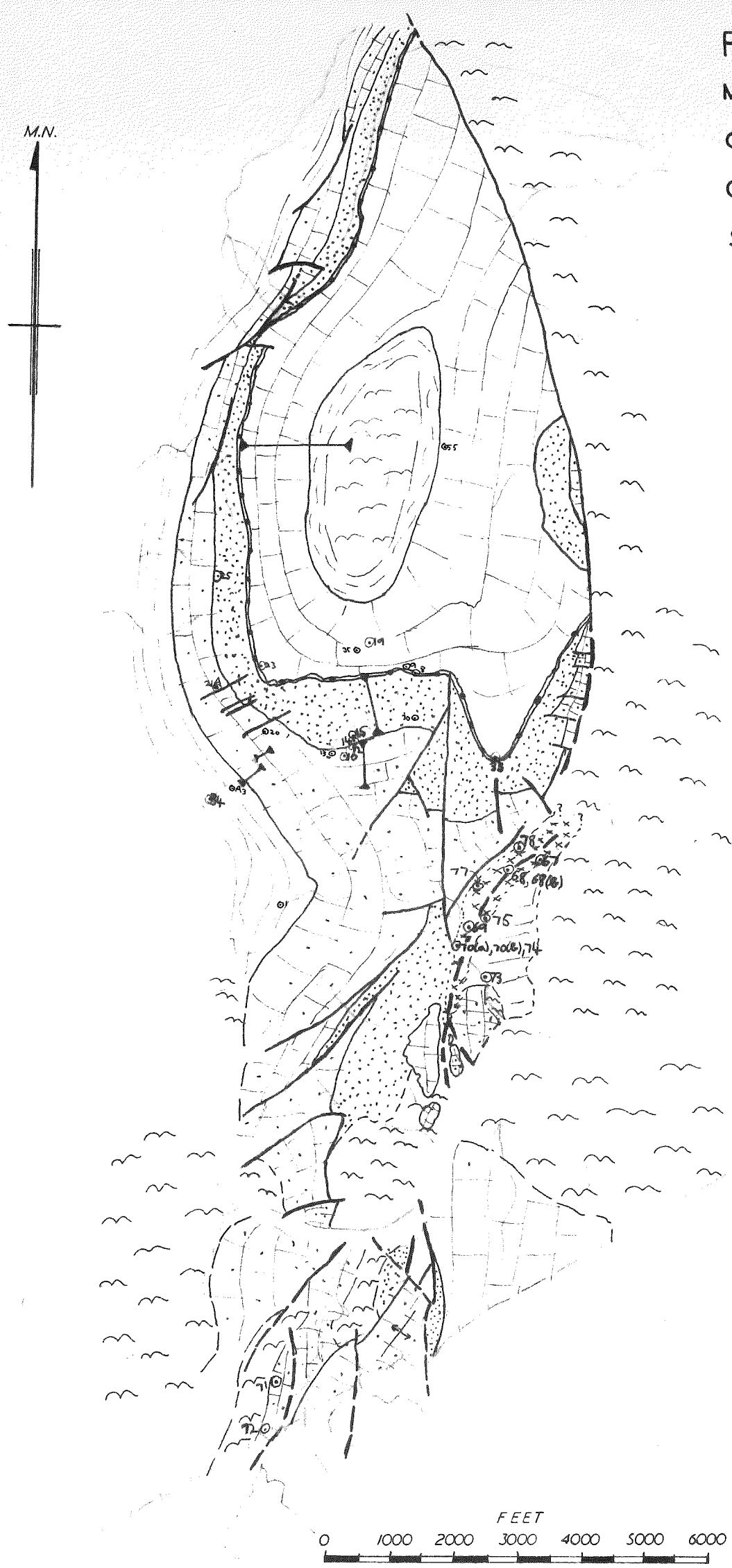
The principal rock types in the Adelaide System are carbonates, clastics and glacials andthe System is divided into four time-rock series. These are the Willouran, Torrensian, Sturtian and Marinoan Series. The latter three series are well exposed in the Flinders Ranges but the Willouran Series is exposed only in diapiric structures as rafts in calcareous diapiric breccias.

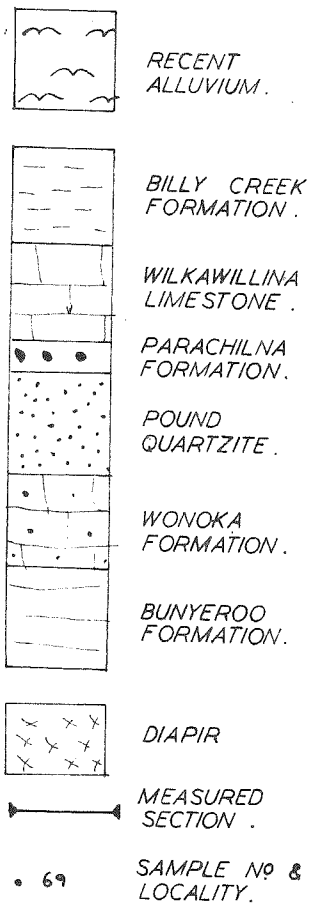
Overlying the shallow water sediments of the Pound Quartzite which occur at the top of the Adelaide System is the Lower Cambrian Hawker Group. The contact relationship is generally confomable but local disconformities do occur.

The Cambrian System rocks are mainly carbonates and red coloured clastics.

FIGURE 2.

MAP SHOWING GENERAL GEOLOGY AND LOCALITIES OF SAMPLES AND MEASURED SECTIONS IN THE EMU BORE AREA.





The more nothern parts of the Flinders Ranges are characterized by the presence of diapirs. The diapirs were active until late Lower Cambrian times and the sediments adjacent to some of these diapirs were greatly effected by their presence in that marked facies changes occur and pebble beds are present.

The fold pattern of the Ranges is thought to have formed during Late Cambrian-Ordovician times.

Later Tertiary fault movements on older faults resulted in the rejuvenation of the mountain chain to its present form.

STRATIGRAPHY:

(A) PROTEROZOIC ROCKS:

Upper Proterozoic rocks are found in the Emu Bore Area.

These are the upper parts of the Bunyeroo Formation, The Wonoka Formation and the Pound Quartzite.

These rocks are lithologically correlated with those in the type section in Berachina Gorge.

(1) BUNYEROO FORMATION:

Little time was spent studying the Bunyeroo Formation mainly because it was poorly exposed. The contact region between the Bunyeroo and Wonoka Formations was studied and mapped and several quick traverses were made across the upper half of the Bunyeroo Formation.

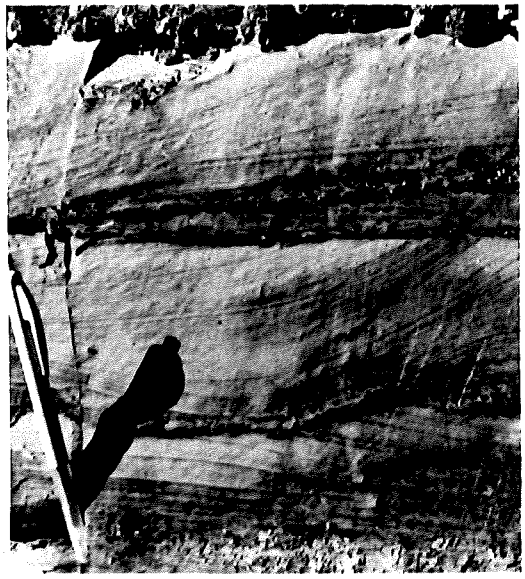
The Bunyeroo Formation is generally a monotonous unit of red and grey-green slightly calcareous, micaceous shales and siltstones. These are thinly bedded and sometimes thin grey laminae alternate with thin red laminae. The rocks part very easily along the bedding

PLATE 1.

a, b: Cross bedding and cut - and fill structures in Wonoka Formation.

c: Flute cast structures in Wonoka Formation (Looking at bottom of bed).

PLATE 1



a.



b.



c.

planes which have oriented micas on them.

Ripple marks and cross bedding are fairly common and bedding planes are often wavy.

The red colour in the rocks is caused by iron oxide stain on the grains.

The contact of the Bunyeroo and overlying Wonoka Formations is gradational in this area. The first evidence of a change in the type of sedimentation is the occurrence of thin bandsof silty, grey, fine to medium grained limestones interbedded with red and grey-green shales and siltstones. The limestones first appear about 100 to 150 feet below the inferred base of the Wonoka Formation. Higher up the sequence, the limestone bands become thicker and the amount of red shales and silts decreases. The base of the Wonoka Formation was placed at the top of the last red clastic band.

The type section in Brachina Gorge was examined and there a similar gradational contact was observed. The lithologies and some of the sedimentary structures in both the Bunyeroo and Wonoka Formations of the type section were indentical to those in the Emu Bore Area.

(2) WONOKA FORMATION:

The Wonoka Formation was divided into two members alower silty limestone member and an upper dolomitic member. The lower member forms moderate outcrops whereas the upper member occurs as good to very good outcrops.

(i) Lower Member: As indicated above the Wonoka Formation is confomable with the Bunyeroo Formation. The lower member of the Wonoka Formation is a regular sequence of interbedded silty glauconitic limestones and grey calcareous shales and siltstones..

PLATE 2

a, b: Typical Ball-and-Pillow Structures in Wonoka Formation.

PLATE 2



a.



b.

The limestones contain silty laminae which generally show cross bedding and cut-and-fill structures. Apart from quartz and calcite, the other major minerals present in the limestones are glauconite (first recognised by Dr. B. Daily) feldspars (both microcline and plagioclase) and micas (biotite and muscovite). The feldspar and quartz grains are generally angular to subangular and this indicates a relatively close source area for these components and the glauconite occurs as equant grains, the surfaces of whichare pitted and angular and seems to fill spaces between other grains.

The calcite in these limestones is generally a fine to medium grained sparry calcite.

The limestone bands are usually thinly bedded and the thickness of the bands is variable. These limestone bands are interbedded with grey calcareous shales and siltstones which are thinly bedded and fissle and are everywhere weathered to such an extent that they outcrop only in creeks.

Numerous thin beds ofintraclastic limestone occur in the lower member; these are generally six inches to a foot in thickness and contain large, flat intraclasts (T.S.A359/15', /182'). These usually lie approximately parallel to the bedding. The percentage mineral content is often different from that of the matrix of the rock and in many cases the calcite in the intraclasts is finer grained than the calcite of the matrix (Plate: 8 a).

The boundaries of the intraclasts are irregular showingsthat they probably weren't transported very far.

In some places the limestones have a reddish colour caused by iron oxide stain on calcite grains (T.S. A359/26'). These bands are quite continuous and could possibly represent subaerial exposure of the limestone for a short time.

Various types of sedimentary structures were observed in the lower member of the Wonoka Formation. The most common were cut-and-fill structures, cross-bedding and ripple marks. Also present were flute casts and several beds containing ball-and-pillow structures. (Plate: 1 a,b, c ; 2 a,b).
The ball-and-pillow structures had a characteristic shape in that they were fairly thick on the margins and truncated on top.

Complex folding caused by slumping was also observed.

Glauconite was separated from two samples of the limestone and looked at closely to see if there were any indications of microfossils, the shapes of which the glauconite would tend to pseudomorph. No traces were found.

The thick ness of this member in the measured section is about 520' and in the northern part of the area it is about 250' (as measured from map). i.e. a thinning of nearly 300' has occured in the space of about 11,000' along strike. The significance of this will be discussed later.

Towards the top of the lower member the amount of limestone decreases and the shales and siltstones increase - the last 40-50 ft. is nearly all shale with several thin dolomitic limestone bands.

(ii) Upper Member : In the area where the section was run and in mostother places in the map area, this member is made up of three prominent bands of dolomitized limestone interbedded with poorly outcropping clastic bands.

The dolomitized limestones are generally made up of medium to coarse grained subhedral dolomite with some calcite. The clastic content is mainly angular to subangular quartz and feldspar of silt size. Black manganese oxides are usually present and these occur as individual grains, as dendrites and filling cracks in the rocks. (T.S.'s A359/525',/590',/16,/17). Some siltstone fragments were also seen in the dolomitized limestones (T.S. A359/525').

The dolomitized limestones show great variation in colour - buff, pale grey, dark grey and pinkish. The bedding in them is poor - they generally form very massive outcrops. Ripple marks are fairly common is these bands.

Two bands of a massive, black, vuggy rock were seen in this member in the measured section. These are made up mainly of manganese oxides (especially pyrolusite), limonite and some hematite and the vugs contain small calcite crystals. These bands were parallel to the bedding and one of them had a strike length of about 150 yards.

The clastic bands interbedded with the dolomitic limestones were made up of fine to medium grained pinkish sandstones and grey-green micaceous, non calcareous shales and siltstones. Both the sandstones and the siltstones contain minor amounts of feldspar; they are thinly bedded, fairly fissile and ripple marked.

Thin discontinuous beds of coarse to very coarse

poorly sorted pebbly sandstones (subgreywackes) occur within the clastic bands - some are very thin (approx. 2" to 1' thick) (T.S. A359/671') and others are thicker and one such band is shown on the measured section. (T.S. A359/742'). These are feldspathic and the grains are subangular to rounded; Another small lense containing poorly sorted, fine to coarse, angular quartz in a calcareous matrix was also found (T.S. A359/4). All these beds are discontinuous laterally.

A thin but persistent bed of dark weathering dolomitic siltstone occurs just below the top band of dolomitized limestone (T.S. A359/1). This bed can be traced through most of the area.

The possible significance of all these beds will be discussed later under the heading of "Geological History."

(3) POUND QUARTZITE:

In the type section this unit is divided into two members - the lower member is the Red Pound and the upper member is the White Pound. In the Emu Bore Area however, the White Pound Member is almost non-existent - it is 2 to 3 feet thick in the measured section but doesn't occur elsewhere within the area.

(i) Red Pound Member: The contact between the Red Pound Member and the upper member of the Wonoka Formation is sharp and no evidence for unconformity could be found.

The lower parts of the Red Pound Member are characterised by chocolate and green coloured micaceous shales and siltstones. The green colouration is generally irregular and gives the rocks a mottled appearance. The green

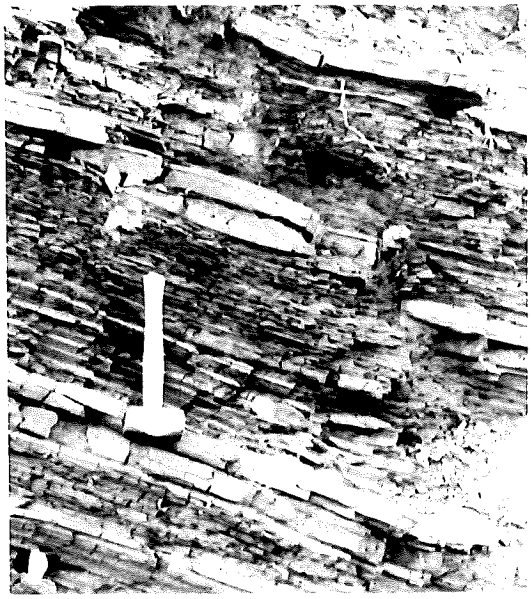
PLATE 3

a: Interbedded red shales and grey limestones in the Bunyeroo Formation just below the base of the Wonoka Formation.

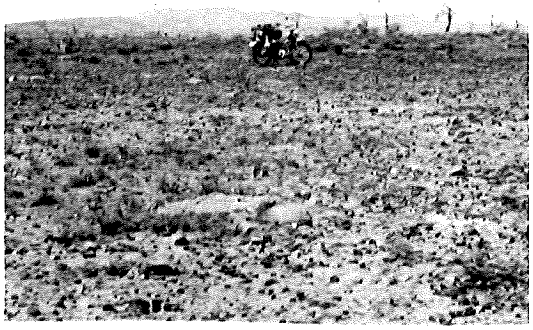
b: Typical Wilkawillina Limestone showing low, rounded outcrop.

c: Contact of Bunyeroo Formation and Wonoka Formation; the Bunyeroo Formation outcrops poorly.

PLATE 3



a.



b.



c.

colour is due to the presence of chlorite in the rock (T.S. A359/2). The red colouration is caused by iron oxide staining on and between the detrital grains. The rocks contain small amounts of feldspar, muscovite and biotite with the quartz and feldspar grains being sub-angular to subrounded indicating a limited amount of transport.

These siltstones are thinly bedded and the bedding is generally wavy and irregular. Ripple marks, cross-bedding and cut-and-fill structures are common and mud-cracks were seen in one or two places.

Some thin bands of pale grey, fine grained sand-stone are interbedded with the red coloured sediments.

Near the base of the member is a one to two feet thick bed of fine to medium grained, yellow-brown, silty dolomite (T.S. A359/3) and one or two other dolomitic bands which are more weathered and are dis-continuous. The yellow-brown bed forms a very good marker horizon and can be found in most parts of the area where Red Pound sediments are present. It has also been noted by J. Gehling in his area further south (Pers. Comm.). A bed with similar lithology was also seen in the type section in Brachina Gorge.

The dolomite is very even grained and is probably penecontemporaneous to early diagenetic. The brown colouration is caused by limonite between the dolomite grains.

The green colouration in the lower sediments of the Red Pound is absent higher up and the sediments here are slighly coarser than those below and they also have a lighter colour (T.S. A 359/850').

They are still thinly bedded and are interbedded with chocolate siltstones (T.S. A359/855').

Fairly thick beds of white to pale buff fine grained micaceous subarkoses are found in the Red Pound Member. One of these is persistent and was mapped out.

The upper parts of the Red P6und Member are made up of interbedded chocolate, red-brown and mauve coloured coarse siltstones(T.S. A359/1160'), and fine sandstones. These are thinly bedded and micaceous and some bands have a flaggy appearance (T.S. A359/1200').

A thin bed of rock made up mainly of fine grained limonite stained calcite and poorly sorted quartz, feldspar and rock fragments was found in places in the Red Pound. This bed was about 1 foot thick and discontinuous along strike. (T.S. A359/6).

Clay galls, ripple marks, cross bedding and current lineations are common sedimentary structures in this member.

As with the Wonoka Formation, the Red Pound Member thins towards the north from about 600 feet in the region of the measured section to about 250 feet at the northern end of the area.

(ii) White Pound Member: The maximum thickness of this member in the Emu Bore Area is 3 feet and it lenses out laterally from the measured section area.

The rock is a well sorted orthoquartzite containing subangular to subrounded quartz grains of fine to medium

sand size. These show secondary overgrowths. Minor amounts of feldspar, biotite and opaques are also present (T.S. A359/1330'). The unit is medium bedded and ripple marked.

Its thinness is probably the result of a period of erosion before deposition of the overlying Parachilna Formation. i.e. a disconformity exists between the Pound Quartzite and the Parachilna Formation.

(B) CAMBRIAN ROCKS:

The Cambrian System in the Emu Bore Area comprises the Parachilna Formation, the Wilkawillina Limestone and the Lower parts of the Billy Creek Formation. Both the Parachilna Formation and the Billy Creek Formation are not shown for the Emu Bore Area on the Parachilna 4 mile sheet compiled by Dalgarno and Johnson in 1963 and 1964.

(1) PARACHILNA FORMATION:

This is generally a very poorly outcropping unit of argillaceous sandstones. The sand fraction varies from fine to coarse grained and is generally subrounded to rounded. A small quantity of feldspar is present in the Formation. The clay content is variable, some rocks containing almost no clay (T.S. A359/7). The Formation is generally white to yellow coloured and often contains secondary gypsum. Most of the sediments are so leached that they crumble very easily.

No specimens of Diplocraterion were found in the Emu Bore Area but they are found further south where the sediments outcrop slightly better. (Pers. Comm. - F. Gaunt.)

The maximum thickness of the Parachilna Formation in the Emu Bore Area is 30 ft. as against 80 ft. in the KennesBore Area (Pers. Comm. - F. Gaunt) and 50 ft. in the Reaphook Hill Area (Pers. Comm. - J. Gehling).

The Parachilna Formation is overlain conformably by the Wilkawillina Limestone.

(2) WILKAWILLINA LIMESTONE:

The Wilkawillina Limestone in the Emu Bore Area is 942 ft. thick where the measured section was run. Outcrop is generally moderate and consists mainly of low, rounded outcrops that project a few inches above the soil. Bedding was usually difficult to find. Most of the Wilkawillina Limestone in the area occurs in a broad syncline, the eastern limb of which is truncated by a large fault.

In the Emu Bore Area the whole interval between the top of the Parachilna Formation and the base of the Billy Creek Formation is represented by three distinct types of limestone which are grouped together under the formational name of Wilkawillina Limestone and which will be discussed in detail below. However, in the type section in Wilkawillina Gorge, the same interval is represented by Wilkawillina Limestone, Parara Limestone, Bunkers Sandstone and Oraparinna Shale. At this point it is stressed that this interval has little time significance because of the lack of fossils useful for correlation. In the type section the top of the Wilkawillina Limestone corresponds closely to the last appearance of the phosphatic brachiopod, "Micromitra" etheridgei and from this it is inferred that the time between the top of the

"Micromitra" and the base of the Billy Creek Formation in the Emu Bore Area is approximately equivalent to the time represented by the Parara Limestone, Bunkers Sandstone and Oraparinna Shale in the type section. Thus large scale facies changes occur between the typesection and the Emu Bore Area.

The sequences in the Rearhook Hill and Kempes Bore Areas are similar to the Emu Bore Area (Per. Comm. J. Gehling and F. Gaunt).

(i) Lower Unit: The lower 300 feet of the formation is a dolomitized to slightly dolomitic limestone and no fossils were found in this part. These rocks are generally slightly silty or sandy and the clastic grains are angular. (T.S.'s A359/1370',/1540',/1550'). The dolomite and calcite grains are anhedral to subhedral in most of the rocks and vary from fine to coarse grained over this part of the sequence, but in any given rock they are usually very even grained.

These rocks generally have a buff to dark grey colouring which is caused by varying amounts of limonite, siderite and black manganese oxides. The colouring is often patchy and this gives a mottled effect. Many of the rocks in the lowest parts of the formation have very dark weathered surfaces due to the development of manganese oxides on them.

Some degree of silicification has occurred right through the formation but it is more common in this lower dolomitized unit. The silicification results in the development of red, siliceous masses, irregular in shape, on the exposed surfaces of the rocks.

These dolomitized limestones are often vuggy and the vugs are completely filled with coarse, sparry calcite.

Some bands of almost undolomitized limestone are present (T.S.'s A359/1584',/1590',/1600'). Some of these contain many patches of sparry calcite and could be classed as "birdseye" limestones, as they posses a typical fenestral texture.

The rocks of this dolomitic unit are medium to thickly bedded and form massive outcrops; very few sedimentary structures were seen - just some occasional ripple marks.

The middle and upper parts of the formation are essentially undolomitized or patchily dolomitized; they are fossiliferous and contain little in the way of manganese oxides on the weathered surfaces. Some silicification has occurred but not as much as in the lower unit.

(ii) Middle Unit: The rocks of this part of the formation are generally pale grey to pinkish sparry limestones, made up of anhedral, medium to coarse grained calcite with very little clastic content.

Bedding is medium to thick but is difficult to see.

Most of the rocks in this unit are at least slightly vuggy and the vugs are completely filled with very coarse calcite.

The first fossils to appear are Archaeocyatha and these have been recrystallized to coarse, sparry calcite (T.S. A359/1780'), and occasionally they are silicified.

The next fossils to appear are "Micromitra"

etheridgei and these first appear 50 to 70 feet above the first Archaeocyatha. The "Micromitra" band is about 140 to 180 feet thick and was mapped out. These fossils were usually quite easy to see because in most cases they weathered out at the surface, even in some extensively recrystallized rocks. (H.S. A359/19N). Both Archaeocyatha and shell fragments of other types of brachiopods were seen in the "Micromitra" band.

Above the last "Micromitra" in this middle unit are about 350 ft. of limestones containing Archaeocyatha, hyolithids and some brachiopod fragments. The total thickness of the whole middle unit is about 400 feet.

(iii) Upper Unit: The upper unit of the Wilkawillina Limestone is mainly made up of "birdseye" limestones of which about 200 ft. occur. (T.S. A359/2170'). These limestones are medium to coarse grained, mauve to white coloured and medium bedded and the birdseye structures are made up of coarse to very coarse sparry calcite. The unit is unfossiliferous.

Bands of intraclastic and oolitic limestone were found within this unit as well as occasional thin limestones with no birdseye strucutres. The intraclasts are well rounded and the oolites are usually very faint.

The very top of the Wilkawillina Limestone is made up of 20 to 30 feet of a yellowish, weathered sandy limestone (T.S. A359/2290'). Very faint remains of Archaeocyatha and hyolithids were seen.

Above come the clastics of the Billy Creek Formation. The contact in the Emu Bore Area was very poorly exposed so no reliable decision could be made as to whether or not it was conformable; however, in the KempesBore Area,

PLATE 4

a: View of part of the diapir showing a large dolomitic limestone raft and the typical light coloured sediments associated with the diapir.

b: Sheared limestone and basic igneous rock associated with the diapir, (the igneous rock is on top of the sheared limestone).

PLATE 4

a.



b.



the contact is locally unconformable and therefore a similar relationship could exist in the Emu Bore Area. (Pers. comm. F. Gaunt)

(3) BILLY CREEK FORMATION:

This unit outcrops poorly and the only occurrence is in the core of the broad syncline in the upper half of the area. Only parts of the basal beds could be seen and these are made up of red to grey-green finely laminated, slightly calcareous, micaceous shales and siltstones. These are interbedded with some thin, fine grained sandstones and grey, fine grained, silty dolomites. (T.S. A359/2505'(a),/2505'(b)). Some ripple marks were seen.

Pistachio green shales similar to those found in the more southern areas occur in the float but no outcrops could be found.

(c) DIAPIRIC ROCKS:

A diapiric body was discovered by Dr. B. Daily in the company of the author, F. Gaunt and J. Gehling.

This body is situated on the eastern side of the area along a major fault. The diapir has an outcrop length of about 4000 feet. and its maximum width is about 400 feet; it tapers towards the south but its northern limit can't be seen because of lack of outcrop.

The main feature of the diapir is the calcareous breccias which are composed of angular fragments of reddish to yellow shales and siltstones and dolomitic limestones in a calcareous matrix. (T.S. A359/12) (Plates 5a,c ; 7b).

PLATE 5

a: Calcareous breccia in the diapir showing a large, angular siltstone fragment.

b: Thin sideritic (?) vein cutting across Bunyeroo Formation sediments. The vein is associated with the diapir and is unaffected by the fold phase which folded the Bunyeroo sediments i.e. it was emplaced after folding.

c: Calcareous breccia showing banding.

PLATE 5



a.



b.



c.

Also associated with the diapir are rafts of pinkish to buff dolomitized limestone (T.S. A359/10) and patches of basic igneous rocks (T.S.'s A359/9, /11,/14,/19,/20). These basic rocks are all altered, the feldspars being converted to sericite and the pyroxenes to amphiboles. Patches of buff coloured, sheared limestones were also found in places. (T.S. A359/13) , (Plate 4b).

Thin veins, probably related to the diapir, were found in the sediments of the Bunyeroo Formation to the east of the diapir. One such vein, made up mainly of concretionary siderite (?), was seen to cut across folded Bunyeroo sediments, the vein itself being unfolded implying that it formed after the folding. (T.S. A359/17 ; Plates 5b, 7c) This fact and the absence of diapir-effected sediments in the area implies that the diapiric activity was fairly late in the history of the area.

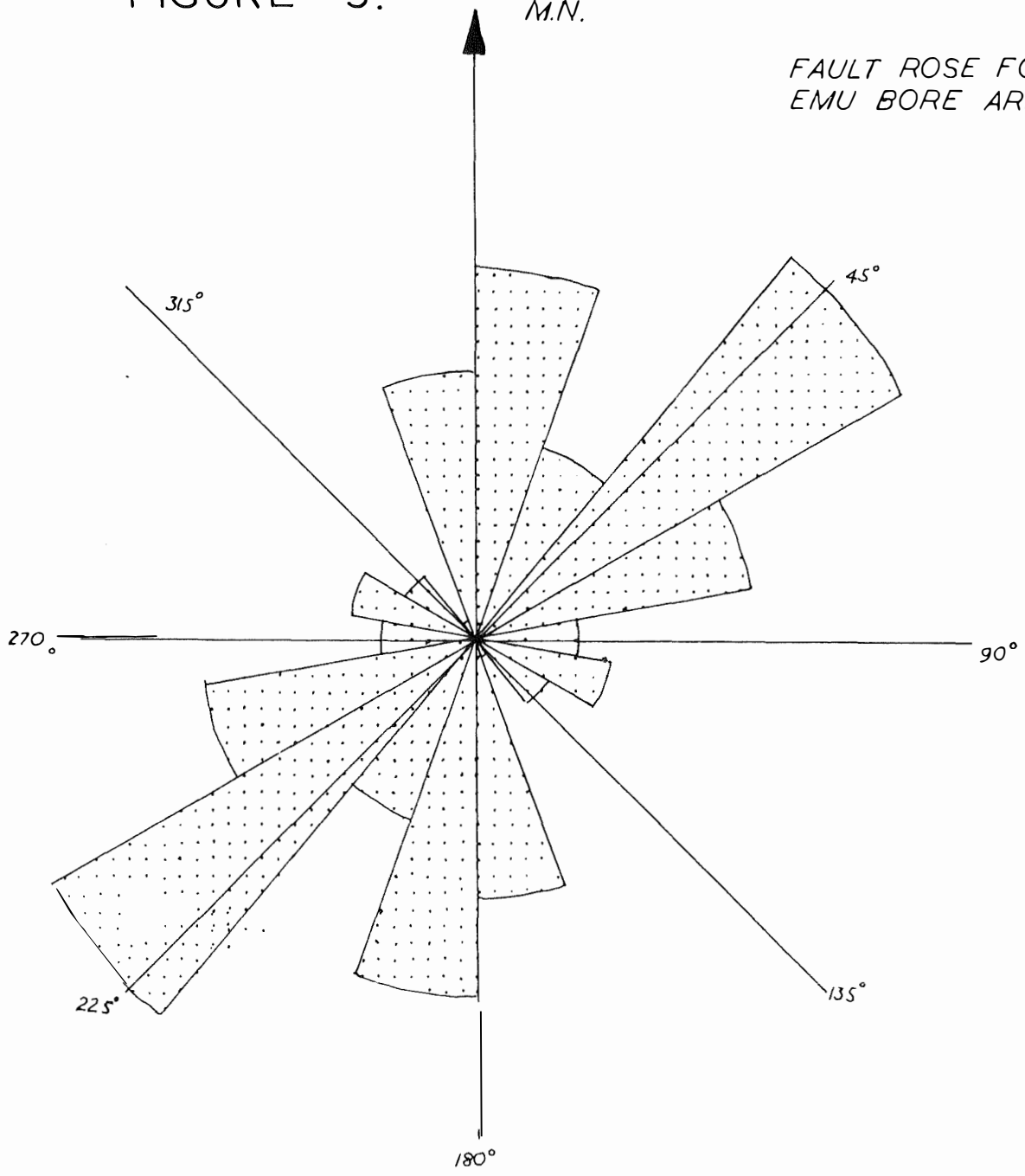
STRUCTURE:

The sediments in the Emu Bore Area have undergone both folding and faulting.

Both the Bunyeroo and Wonoka Formations are folded into fairly small, tight folds adjacent to the diapir and these plunge at about 30° - 35° towards about 60°. The folding is more intense in this region near the diapir than anywhere else - this may be due to the presence of a large fault with which the diapir is associated. The Pound Quartzite is also fairly tightly folded in places, for example, just to the north of the vermin proof fence.

Elsewhere the folding is more open.

FIGURE 3.



FAULT ROSE FOR EMU BORE AREA

The Wilkawillina Limestone and the sediments below it form a broad syncline in the northern half of the area. The dips of the limbs are moderate (35° - 45°) and the structure plunges gently to the N. N. E.

Quite a lot of faulting has occurred in the area - there are numerous small faults and several larger ones. Most of the small faults on the western limb of the broad syncline finish in the Pound Quartzite. No evidence for faulting during deposition was found here - the Pound Quartzite was probably incompetent enough to take the stresses without fracturing.

A fault-rose was drawn for the area and two distinct trends can be seen - one between 0° and 20° and the other towards about 45°. Similar trends were obtained for the Reaphook Hill and Kempes Bore areas (Pers. comm. J. Gehling, F Gaunt).

The two main directions lie approximately symmetrically about the fold axis of the syncline and this pattern suggests that the folding and faulting are related.

MINERALIZATION:

Minor amounts of mineralization were found in various places around the area.

Thin coatings of malachite on bedding planes and in fractures were found in the Bunyeroo Formation about 100 feet below the base of the Wonoka Formation in the creek where the measured section was run (fig.2). This is of secondary origin. Malachite mineralization was seen also in the diapir, especially in the calcareous breccias. Some rocks contained up to 5p.c. malachite (visual estimate).

Quite a lot of hematite is associated with the diapir - this occurred mainly as small veinlets in the rocks and was mainly made up of specular hematite.

Small veins of barytes were also associated with the diapir.

Manganiferous rocks occur near the top of the Wonoka Formation and at one place a band up to 10 feet. thick and 150 yards long, forms a black, massive, finegrained outcrop. Limonite and manganese oxides are the main constituents of this rock with minor amounts of hematite.

The base of the Wilkawillina Limestone is also manganiferous.

GEOLOGICAL HISTORY:

The red beds ofthe Bunyeroo Formation probably represent a period of marine regression i.e. they were deposited in shallow water. This water was generally moderately turbulent as is evidenced by the presence of ripple marks and wavy bedding; however, there were periods when deposition was non-turbulent and this led to planar beds being deposited. Because of the rarity of mafic minerals inthe rocks and the angularity of the iron oxide grains it is implied that the red colour resulted from in-situ alteration of mafics such as hornblende and biotite to give red iron oxide pigment (Walker, 1967). This process requires a well oxygenated environment which would be provided by the very shallow water.

The thin grey laminae present could result from

a lack of original hornblende or an effecient winnowing out of the hornblende from these bands, or just by leaching out of the red colour.

The top of the Bunyeroo Formation is marked by interbedded limestones and red clastics which would have formed as a result of a series of minor rises and falls in sea level. These represent the start of a transgression during which the Wonoka Formation was deposited. The onset of the transgression was very gradual as is seen by the fact that the interfingering zone in quite thick and the periods of red bed deposition gradually decrease until a stage is reached when no more red beds are deposited.

The clastic rich beds in the Wonoka Formation represent periods of increased detrital sedimentation in the basin and these alternate with limestones which formed when detrital sedimentation was less. The angularity of the grains in this and higher formations suggest that the source is relatively near and the reasonably high fresh feldspar content also points to this conclusion. The feldspar content also suggests that the source is some sort of igneous or metamorphic rock.

One of the main features of the Wonoka Formation is its richness in glauconite which proves that the rock was deposited in a marine environment. A recent paper by Porrenga (1967) shows that present day glauconite is most common between depths of 30m. and 700m. at temperatures greater than 15°C. The sedimentary structures in the Wonoka Formation (ripple marks, cross bedding, cut-and-fill, flute casts, ball-and-pillow structures and intraclasts) indicate a fairly turbulent environment right through the lower member of the formation and this in turn seems to imply a reasonably

shallow depth.

Thus it is likely that, for the most part, the lower member of the formation was deposited in fairly shallow waters.

Thin, persistent bands of red limestone are found in the area and these could represent brief periods of subaerial exposure.

The thinning of the Wonoka Formation (and the Pound Quartzite) towards the north of the area could be due to a local high in the depositional basin and this may or may not be related to diapiric activity. A definite reason for the thinning would be hard to give because of lack of evidence, but the fact that a diapir is present in the area does favour this explanation.

The extensive dolomitization in the upper member of the Wonoka Formation indicates the onset of restrictive conditions in the depositional environment. i.e. a shallowing of the seas and/or the formation of some sort of a barrier to the free circulation of water. (Fairbridge, 1957). The dolomite is probably penecontemporaneous to early diagenetic. The lack of dolomite in the interbedded shales and silts probably represents periodical freshening of the waters which would result from an increased runoff from the land (or break down of the barrier). The increased clastic content seems to point to the former explanation as the more probable one.

The pebbly sandstones in this member could represent local stream deposits.

The manganiferous rocks probably formed by later

oxidation of manganese rich sediments, the manganese ions being converted to manganese oxides (Krauskopf, 1967).

This upper member is probably the beginning of a regression which later led to the deposition of the Red Pound Member.

The sedimentary structures in the Red Pound Member indicate that deposition occurred in a fairly turbulent environment. Some of the structures such as clay galls and the occasional mudcracks indicate that the water was extremely shallow. These sediments could have been deposited in a deltaic type environment. The red iron oxide colouration, as discussed previously, is probably due to in-situ alteration of mafic minerals. The absence of detrital mafics and the lack of rounding of the iron oxide grains supports this hypothesis.

The thin dolomite band near the base signifies the formation of a restricted lagoonal environment for a brief period of time. The interbedded light coloured to white sandstones and siltstones show that short periods of efficient winnowing by currents of the incoming sediments occurred - i.e. the mafic rich detrital grains were winnowed from the sediment and therefore no red colour could develop. These lighter coloured bands are more prominent in the southern and central parts of the area and the bands that were mapped thin towards the north.

As indicated previously the White Pound Member is almost totally absent from the area. It is still part of the shallow water regressive sequence and its thinness is probably the result of a period of erosion before the trangression which resulted in the deposition

of the Lower Cambrian rocks. i.e. a disconformity exists between the Pound Quartzite and the Parachilna Formation.

The Parachilna Formation is the basal bed of the Lower Cambian transgression and it is a shallow water, near shore deposit.

The lower dolomitized parts of the Wilkawillina Limestone represent a restricted, possibly lagoonal environment suitable for dolomite formation. The even grain size of the dolomite within particular bands seems to suggest that it was penecontemporaneous to early diagenetic in origin. This lagoonal environment was interrupted for short intervals of time by periods of supratidal deposition and less restricted deposition as is shown by the interbedded birdseye limestones and undolomitized limestones.

The dolomitization in the rest of the formation is patchy and this suggests a later diagenetic effect.

The faunal assemblage (Archaeocyatha, "Micromitra"; hyolithids) and mineralogy of the middle parts of the formation indicate a shallow, clean, well oxygenated environment swept by gentle winnowing currents which removed any fine carbonate mud. The fact that there was little turbulence is suggested by the almost total lack of oolitic andintraclastic bands.

A shallowingof the waters later on is indicated by the fairly thick development of birdseye limestones which are thought to form in an intertidal to supratidal environment (Shinn, 1968). An increase in water agitation occured also in this time because both oolites and intraclasts were found here.

An increase in clastic intake occurred towards the

end of the transgressive phase and this heralded the start of another major regression during which the Billy Creek Formation was deposited.

The diapiric activity may have started in the Upper Proterozoic if the thinning of the sediments can be attributed to this cause; however, at no time during sedimentation was the diapir exposed to erosion - no debris attributable to a diapiric source was found in the sediments. The present exposure of the diapir resulted from movement along a major fault fairly late in the area's history.

The exact age of the folding and faulting can't be determined but it occurred well after sedimentation had ceased.

CONCLUSIONS:

The whole sequence from Upper Proterozoic to late Lower Cambrian is a shallow water sequence marked by periodsof regression and transgression. All evidence points to the fact that diapiric activity occurred fairly late in the area's history.

From the economic point of view the only viable prospect is in the region of the diapir where most of the mineralization was seen. A reconnaissance sampling survey could be done in this area to evaluate its worth.

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Appendix 1

Description of Measured Section.

Pictorial representation of section in pocket at back.

0' - 15' : Grey fine to medium grained, silty glauconitic limestone; thinly bedded. Interference ripples in places and some crossbedding. These limestones are interbedded with grey-green, thinly bedded, micaceous calcareous shales showing cross bedding in places.

15' - 15'6" : 6" thick band of intraclastic limestone containing large flat pebbles approximately parallel to bedding.

15'6" - 26' : Thinly bedded, poorly glauconitic silty limestones interbedded with grey calcareous shales. Maximum thickness of each individual band of limestone and shale is about 6".

26' - 27' : Thin band of fine to medium grained, brownish coloured limestone.

27' - 46' : Interbedded grey-green thinly bedded calcareous shales and grey, silty glauconitic fine to medium grained limestones. The various interbeds vary in thickness from 2" to 2'. Cross bedding and ripples common.

46' - 46'6" : Thin intraclastic limestone band; pebbles less glauconitic than matrix material.

46'6" - 50' : Glauconitic silty limestone.

50' - 50'6" : Intraclastic limestone.

50'6" - 55' : Glauconitic silty limestones and calcareous silty shales with thin intraclastic band at 55'.

55' - 58' : Glauconitic silty limestones and grey calcareous shales.

58' - 59' : Intraclastic limestone.

59' - 78' : Interbeds of calcareous shales and silty glauconitic limestones. The limestone beds are thin.

78' - 125' : The limestone interbeds are thicker in this interval (up to 1 ft. thick).
Cross bedding, wavy bedding, cut and fill structures.

125' - 126'6": Fine grained, thinly bedded glauconitic limestone showing ball and pillow structures.

126'6" - 182': Interbedded calcareous shales and siltstones and glauconitic medium to fine grained silty limestones. The alternate beds are thin.
Thin intraclastic band at 146'.

182' - 206' : As before but limestone interbeds are thicker - 2' to 2'6".
Minor slumping at 182!
The limestones are generally very glauconitic.

in this part of the section.
Between 189' & 190' is a band containing small ball and pillow structures.
Between 198' and 200'6" is a band of larger ball and pillow structures.
Some of the limestone bands in this sequence contain very complex slump folds and complex bedding.

206' - 214' : Band of thinly bedded, glauconitic silty limestones with no interbedded calcareous shales.
Thin intraclastic band at 211' and just above this is a band of red limestone.

214' - 320' : A sequence of equal amounts of fine grained slightly glauconitic silty limestones and thinly bedded calcareous shales and siltstones.
The limestone interbeds are up to 1'6" thick and they are thinly bedded with silt laminae.
Several thin intraclastic bands are present.
Also cross bedding, wavy bedding and ripples.
A 1'6" band of reddish limestone occurs at 226'.
Ball and pillow structures were found at 223', 231' & 293'.
A 2ft. thick intraclastic band occurs at 259' and another thinner band at 267'.

320' - 339' : This sequence of calcareous shales and silty limestones contains more limestone than shale. Rock types basically same as before.

339' - 350' : Interbeds of silty limestone and calcareous siltstones with about equal amounts of limestone and silt.
The limestone interbeds are up to about 1 ft. thick.
Some intraclastic bands.

350' - 450' : Same rock types but the calcareous silts predominate over the limestones.

450' - 459' : Pale buff speckled, fine to medium grained, silty, slightly glauconitic dolomitized limestone.
Thinly bedded.

459' - 517' : Grey-green, non calcareous, silty shales, interbedded with thin silty limestones.
Also some interbeds of pinkish, silty, dolomitized limestone.

517' - 558' : Fine to coarse grained, speckled, sandy dolomitic limestone; fairly finely laminated.
Colour varies from pale buff to grey.

558' - 588' : Sequence of interbedded pinkish to buff speckled medium grained quartzites and pink to yellowish siltstones and fine sandstones.

Both the quartzites and the silts are thinly bedded.
Cross bedding and ripple marks are common.
The siltstones are fissile but the quartzites form more solid outcrops.

588' - 661' : Medium grained buff to grey coloured sandy dolomitic limestone.
Thinly bedded but very massive in outcrop.
Cross bedding fairly common.
At 631' is a black, fine grained manganiferous rock which forms a discontinuous outcrop.

661' - 721' : Sequence of fine to medium grained, pinkish micaceous sandstones and siltstones.
These are thinly bedded and fairly fissile.
Ripple marks common.
At 671' is a 2" thick discontinuous band of a very coarse grained, calcareous sandstone.
Contains rounded quartzgrains in a carbonate matrix.

721' - 725' : Medium grained pale buff dolomitic siltstone with very dark weathered surfaces. Fairly thinly bedded but forms massive outcrops.

725' - 740' : White, fine grained, slightly calcareous sandstone.
Fairly thickly bedded; bedding planes wavy.

740' - 744' : Pebble band with well rounded medium to very coarse quartz pebbles in a calcareous matrix. No bedding discernible.

744' - 753' : Black to brown mass of manganiferous rock. Also contains limonite and hematite. Fairly vuggy with calcite lining the vugs.

753' - 759' : Poorly outcropping dolomitic limestone. Pink to pale buff coloured and speckled.
Fine to medium grained and thin to medium bedded.

759' - 846' : Chocolate and green coloured micaceous shales and siltstones. The green colouration is due to chlorite in the rock and is a secondary effect - it gives the rock a mottled appearance. Thinly bedded and very fissile. Bedding generally wavy.
Some interbeds of fine grained, pale grey, thinly bedded, sandstone are present.
Thin dolomite bands occur at789', 809' & 839'. The ones at 789' & 839' are about 6" thick and very weathered whereas the one at 809' is 1 ft. to 1'6" thick and is yellow-brown in colour, contains black speckles and is fine to medium grained.

846' - 1035' : Reddish brown, fine grained micaceous sandstones and siltstones with very little green colouration in the rock.

Thinly bedded; bedding planes wavy; ripple marks.
Interbedded with thin, dark chocolate, siltstones and red-brown quartzites showing current lineations.

1035' - 1053' ; White to pale buff, fine to medium grained, medium bedded sandstone. Some bands have heavy mineral laminae. Faint current lineations and ripple marks.

1053' - 1085' : Chocolate, micaceous, thinly bedded siltstones poorly outcropping.

1085' - 1135' : White to pale buff, fine to medium grained, finely laminated sandstone with some heavy mineral laminae. Numerous clay galls & ripple marks and some current lineations. Some cross bedding.

1135' - 1150' : White, fine grained micaceous sandstone more fissile than previous white sandstone. Large interference ripples on bedding planes.

1150' - 1191' : Chocolate coloured micaceous siltstones interbedded with very deep mauve coloured micaceous siltstones.
Thinly bedded; fissile.
Clay galls present.
At 1176' is a 6" thick band of red-brown silty - fine sandstone that slabs easily

along bedding planes. The red colour is leached out at the edges of slabs of the roc

1191' - 1329' : Sequence of red-brown to mauve coloured micaceous coarse siltstones and fine sandstones.
Thinly bedded with flaggy appearance.
Some thin interbedded white (possibly leached) fine grained sandstones.

1329' - 1332' : White, fine to medium grained quartzite.
Medium bedded and ripple marked.

1332' - 1363' : Medium to coarse grained white, friable, argillaceous sandstone. Very weathered - weathers to white and yellow clayey material.

1363' - 1538' : Dark grey to pink medium grained dolomitic limestone. Forms massive outcrops and is thinly bedded inplaces.
Bedding wavy.
Vuggy and intraclastic in places.

1538' - 1541' : Fine to medium grained, dark grey dolomitic limestone. Vugs filled with calcite.
Massive outcrop.

1541' - 1583' : Yellow and grey mottled fine to medium grained slightly dolomitic limestone. Vugs filled with coarse sparry calcite.
Massive outcrop; bedding irregular.

1583' - 1585' : Very fine to fine grained pinkish vuggy limestone. Sparry calcite in vugs.

1585' - 1660' : Fine to medium grained slightly dolomitic limestone; mauve to pink coloured. Generally very vuggy with sparry calcite in vugs.

1660' - 1667' : Archaeocyatha in a limestone similar to that between 1585' to 1660'.
The archaeocyatha are poorly preserved.
Recrystallized.

1667' - 1745' : Same rock type but few fossils present.
Micromitra appear at 1685'.
These fossils weather out at the surface of rocks.

1745' - 1775' : Fine to medium grained pink to grey mottled limestone. No fossils.

1775' - 1819' : Archaeocyatha and Micromitra.
Medium to coarse pinkish limestone.

1819' - 1849' : Few fossils; some brachiopod shell fragments.
Medium to coarse grey to buff limestone.
Slightly dolomitic.
Coarse calcite in vugs.

1849' - 1853' : Medium to coarse, pale pinkish to almost white limestone with Archaeocyatha and brachiopod fragments. The last Micromitra occur at 1853'.

1853' - 1904' : Medium to coarse grained, buff to grey limestone (slightly sandy).

1904' - 1914' : Pink, medium grained, sandy limestone with Archaeocyatha and Hyolithids.

1914'- 1953' : Medium to coarse grained, buff to grey coloured vuggy limestone containing brachiopod fragments.
Coarse sparry calcite in vugs.

1953' - 2031' : Unfossiliferous, light coloured, fine to medium grained limestone.
Massive and thickly bedded.

2031' - 2033' : Fine grained, mauve limestone with faint traces of Archaeocyatha and Hyolithids.

2033' - 2094' : Pinkish, medium to coarse grained limestone with Archaeocyatha and Hyolithids. More abundant near the lower part of this particular footage.

2094' - 2134' : Medium to fine grained pale pink to pale mauve birdseye limestone.
Coarse sparry calcite fills the elliptical "eyes" in the limestone. These eyes are parallel to the bedding.

2134' - 2142' : Medium to coarse intraclastic and oolitic limestone.

2142' - 2219' : Pink to mauve birdseye limestone. Fine to medium grained lower down and very fine to fine grained higher up.

2219' - 2225' : Fine grained white vuggy limestone with coarse calcite and siderite in the vugs.

2225' - 2286' : Fine to medium grained mauve to whitish limestone with coarse calcite in elliptical birdseye structures parallel to bedding.

2286' - 2299' : Buff coloured, sandy, medium to coarse grained limestone. Very weathered.

2299' - 2303' : Pale buff to mauve coloured, fine to medium grained limestone containing Archaeocyatha and Hyolithids.
Intraclastic in places - small, round intraclasts.

2303' - 2305' : Weathered, yellow to white, medium to coarse grained sandy limestone.

2305' - 2307' : Greenish-yellow, medium to coarse grained pebbly, well weathered sandstone.
Contains rounded quartz pebbles.

2307' - 2538' : Only patchy outcrop in this interval and no outcrop beyond 2538'. Where outcrop occurs, it is made up of red and greenish micaceous shales and siltstones. These are thinly bedded and part fairly easily along the bedding planes.

At 2505', 2536' and 2538' are thin bands of fine grained dolomite. These are grey to buff coloured.

APPENDIX 2

Descriptions of thin sections and hand specimens

Some of the sections and rocks were stained with Alizarine Red-S (A.R.S.) and/or with a mixture of Potassium Ferricyanide (P.F.)and A.R.S. Calcite stains pink with A.R.S. but dolomite remains unstained. With A.R.S. & P.F. mixture Calcite stains pink, ferroan calcite blue, dolomite unstained and ferroan dolomite turquoise.

List of hand specimens and thin sections handed up with thesis:-

Rocks not on measured section:-

T.S. No.	H.S. No.
A359/1	10
2	14
3	15 (stained)
4	21A
5 (stained)	23
6	25
7	33
8	34
9	67
10(stained)	68
11	68(b)
12	69
13	70(a)(stained)
14	70(b)
15(stained)	71
16(stained)	72
17	73
18	74
19	75
20	78

Rocks from measured section:

The numbers refer to distance of rock from base of Wonoka Formation.

T.S. No.	H.S. No.	T.S. No.	H.S. No.
A359/2'(stained)	A8	A359/1540'(stained)	37
15'(stained)	A11	1550'	38
26'(stained)	A12	1584'(stained)	39
182'	A14(stained)	1590'(stained)	40(a)
212'(stained)	A17	1600'(stained)	40(b)
480'	A22(stained)	1640'(stained)	41
525'	A23(stained)	1750'(stained)	42
590'(stained)	A27	1780'(stained)	43
671'	A30	1920'	44(stained)
742'	A33	2040'(stained)	47
850'	A38	2150'(stained)	48
855'	A39	2170'	49(stained)
1090'	A42	2220'(stained)	51
1160'	A44	2505'(a)(stained)	52
1200'	A45	2505'(b)(stained)	53
1330'	A46	2290'(stained)	61
1370'	36	2135'(stained)	62

HAND SPECIMENS WITH NO THIN SECTIONS ACCOMPANYING THEM:-

Sample No.	Footage above base of measured section (where applicable).
A359/ 1N	
8N	
9N	
12N	
13N	
19N	
20N	
30N	
35N	
55N	
56N	2306'
57N	2315'
58N	2304'
59N	2300'
63N	1833'
64N	1849'
77N	
A3N	
A15N	203'
A18N	260'
A19N	335'
A25N	560'
A26N	565'

DESCRIPTIONS OF ROCKS NOT ON MEASURED SECTION:-

T.S. A359/1 ; H.S. 10 : Dolomitic Siltstone. (Upper Wonoka Member)

Macro: Buff coloured rock with irregular dark grey layers parallel to bedding. The dark grey layers probably secondary in nature.

Micro: Quartz: (55p.c.) Well sorted; grain size .2 to .3 mm.; angular to subangular. Grains separated by matrix. Some grains contain air bubbles and calcite (or dolomite) inclusions.

Dolomite: (40p.c.) Very fine grained matrix material between the quartz grains; subhedral. Grains have a brownish tint possibly caused by limonite.

Feldspar: (4-5p.c.) Plagioclase more abundant than microcline; angular to subangular; same size as quartz.

Muscovite (trace) Small oriented flakes.

Tourmaline (trace) Subangular; size .2 to .3 mm.

Opaques (1 p.c.) Possibly a manganese oxide. Faint bedding is discernible in the rock.

T.S. A359/2 ; H.S. 14 : Subarkose (Folk). (Lower Red Pound)

Macro : The two rocks on this slide were taken from the same location and are identical except that one is red and the other is green - these rocks were interbedded with each other.

Both rocks are thinly bedded and contain clay galls.

Micro : Quartz (75p.c.) Subangular to subrounded; grain size .05 to .2 mm. (well sorted). Grains generally interlocking - suggests secondary overgrowth.

Feldspar : (1 p.c.) Mainly plagioclase but some K-feldspar. About same size as quartz.

Biotite and Muscovite : (1 p.c.) Small flakes parallel to bedding.

Iron oxide : 20p.c. in the red coloured rock and less than 1 p.c. in the greenish rock. Angular and fine grained - coats the grains.

Chlorite : 25p.c. in the green rock and 1 p.c. in the red rock. Some of the flakes are quite large. Occurs between grains.

T.S. A359/3 ; H.S. 15 : Limonite rich, silty dolomite. (Red Pound)

Macro: Fine grained brownish-yellow rock. No stain with A.R.S. therefore probably dolomite or dolomitized limestone. Weathering has produced dendritic structures in the rock.

Micro: Dolomitized calcite and/or dolomite(85p.c.): Even grained; anhedral; grainsize .01 mm. Most grains have a brownish coating.

Quartz: (3p.c.) Angular to subangular; .05 mm.; in diameter; fairly evenly dispersed through the rock.

Opaques: (4p.c.) Irregular shaped masses between grains of other minerals. Dendritic in places - possibly manganese oxides.

Brownish Material (Limonite): (5-7p.c.) Extremely fine grained; occurs on grain surfaces.

Biotite: (1 p.c.) Irregular flakes.

Intraclasts: Relics of intraclasts present - angular boundary. Some up to 1cm. long.

T.S. A359/4 ; H.S. 21A : Calcareous grit. (Upper Wonoka Member)

Macro: Buff coloured rock partly composed of medium grained angular quartz and partly of very coarse angular quartz in a fine grained calcareous matrix.

Micro: Quartz (55-60p.c.) Size .1 mm. in one part of slide; subangular. In the other part of the slide, size varies from .5 mm. to 3 mm.; angular to subangular in this part. Inclusions of calcite, biotite, feldspar and air bubbles in the larger grains. Grains separated by matrix.

Calcite: (30p.c.) .01 - .04 mm.; form the matrix of the rock. brownish colour.

Biotite: (1 p.c.) Inclusions in quartz and small flakes in rock.

Feldspar: (3-5p.c. Equal amounts of plagioclase and K - feldspar. Same grainsize and rounding as the quartz. Inclusions of calcite, biotite and air bubbles.

Opaques: (1 p.c.) Smell irregular patches between grains.

Rock fragments: (5p.c.) Up to 1.5 mm. in size - fragments of siltstone.

T.S. A359/5 ; H.S. 23 : Dolomitized limestone. (Near base of Wilkawillina limestone)

Macro: Buff coloured, fine grained, dolomitized limestone.

Micro: Dolomite (98p.c.) Very even grained (.05 - .1 mm.) No stain with A.R.S. Buff coloured (limonite stain). Colour lighter adjacent to small cracks in the rock.

Calcite: (1 p.c.) Coarse grained; stained pink with A.R.S. occurs in vugs.

Opaques: (1 p.c.) Possibly manganese oxides - occurs in cracks in rock.

Quartz: ($\leq$1 p.c.) Small angular grains.

T.S. A359/6 ; H.S. 25 : Calcareous grit. (Red Pound)

Macro: Brownish colour with fine to coarse quartz grains set in a calcareous matrix.

Micro: Quartz (20 - 25p.c.) Poorly sorted - grainsize .05 to 2 mm.; angular to subangular; biotite and calcite inclusions. Most grains separated by matrix. Thin, wavy, parallel quartz rich bands cross the slide at intervals and these tend to bend around large grains in the rock.

Rock fragments: (1 p.c.) Large elliptically shaped pieces of siltstone.

Feldspar: (2p.c.) Same grainsize as quartz. Sericite occurs in cracks in these grains.

Brownish material: (70p.c.) Possibly limonite or brown calcite. Very fine grained. Forms the matrix material of the rock.

Opaques: (4 - 5p.c.) Irregular masses.

Biotite: (1 p.c.) Small flakes.

T.S. A359/7 ; H.S. 33 : Subarkose (Folk) (Parachilna Formation)

Macro: The rock shows reasonable sorting and is made up of coarse, rounded quartz grains with some calcite cement between the grains.

Micro; Quartz: (90 - 93p.c.) .2 to 1 mm., in size. Subrounded to rounded. Some have secondary overgrowths and others show undulose extinction. Some are recrystallized to a mosaic of interlocking fine to medium quartz grains.

Feldspar: (2 - 3p.c.) Both plagioclase and microcline; grainsize .2 to .5 mm.; subrounded to rounded.

Cement: (5p.c.) Very fine grained calcite.

Biotite: (?) trace amounts.

T.S. A359/8 ; H.S. 34 : Silty microspar limestone interbedded with red calcareous shale. (Bunyeroo Formation)

Macro: The rock is fine to medium grained and contains red layers alternating with greenish layers. The rock is micaceous.

Micro: Quartz (30 - 35p.c.) .03 - .05 mm.; subangular. The red bands are more quartz rich than the grey ones.

Calcite: (40 - 45p.c.) Anhedral and fine grained; microspar.

Iron Oxide: (10p.c.) Forms a coating round the grains in the red laminae; very fine grained.

Muscovite: (10p.c.) .05 mm; flakes parallel to bedding.

Opaques: (2p.c.) Irregular grains slightly smaller than the quartz.

T.S. A359/9 ; H.S. 67 : Altered basic igneous rock. (From diapir)

Macro: Greenish, medium grained rock; very altered; no structures present.

Micro: Sericitized Feldspar (?) (15p.c.) Grains very ragged and up to 1.5 mm. in size.

Sericite: (30p.c.) Evenly dispersed through slide as small flakes.

Holes in slide: (40p.c.)

Opaques: (2p.c.) Irregular grains.

Biotite: (10p.c.) Ragged flakes up to .5 mm. in size.

T.S. A359/10 ; H.S. 68 : Altered limestone. (from Diapir)

Macro: Buff coloured, medium grained rock with (h)ematite veins through it; calcareous.

Micro: Calcite (60p.c.) Stained pink with A.R.S. Small, brownish coloured, anhedral grains; some coarser calcite in veinlets.

Feldspar: (15p.c.) Unoriented needles; size ranges from less than .1 mm. to about .7 mm. Larger ones generally ragged in appearance.

Biotite: (?) (4p.c.) Irregular yellow - brown flakes about .5 mm. in size.

Hematite: (10p.c.) Small flakes in veinlets.

Brown material on calcite grains: (10p.c.)

T.S. A359/11 ; H.S. 68(b) : Altered basic rock. (From Diapir)

Macro: Coarse grained, yellowish - green coloured rock containing feldspar, epidote and amphibole. Fairly weathered; porous.

Micro: Altered Feldspar (30 - 35p.c.) Original feldspar replaced by amphibole. Originally the feldspars were subhedral elongate grains up to 1.5 mm. long and the amphibole replacing the feldspar is about .2 mm. in size.

Amphibole: (35 - 40p.c.) Irregular green grains averaging .1 mm. in size.

Epidote: (10 - 12p.c.) Some in veinlets - anhedral to subhedral grains .1 mm. in size. Some euhedral crystals .1 mm. long.

Opaques: (3 - 5p.c.) Anhedral grains .2 to .5 mm. in size.

Chlorite: (?) (10 - 15 p.c.) Irregular flakes about same size as amphibole grains.

T.S. A359/12 ; H.S. 69 : Plate 7b : Calcareous Breccia. (From Diapir)

Macro: The rock contains angular, reddish siltstone fragments in a calcareous matrix.

Micro: Calcite (35p.c.) Subhedral; size .2 mm. to 1 mm; Inclusions of quartz, opaques and feldspar. Occurs mainly between the rock fragments.

Rock fragments: (60 - 65p.c.) Angular; great variation from fine grained to large pebble size and boulder size. Fragments of shale and siltstone and silty limestone present; buff to reddish colour. These contain quartz, muscovite and opaques. Opaque content quite high in some fragments (up to 10p.c.).

T.S. A359/13 ; H.S. 70(a) : Sheared limestone. (From Diapir)

Macro: Some small quartz pebbles in a carbonate matrix. Rock is shear banded.
A.R.S. gives rock a pink stain and A.R.S. & P.F. gives a blue stain implying presence of ferroan calcite. Rock is buff coloured.

Micro: Calcite (95p.c.) Anhedral, buff coloured; .1 to .5 mm. in size.

Quartz: (1p.c.) Anhedral grains; .1 to 1 mm. in size; some recrystallized to a mosaic of small grains. Minute inclusions.

Feldspar: (1 - 2p.c.) Subhedral to euhedral; exsolution shown by some grains; .3 to 3 mm. in size; calcite inclusions.

Opaques: (<1p.c.) Generally small irregular grains; one grain is 1.5 mm. long.

T.S. A359/14 ; H.S. 70(b) : Altered basic rock. (From Diapir)

Macro: Medium to fine grained greenish rock composed mainly of feldspar and biotite. The rock is massive and dense and contains no grains with a preferred orientation.

Micro: Plagioclase (50p.c.) Anhedral to subhedral; average size .1 by .7 mm.; simple twinning. Most are at least slightly sericitized.

Microcline: (5p.c.) Very sericitized; some up to .5 mm. across. Most occurs in thin veinlets whose margins are sericitized.

Biotite: (?) or amphibole (?) (35p.c.) Anhedral ragged grains .2 to .4 mm. in size.

Opaques: (7p.c.) Most anhedral but some subhedral to euhedral with six sided crossections (hematite ?).

T.S. A359/15 ; H.S. 71 : Dolomitized limestone. (Upper Woroka Member)

Macro: medium grained buff coloured dolomitic limestone.

Micro: Dolomitized calcite (80p.c.) Unstained by A.R.S. Fine grained; brownish coloured; appears to be intraclastic - intraclasts rounded and separated by coarser, anhedral dolomite & calcite.

Calcite: (20p.c.) Stained pink with A.R.S.; anhedral, medium grained; most occurs between the intraclasts.

Quartz: (less than 1p.c.) Angular; silt size.

Opaques: (less than 1p.c.)

T.S. A359/16 ; H.S. 72 : Dolomitized limestone. (Upper Wonoka Member)

Macro: Massive, grey, medium to coarse grained dolomitic rock.

Micro: Dolomite (85 - 90p.c.) No stain with A.R.S.; Generally coarse grained; subhedral to euhedral; pale brownish coloured; some finer grained patches.

Opaques: (10 - 15p.c.) Anhedral medium sized black grains. Tends to occur in clusters between the carbonate grains.

Quartz and silica; (1p.c.) angular, medium sized grains.

T.S. A359/17 ; H.S. 73 : Plate 7c: Concretionary rock.
(From vein in Bunyeroo)

Macro: Coarse to very coarse black rock containing semi-round concretions separated by a fine grained matrix. Angular shale and siltstone fragments and large barite and calcite crystals are also present.

Micro: Siderite (?) (70 - 75p.c.) Average 1 - 3 mm. Most are rounded with concretionary banding made up of alternate siderite and calcite.

Calcite: (15 - 20p.c.) Fine to coarse grained; anhedral; appears as irregular cross cutting veinlets and in the concretions.

Barite: (5p.c.) Several very large crystals up to 10 mm. long; peculiar mottled texture.

Rock fragments (5p.c.) Angular; red siltstone and shale fragments probably derived from the Bunyeroo Formation.

Quartz: (1 p.c.) Occurs near the rock fragments as anhedral, coarse grains.

T.S. A359/18 ; H.S. 74 : Silty limestone . (Upper Wonoka Member)

Macro: Massive, grey silty calcareous rock with some very large quartz and feldspar grains.

Micro: Quartz (30p.c.) Angular; size range .01 mm. to 1.0 mm. Inclusions of muscovite and opaques.

Calcite: (65p.c.) Fine to medium grained matrix material between the quartz grains; some coarser sparry calcite present.

Opaques: (3p.c.) Possibly hematite; angular; size range from less than .01 mm. to .2 mm. Most occur as inclusions in the quartz and calcite grains.

Muscovite: (trace) Small flakes.

Feldspar: (2p.c.) Some large pinkish grains up to 2 mm. across as well as smaller grains. Larger grains show exsolution.

T.S. A 359/19 ; H.S. 75 : Altered basic rock. (From diapir)

Macro: Medium grained green rock containing unoriented altered feldspars and amphibole.

Micro: Sericite (40p.c.) Replaces feldspar; very fine grained; the laths in which the sericite occurs vary in length from .1 mm to 2 mm. Most of the laths have ragged edges but most were originally subhedral.

Plagioclase: (1p.c.) Some unaltered plagioclase grains are still present. The original amount of plagioclase would have been about 40p.c.

Opaques: (5 - 7p.c.) Probably an iron mineral; irregular grains up to .5 mm.; some occur as inclusions within other mineral grains (amphiboles). Some occurs around relict grains and along fractures within these.

Amphibole: (45p.c.) Irregular, pleochroic grains, average size .5 mm. Inclusions of opaques. Some replace original pyroxenes (?) - euhedral outlines can still be seen.

Epidote: (3 - 5p.c.) Same size as amphibole; some occurs in the relict pyroxenes.

Chlorite: (3p.c.) Yellow - green irregular flakes.

T.S. A359/20 ; H.S. 78 : Altered basic rock. (From diapir)

Macro: Fine grained, grey-green, massive rock made up mainly of feldspar, opaques and amphiboles. Small veinlets cut through the rock.

Micro: Opaques (35 - 40p.c.) Probably iron minerals and some fluorite (?) ; generally anhedral but some are subhedral to euhedral with a square cross section. Less than .1 mm. in size. Some opaques occur as inclusions in relict feldspar crystals.

Feldspar (25 - 30p.c.) Small, unoriented needles, most being up to .5mm. long. Some have a ragged appearance. Most feldspar grains are at least partially sericitized.
The feldspars form an interlocking mat-like texture.

Amphibole: (30pc.) Generally small irregular green grains but some larger ones reach .3 mm. Some seem to have replaced pyroxene (?) - relict euhedral outlines up to 1 mm. long. Most of these relict grains are bounded by opaque minerals.

Chlorite: (3p.c.) Anhedral flakes - some occurs near veinlet.

Quartz and calcite: (4 - 5p.c.) Mainly in veinlet. Calcite seems to be replacing quartz - forms rounded patches within the quartz grains. Quartz up to 1 mm. across. Some calcite in groundmass of rock.

Epidote: (1 - 2p.c.) Yellow - green grains.

THE FOLLOWING THIN SECTIONS ARE FROM THE MEASURED SECTION:

T.S. A359/2' ; H.S. A8 : Red silty limestone. (near base of Wonoka)

Macro: Medium grained, thinly bedded red silty limestone.

Micro: Calcite (50 - 55p.c.) Stained pink with A.R.S. A mixture of A.R.S. & P.F. gave a blue stain but this is

caused by the abundant iron oxides present rather than ferroan calcite.
Calcite is fine to medium grained.

Quartz: (30 - 35p.c.) Medium to fine grained; angular.

Iron Oxides: (15p.c.) Very fine grained.

T.S. A359/15' ; H.S. A11 : Intraclastic limestone.

Macro: Grey, medium grained, silty limestone with large, flat intraclasts.

Micro: Intraclasts (35p.c.) Subrounded ; large size; material in them (mainly calcite with some quartz) is finer grained than the matrix. Stained pale blue by A.R.S. & P.F. implying presence of ferroan calcite.

Matrix: (65p.c.) Anhedral calcite and angular quartz. Also stained blue.

T.S. A359/26' ; H.S. A12 : Silty limestone.

Macro: Medium grained, massive, red,silty limestone.

Micro: Calcite (70p.c.) Fine to medium grained. Blue stain with A.R.S. & P.F. but this is probably due to the iron oxides.

Quartz: (15p.c.) Fine to medium grained; angular.

Iron Oxides: (15pc.) Very fine grained.

T.S. A359/182' ; H.S. A14 : Plate 8a (Glauconitic, silty) intrasparite.

Macro: Most of rock stained blue with A.R.S. & P.F. implying ferroan calcite; unstained parts are sandy layers. The rock is a grey limestone containing medium grained calcite and large, finer grained intraclasts.

Micro: Intraclasts (25p.c.) Elliptical cross section with long axis parallel to bedding. Up to 40 mm. long. Boundaries irregular (subrounded). Little quartz in the intraclasts (5p.c.) - mainly fine grained anhedral calcite. Opaques (1p.c. and glauconite. (1 - 2 p.c.)

Matrix: (75p.c.) Generally coarser than intraclasts. made up of fine to medium grained sparry calcite (80p.c.); medium grained, angular quartz (15 - 17p.c.); medium sized glauconite (1 p.c.) and fine grained opaques (2p.c.).

T.S. A359/212' ; H.S. A17 : Red Sparry limestone.

Macro: Medium grained, red limestone showing no bedding.

Micro: Calcite (90p.c.) Medium grained; anhedral; stained red with A.R.S. The iron oxides cause a blue stain with A.R.S. & P.F.

Quartz: (5p.c.) Medium grained; angular.

Iron Oxide: (5p.c.) Very fine grained.

T.S. A359/480' ; H.S. A22 : Microsparite.

Macro: Fine grained pale brown rock; thinly bedded; A.R.S. gives a red stain implying that the rock is made up of calcite.

Micro: Calcite (97p.c.) even grained, equant, anhedral. Size .05 to .1 mm. Grains have a thin coating of brown material.

Opaques: (2p.c.) Possibly iron oxides; anhedral; often forms bands parallel to bedding. Size .02 to .04 mm.

Quartz: (1p.c.) Same size as opaques; subangular.

T.S. A359/525' ; H.S. A23 : Silty dolomitized limestone.

Macro: A.R.S. gives no stain i.e. rock is completely dolomitized. The rock is pink to buff coloured, medium to fine grained, massive and contains stylolites.

Micro: Dolomite (85 - 90p.c.) Anhedral; average size .05 to .1 mm.; very even grained. Some coarse euhedral dolomite is also present. Cleavages in these are lined with a brownish material.

Quartz: (5p.c.) Angular; size varies from .05 to 1 mm. Some of the larger grains contain inclusions of feldspar, opaques and dolomite.

Feldspar: (5p.c.) Angular; anhedral; .05 to 1 mm. in size.

Opaques: (2p.c.) Tiny irregular grains.

Rock fragments : (?) (1 p.c.) Elliptically shaped pieces of siltstone 3 by 1.5 mm. in size.

T.S. A359/590' ; A27 : Silty dolomitized limestone.

Macro: Massive buff coloured rock cross by numerous black veinlets.

Micro: Dolomite (85p.c.) Unstained by A.R.S.; anhedral, fine to medium grained; brownish colour.

Quartz: (10p.c.) Angular; generally medium grained; tends to concentrate in hands.

Calcite: (1 p.c.) Some veinlets contain medium grained anhedral calcite.

Opaques: (5p.c.) Generally very fine grained; occurs in the veinlets that cut the slide. Possibly manganese oxides.

T.S. A359/671' ; H.S. A30 : Plate 8b : Subgreywacke (Folk)

Macro: Coarse to very coarse rock containing poorly sorted well rounded quartz pebbles up to 4 mm. across; no bedding; fairly porous.

Micro: Quartz (80p.c.) Poorly sorted; .1 - 3 mm. in size. Coarser grains well rounded but smaller ones are subangular to subrounded.
Some of the coarser grains recrystallized to a mosaic of smaller grains; undulose extinction. Most grains have secondary overgrowths in optical continuity - they are now interlocking.

Rock fragments: (15p.c.) Subrounded to rounded siltstone fragments; 0.2 to 3 mm. in size; composed of subrounded quartz grains with some calcite (?) cement.

Feldspar: (5p.c.) Plagioclase and K-feldspar present. .1 to .5 mm. in size; subrounded to rounded; fresh appearance.

Opaques: (trace)

T.S. A359/742' ; H.S. A33 : Argillaceous subarkose (Folk)

Macro: Medium to very coarse grained rock containing poorly

sorted quartz grains up to 4 mm. in diameter; no bedding.

Micro: Quartz (75p.c.) Subangular to rounded; poorly sorted; size varies from .05 to 4 mm. Some contain inclusions of feldspar and muscovite.

Feldspar: (10p.c.) Mainly K-feldspar but some plagioclase; grainsize and rounding same as for quartz; inclusions of muscovite and quartz.

Rock fragments: (5p.c.) Mainly siltstone and shale fragments; up to 1 mm. in size; subrounded.

Clay: (10p.c.) Very fine grained, brown matrix of the rock.

T.S. A359/850' ; H.S. A38: Subarkose (Folk)

Macro: Red, medium grained, dense rock with numerous sets of cross bedding. Composed mainly of quartz, biotite and iron oxide.

Micro: Quartz (85p.c.) .05 to .1 mm. in size; angular to subangular; the interlocking nature of the grains suggests that some secondary overgrowth has occured.

Feldspar: (5p.c.) Plagioclase and K-feldspar; angular to subangular; average size .05 mm.

Biotite: (5p.c.) Irregular flakes parallel to bedding. .1 mm. long (average).

Muscovite: (2 - 3p.c.) Colourless flakes parallel to bedding.

Iron Oxide: (2p.c.) Very fine grained - gives rock red colour.

T.S. A359/855' ; H.S. A39 : Plate 8c: Subarkose (Folk)

Macro: The rock is fine to medium grained and has a chocolate colour. The bedding is very wavy.

Micro: Quartz (85p.c.) Subangular to subrounded; well sorted; average size .1 mm.; stained by iron oxide.

Feldspar: (5 - 7p.c.) Microcline and plagioclase; grainsize and rounding similar to the quartz.

Hornblende and/or biotite: (3p.c.) Larger grains ragged; largest grain is about .5 mm. long; most are .3 mm. long.

Opaques: (5 - 7p.c.) Iron oxides - gives rock its red colour; angular; probably formed in-situ.

T.S. A359/1090' ; H.S. A42 : Subarkose (Folk)

Macro: The rock ismade up of medium grained quartz and has a light colour; contains clay galls. Bedding not prominent.

Micro: Quartz (85 - 90p.c.) Average size .2 mm.; even grained; subangular to subrounded; grains interlocking - probably as a result of secondary overgrowth.

Feldspar: (2 - 3p.c.) Plagioclase and K-feldspar both present. Slightly finer and less rounded than the quartz grains.

Muscovite: (2p.c.) Elongate flakes averaging .2 mm. in lengt

Apatite: (?) (trace) Rounded; grains contain fractures.

Holes in slide: (5p.c.)

Opaques: (1p.c.)

T.S. A359/1160' ; H.S. A44 : Sub arkose (Folk)

Macro: Medium grained, reddish brown rock made up mainly of quartz and feldspar; clay galls.

Micro: Quartz (90p.c.) Even grained; subangular to subrounded; size .2 to .3 mm. over most of the rock but very fine grained in the clay galls.
Some secondary overgrowth - grains generally interlocking.

Feldspar: (3p.c.) Plagioclase and K-feldspar present, generally finer grained than the quartz.

Biotite and Muscovite: (2p.c.) Elongate flakes .2 to .3 mm. long.

Opaques: (5p.c.) Very fine grained; tends to concentrate in clusters about groups of quartz grains.

Apatite: (?) (trace) Fractured grains with high relief.

T.S. A359/1200' ; H.S. A45 : Subarkose (Folk)
Two pieces of rock are mounted on this slide - one has the red colour leached out of it.

Macro: Both rocks mainly quartz; one is red and the other white; both show faint bedding.

Micro: Quartz (85p.c.) Subangular to subrounded; size .2 to .3 mm.

Feldspar: (1 p.c.) Some plagioclase and K-feldspar present in both rocks. About same grainsize and rounding as the quartz.

Biotite and muscovite: (1 p.c.) Small, irregular flakes.

Iron oxide: About 1 p.c. in the light coloured rock and 3 - 4p.c. in the reddish rock.

Holes in Slide: (10p.c.)

T.S. A359/1330' ; H.S. A46 : Orthoquartzite (Folk)

Macro: Nearly all medium grained quartz. No sedimentary structures. The rock is massive and has a very low porosity.

Micro: Quartz (95p.c.) Subangular to subrounded, average size .1 to .3 mm. Grains interlocking; secondary overgrowths; air bubble inclusions.

Feldspar: (3p.c.) Mainly plagioclase; generally finer grained than the quartz.

Biotite: (less than 1p.c.) Small flakes.

Apatite: (?) (trace) Fractured grains with high relief.

Opaques: (1p.c.) Generally very fine grained but some up to .2 mm. across.

Matrix: (1p.c.) Probably clay.

T.S. A359/1370' ; H.S. 36 : Dolomitized limestone.

Macro: Massive, buff coloured, medium grained rock with some small solution cavities.

Micro: Slide very thick to facilitate staining.
Dolomite: (95p.c.) Unstained by A.R.S.; fine to medium grained; anhedral; brownish colour.

Silica: (trace) Fills cavities in the rock.

Quartz: (5p.c.) Angular; medium grained.

Opaques: (1 p.c.)

T.S. A359/1540' ; H.S. 37 : Dolomitic limestone.

Macro: Medium grained, massive, grey rock with patches of sparry calcite.

Micro: Calcite (85p.c.) Stained pale pink with A.R.S.; anhedral; brownish colour; medium grained; some may be slightly dolomitized.
Some coarse, sparry calcite in vugs.

Dolomite: (10 p.c.) Anhedral, medium sized grains.

Quartz: (2 - 3p.c.) Angular, medium sized grains.

Opaques: (2p.c.)

T.S. A359/1550' ; H.S. 38 : Plate 6a :(Neomorphic) medium crystalline pseudospar (Folk)

Macro: Pale buff coloured rock consisting mainly of medium to finegrained calcite; some darker areas caused by manganese or iron oxides.

Micro: Calcite (97p.c.) Size generally .1 to .4 mm.; coarser patches of sparry calcite also present. Generally

anhedral; grains interlocking.

Opaques: (3 - 4p.c.) Black to brown shapeless masses on grain boundaries. Tends to concentrate in patches in the rock.

T.S. A359/1584' ; H.S. 39 : Plate 6b : Dismicrite (Folk)

Macro: Fine grained, buff coloured, massive rock with numerous patches of sparry calcite.

Micro: Calcite (90p.c.) Very even grained; medium sized; anhedral. Stained pink with A.R.S. Some coarse sparry calcite in the "birdseye" structures.

Dolomite: (5p.c.) Unstained.

Siderite: (5p.c.) Dark brown colour; euhedral; lines some of the birdseye structures.

T.S. A359/ 1600' ; H.S. 40(b) : Slightly dolomitic limestone.

Macro: Medium grained, grey, massive rock.

Micro: Calcite (95p.c.) Medium grained, anhedral, clouded with grey material; stained pink with A.R.S. Some small vugs are filled with sparry calcite.

Dolomite: (2 - 3p.c.) Euhedral rhombs.

Opaques: (2p.c.) Some are possibly siderite.

T.S. A359/1640' ; H.S. 41 : Dolomitized limestone.

Macro: Massive, medium to coarse grained, buff to grey coloured rock.

Micro: Dolomite (90p.c.) Unstained by A.R.S., medium grained, subhedral, pale buff coloured. These seem to occur as part of rounded intraclasts in the rock.

Calcite: (15p.c.) Mainly as sparry calcite between the dolomitized intraclasts - stained pink with A.R.S.

Opaques: (5p.c.)

T.S. A359/1750' ; H.S. 42 : Fossiliferous intrasparite (Folk)

Macro: Massive, grey coloured, medium grained limestone with intraclasts and fossil fragments.

Micro: Calcite (50p.c.) Stained pink; coarse to medium grained; sparry; occurs between the intraclasts.

Intraclasts: (50p.c.) Fairly well rounded; made up of fine grained calcite (stained pink). Very elongate cross sections.

Fossil fragments: Fragments of brachiopod shells.

T.S. A359/1780' ; H.S. 43 : Biosparite (Folk)

Macro: Massive, medium to coarse grained, grey, very fossiliferous limestone.

Micro: Calcite (98p.c.) Pink stain with A.R.S. The calcite is all sparry and is medium to very coarse grained. Most of the calcite is clear but some, which makes up the septa of the Archaeocyatha, is brown coloured and may be partly dolomitized.
Grains are euhedral to anhedral.

Quartz: (2p.c.) Medium sized anhedral grains.

T.S. A359/1920' ; H.S. 44 : Pseudosparite (Folk)

Macro: Buff coloured limestone with irregular patches of black minerals. A.R.S. gives a pink stain implying calcite. Rock is medium grained.

Micro: Calcite (98p.c.) Grains anhedral and equant. Average size .2 to .5 mm. Brownish material at boundaries of grains.

Opaques: (1 - 2p.c.) Small irregular grains evenly dispersed through most of the slide; more concentrated in places.

Silica: (1 p.c.) Irregular patches.

T.S. A359/2040' ; H.S. 47 : Fossiliferous, intraclastic, oosparite (Folk)

Macro: White coloured, medium grained massive rock containing Archaeocyatha and Hyolithids.

Micro: Calcite (95p.c.) Stained pink with A.R.S.; generally medium grained, anhedral. Some is very fine grained - in septa of Archaeocyatha.
Recrystallized oolites (30p.c.) and intraclasts (15p.c.) present in the rock.
The oolites are generally about .5 m.m. in diameter and the intraclasts have elliptical cross sections.

Dolomite: (3p.c.) Medium sized, euhedral rhombs.

Quartz: (2p.c.) Medium sized; angular.

T.S. A359/2150' ; H.S. 48 : Dismicrite (Folk)

Macro: Medium grained, massive, mauve coloured rock with numerous "birdseye" structures.

Micro: Calcite (80p.c.) Subhedral to anhedral; medium grained and cloudy in most of the rock but sparry in the birdseye structures.
Stained pink with A.R.S.
"Birdseyes" very irregular and elongate.

Dolomite: (20p.c.) Unstained; euhedral; medium sized.
The rock is stylolitic.

T.S A359/2170' ; H.S. 49 : Plate 6c : Dismicrite (Folk)

Macro: A.R.S. & P.F. stains rock pink implying calcite. Rock consists of fine to medium grained sparry calcite in "eyes" and fine grained, brownish coloured calcite in rest of rock. The eyes are elongate parallel to bedding.

Micro: Calcite (99p.c.) 75p.c. of the rock is made up of fine grained brownish calcite and the rest is sparry, anhedral, medium to coarse grained calcite in the "birdseye" structures. These "eyes" are up to 15mm. long.

Dolomite: (1 p.c.) Medium grained, euhedral rhombs adjacent to stylolites in the rock.

Some siderite (?) is also associated with these stylolites.

T.S. A359/2220' ; H.S. 51 : Dismicrite (Folk)

Macro: Fine grained, massive, grey, rock containing patches of sparry calcite and siderite.

Micro: Calcite (95p.c.) Pink stain with A.R.S. Most (65 - 70p.c.) is fine to very fine grained, cloudy calcite. About 30p.c. is medium to coarse grained sparry calcite in "birdseye" structures. These "eyes" are smaller than in the previous slide.

Dolomite: (4p.c.) Medium grained, euhedral rhombs.

Siderite (?) (1p.c.) Dark brown material; subhedral.

T.S. A359/2505' ; H.S. 52 : Silty dolomitic limestone.

Macro: Fine grained, buff coloured rock with thin, wavy laminae.

Micro: Calcite and dolomite (90 - 95p.c.) slight pink stain with A.R.S. implies that some calcite is present but exact amount is hard to determine because of the fine grain size of the rock. Most of the calcite and dolomite are fine grained, anhedral and buff coloured. Some of the bands are almost medium grained.

Quartz: (5 - 10p.c.) Fine grained; angular.

T.S. A359/2505'(b) ; H.S. 53 : Slightly silty dolomite.

Macro: Thinly bedded buff coloured, fine grained, dolomite.

Micro: Dolomite (97 - 98p.c.) No stain with A.R.S. Fine grained; buff coloured; anhedral.

Quartz: (2 - 3p.c.) Fine grained; angular.

T.S. A359/2290' ; H.S. 61 : Sandy intraclastic limestone.

Macro: White to pinkish coloured, medium to coarse grained,

porous sandy limestone; very weathered.

Micro: Intraclasts (?) (45p.c.) Rounded; cloudy; made up of fine calcite (stained pink with A.R.S.)

Calcite: (45 - 50p.c.) Stained pink with A.R.S.; medium to coarse grained; anhedral; occurs between the intraclasts.

Quart z: (5 - 7p.c.) Medium to coarse grained; angular to subrounded.

T.S. A359/2135' ; H.S. 62 : Plate 7a : Oolite bearing, silty intrasparite.

Macro: Massive, medium grained, pinkish limestone with large, rounded intraclasts and a fair amount of sand.

Micro: Intraclasts (20 - 25p.c.) Very large; well rounded; some have a thin layering around their edges. Generally composed of medium grained calcite (90p.c.) and angular silt si,ed quartz grains (10p.c.) Calcite is stained pink with A.R.S.

Oolites: (?) (15p.c.) Very faint; average size .1mm.

Calcite: (45p.c.) Medium to coarse grained; sparry in places. Stained pink by A.R.S. Generally anhedral.

Quartz: (15p.c.) Medium to coarse grained; subrounded.

ROCKS WITH NO THIN SECTIONS:-

A359/1N. From Bunyeroo Formation:

Red, fine grained, very thinly bedded shale. Some of the laminae are grey coloured. Rock parts fairly easily along bedding planes - these have micas on them.

A359/8N. From Parachilna Formation:

White, medium grained argillaceous sandstone. The quartz grains are moderately rounded and have clay material around them.

The rock has partings parallel to bedding.

A359/9N. From base of Wilkawillina Limestone. Grey to buff coloured, medium to coarse grained dolomitic limestone. Some patches of black material

No bedding.

A359/12N. Manganiferous rock.

Fine grained black rock made up mainly of pyrolusite and some hematite. Massive, Vuggy; vugs lined with calcite. Hematite occupies small veinlets in the rock.

A359/13N. From upper member of Wonoka Formation.

Poorly sorted, medium to coarse grained sandstone with large, well rounded quartz grains.

Non calcareous.

No bedding.

A359/19N. Massive, medium grained, buff coloured limestone containing Micromitra.

A359/20N. From lower member of Wonoka Formation.

Grey-green fine grained silty shale; non calcareous. Very thinly bedded.

A359/30N. From Red Pound Member.

White to pale grey, medium grained micaceous sandstone. The quartz grains are generally subrounded. The rock is medium bedded.

A359/35N. From Wilkawillina Limestone.

Fine to medium grained pale buff limestone containing Archaeocyatha. These are silicified in places. The rock is massive and contains dark manganiferous patches.

A359/55N. From top of Wilkawillina Limestone.

Medium to coarse grained sandy limestone; very weathered. Buff coloured and medium bedded.

A359/56N. From base of Billy Creek Formation.

Yellow medium grained, weathered calcareous sandstone showing what could be cross-bedding.

A359/57N. From base of Billy Creek Formation.

Red, fine to medium grained, thinly bedded micaceous siltstone.

Very weathered.

A359/58N. From top of Wilkawillina Limestone.

A white, medium grained limestone with yellowish patches of siderite. Massive.

A359/59N. From top of Wilkawillina Limestone.

White to mauve, medium grained, massive limestone containing fragments of Archaeocyatha and hyolithids.

A359/63N. From Wilkawillina Limestone.

Grey, medium to coarse grained, massive limestone containing "Micromitra".

A359/64N. From Wilkawillina Limestone.

Medium grained, pinkish, massive limestone containing "Micromitra".

A359/77N. Pinkish, coarse grained rock with veinlets of hematite and irregular patches of malachite (from diapir).

A359/A3N. From Bunyeroo Formation.

Red, fine grained calcareous, micaceous siltstone

showing cross-bedding. The rock doesn't part very easily along bedding planes.

A359/A15N. From Wonoka Formation.

Medium grained, grey silty glauconitic limestone containing, thin silt laminae. The rock shows slump structures, these being quite complex.

A359/A18N. From Wonoka Formation.

Medium grained, grey intraclastic (?) limestone. The intraclasts have an irregular shape and are partly separated by a finer grained, brownish material.

A359/A19N. From Wonoka Formation.

Medium grained, grey silty limestone. Thinly bedded. Shows flattened ripple structures.

A359/A25N. From upper member of Wonoka Formation.

Grey coloured, medium grained quartzite containing thin laminae of a black mineral. The bedding planes have oriented micas on them.

A359/A26N. From upper member of Wonoka Formation.

Buff coloured, thinly bedded siltstone with micas on the bedding planes. Breaks easily along bedding; the bedding is wavy.

APPENDIX 3

Photomicrographs of Selected Thin Sections.

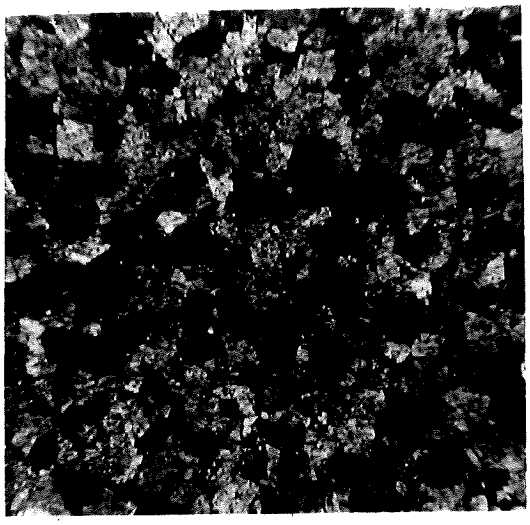
PLATE 6

a: T.S. A359/1150' : Crossed nicols. Typical pseudospar texture.

b: T.S. A359/1584' : Uncrossed Nicols. The lighter parts of the photo are coarse sparry calcite in irregular shaped birdseye structures; the darker parts are fine to medium grained calcite - they appear dark because the slide is fairly thick.

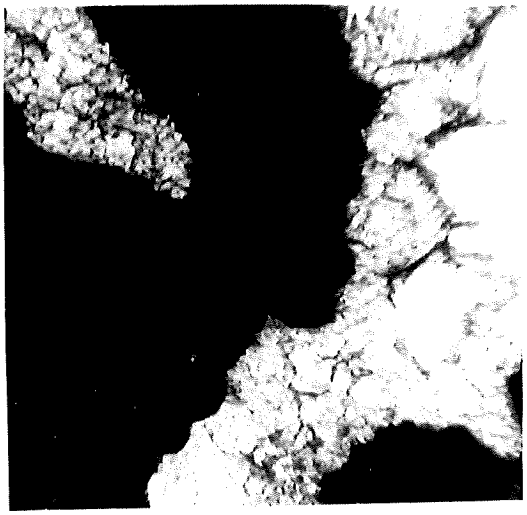
c: T.S. A359/2170' : Uncrossed Nicols. Birdseye limestone texture showing coarser sparry calcite in eyes and fine to medium calcite in matrix. A stylolite is also present and partly follows the boundary of one of the "eyes".

PLATE 6



a. ·5 mm.

·5 mm. b.





c. ·5 mm.

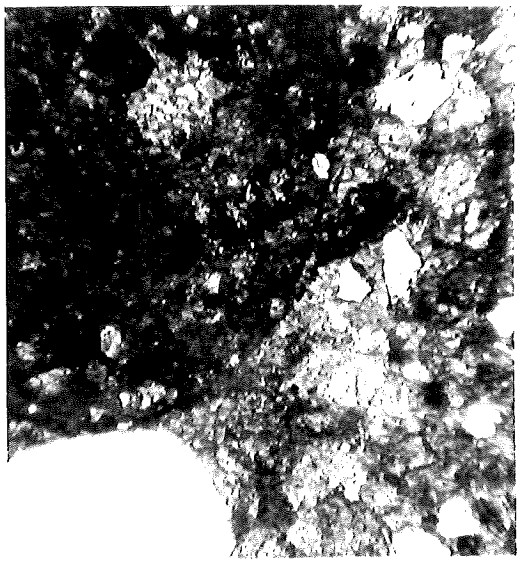
PLATE 7

a: T.S. A359/2135' : Crossed Nicols. Intraclastic limestone from Wilkwillina limestone showing a large rounded intraclast (upper left), angular to rounded quartz grains (clear), sparry calcite cement and a possible oolite (very faint) in the angle formed by the large intraclast and the large quartz grain.

b: T.S. A359/12 : Uncrossed Nicols. Calcareous Breccia from diapir showing sparry calcite cement and a large, angular siltstone fragment in the Upper rightof the photo.

c: T.S. A359/17 : Uncrossed Nicols. Siderite from small vein in Bunyeroo Fromation showing concretionary texture. The lighter coloured patches are calcite.

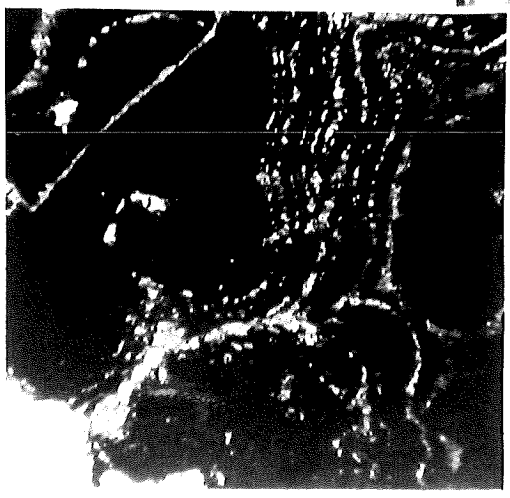
PLATE 7



a. ·5mm.

·5mm. b.





c. ·5mm.

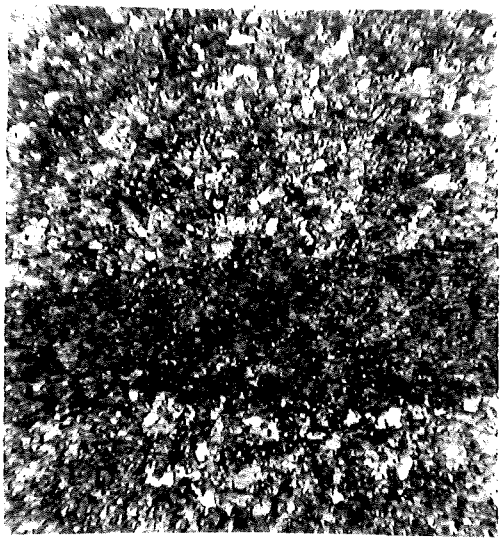
PLATE 8

a: T.S. A359/182' : Uncrossed Nicols. Intraclastic limestone from Wonoka Formation showing the fine grained nature of the intraclast as compared to the matrix.

b: T.S. A359/671' : Crossed Nicols. Coarse sandstone band in Wonoka Formation showing the recrystallized nature of the quartz grains and a siltstone fragment (lower right).

c: T.S. A359/855' : Crossed Nicols. From Red Pound Member. Shows the relationship of the iron oxide stain (dark coloured) to the quartz grains.

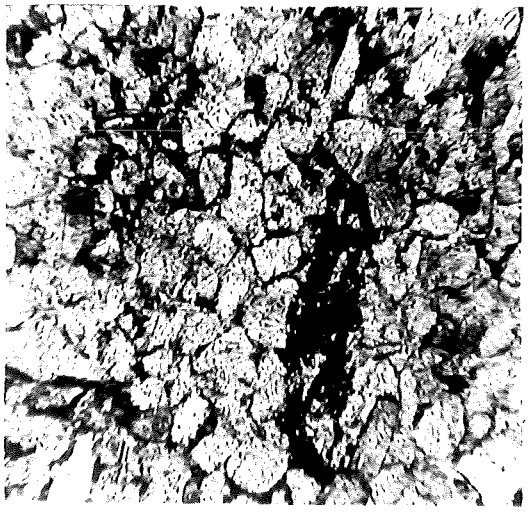
PLATE 8



a. ·5mm.

·5mm. b.





c. ·5mm.

MEASURED SECTION

WONOKA FORMATION

600'
A 27.
A26N.
A25N.
550'
A 23.
500'
A22.
450'
In.L.S.
400'
In.L.S.
350'
A19N.
In.L.S.
300'
B&P
In.L.S.
A18N.
250'
B&P
In.L.S.
A17.
A15N.
200'
B&P
In. L.S. – A14.
150'
In.L.S.
B&P
00'
50'
In.L.S.
D. – A12.
In.L.S. – A11.
0'
A 8

POUND QUARTZITE

1200'
A45.
A44.
1150'
1100'
A42.
1050'
1000'
950'
900'
A 39.
A 38.
850'
Dls.
Dls.
800'
Dls.
750'
A33.
700'
A30.
650'
600'

PARACHILNA FORMATION

1800'
Pink; Med. to coarse grained.
43.
Fine grained.
42.
1750'
Fine to med. grained.
1700'
1650'
41.
Mauve to pink; Fine to med. grained.
1600'
40 (b).
40 (a).
Pink; Very fine grained.
39.
Yellow to grey; Fine to med. grained.
1550'
38.
Dark grey; Fine to med. grained.
37.
1500'
Grey to pink; Fine grained.
1450'
1400'
36.
1350'
A 46.
1300'
1250'
1200'

BILLY CREEK FORMATION

2400'
2350'
57N.
56N.
58N.
59N
In.L.S.
61.
2300'
2250'
51.
Pink to mauve; Very fine to fine grained.
2200'
49.
2150'
48.
In.L.S.
62.
Pink to mauve; Fine grained.
2100'
Pink; Med. to coarse grained.
2050'
47.
Fine grained.
2000'

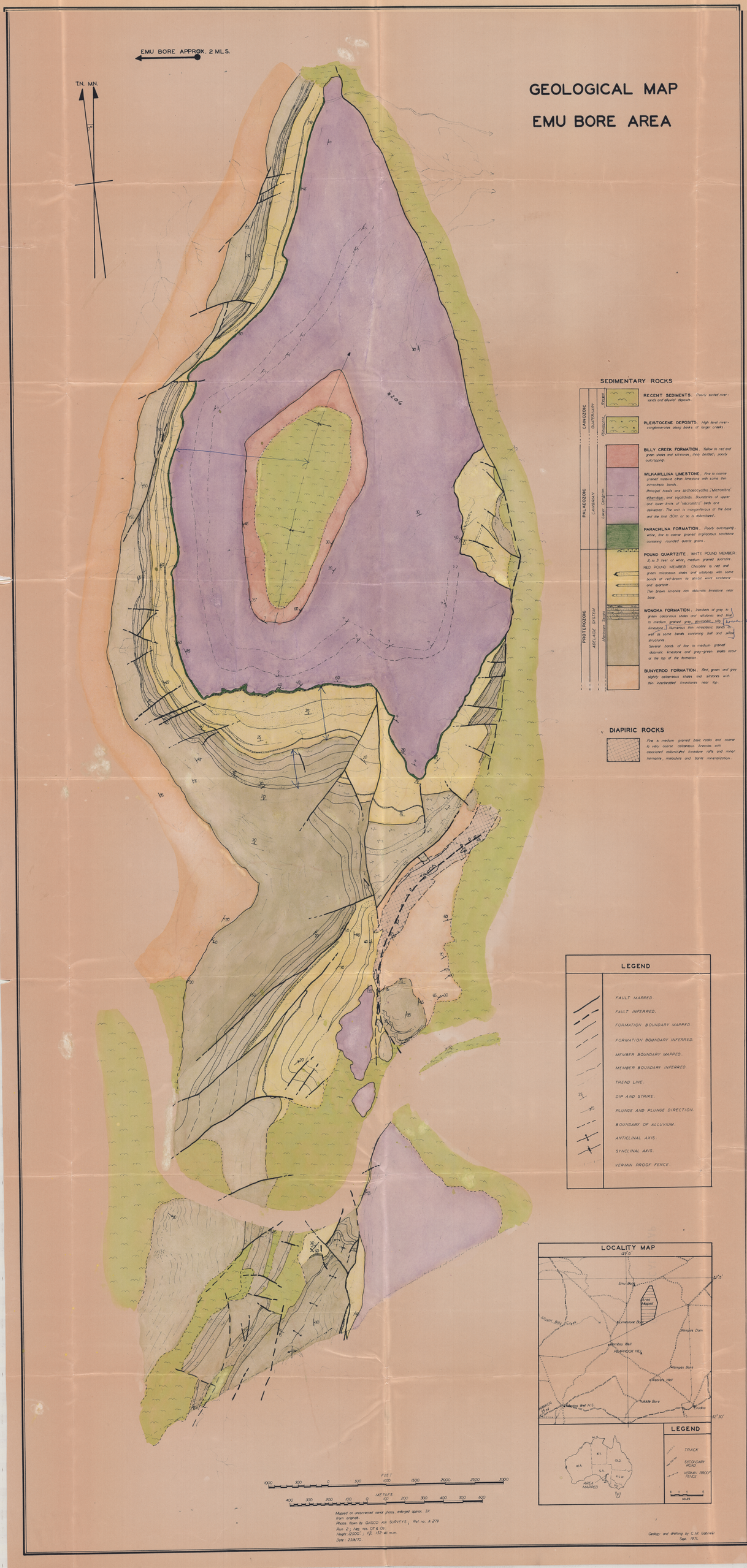
WILKAWILLINA LIMESTONE

1950'
Buff; Med. to coarse grained.
44.
1900'
Pink; Med. grained.
Buff; Med. to coarse grained.
1850'
64N.
63N.
1800'

2600'
2550'
D.
2500'
D. – 52, 53.
2450'
2400'

LEGEND

- Limestone.
- Dolomitic Limestone.
- Slightly Dolomitic Limestone.
- Silty Limestone.
- Silty Dolomitic Limestone.
- D. Dolomite.
- Sandy Dolomitic Limestone.
- Sandy Limestone.
- Birdseye Limestone.
- In. L.S. Intraclastic Limestone.
- B&P. Ball & Pillow Structures.
- Sandstone.
- Siltstone.
- Shale.
- Sandstones & Siltstones.
- Argillaceous Sandstone.
- Arenaceous Shale.
- Calcareous Sandstone.
- Oolitic Limestone.
- Manganiferous Rock.
- A Archaeocyatha.
- H Hyolithids.
- M Micromitra.
- B Other Brachiopods.
- Glauconite.


GEOLOGICAL MAP
EMU BORE AREA
EMU BORE APPROX. 2 MLS.
T.N. M.N.
SEDIMENTARY ROCKS
CAINOZOIC
QUATERNARY
Recent
RECENT SEDIMENTS. Poorly sorted river-sands and alluvial deposits.
Pleistocene
PLEISTOCENE DEPOSITS. High level river-conglomerates along banks of larger creeks.
PALAEOZOIC
CAMBRIAN
Lower Cambrian
BILLY CREEK FORMATION. Yellow to red and green shales and siltstones, thinly bedded; poorly outcropping.
WILKAWILLINA LIMESTONE. Fine to coarse grained massive clean limestone with some thin intraclastic bands.
Principal fossils are Archaeocyatha, 'Micromitra' etheridgei, and Hyolithids. Boundaries of upper and lower limits of 'Micromitra' beds are delineated. The unit is manganiferous at the base and the first 150ft. or so is dolomitized.
PARACHILNA FORMATION. Poorly outcropping, white, fine to coarse grained argillaceous sandstone containing rounded quartz grains.
POUND QUARTZITE. WHITE POUND MEMBER. 2, to 3 feet of white, medium grained quartzite.
RED POUND MEMBER. Chocolate to red and green micaceous shales and siltstones with some bands of red-brown to almost white sandstone and quartzite.
Thin brown limonite rich dolomitic limestone near base.
PROTEROZOIC
ADELAIDE SYSTEM
Mesmaph Sheets
WONOKA FORMATION. Interbeds of grey to green calcareous shales and siltstones and fine to medium grained grey glauconitic silty limestone. Numerous thin intraclastic bands as well as some bands containing ball and pillow structures.
Several bands of fine to medium grained dolomitic limestone and grey-green shales occur at the top of the formation.
BUNYEROO FORMATION. Red, green and grey slightly calcareous shales and siltstones with thin interbedded limestones near top.
DIAPIRIC ROCKS
Fine to medium grained basic rocks and coarse to very coarse calcareous breccias with associated dolomitized limestone rafts and minor hematite, malachite and barite mineralization.
LEGEND
FAULT MAPPED.
FAULT INFERRED.
FORMATION BOUNDARY MAPPED.
FORMATION BOUNDARY INFERRED.
MEMBER BOUNDARY MAPPED.
MEMBER BOUNDARY INFERRED.
TREND LINE.
DIP AND STRIKE.
PLUNGE AND PLUNGE DIRECTION.
BOUNDARY OF ALLUVIUM.
ANTICLINAL AXIS.
SYNCLINAL AXIS.
VERMIN PROOF FENCE.
LOCALITY MAP
139°15'
32°15'
Emu Bore
Area Mapped
Mount Billy Creek
Limestone Bore
Stempes Dam
Bamboo Well
RIMPHOCK HILL
Mempes Bore
Weavers Well
Middle Bore
Enudina
MAKER 33 mi
Martins Well H.S.
32°30'
LEGEND
TRACK
SECONDARY ROAD
VERMIN PROOF FENCE
MILES
W.A.
N.T.
QLD.
S.A.
N.S.W.
AREA MAPPED
FEET
METRES
Mapped on uncorrected aerial photos, enlarged approx. 3X from originals.
Photos flown by QASCO AIR SURVEYS; Ref. no. A 279
Run 2; Neg. nos. 07 & 09.
Height 12500'; f/c 152·41 m.m.
Date: 25/8/70.
Geology and drafting by C.M. Gabriel
Sept. 1971.