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PETROLOGY OF SURFACE SAMPLES FROM THE AMADEUS BASIN, NORTHERN TERRITORY

by

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INTRODUCTION

The aim of this study is to give as far as possible detailed petrological descriptions of field samples from the Amadeus Basin, Northern Territory.

These samples have been collected either by B.M.R. field parties or by the author during a short field trip in the central part of the Amadeus Basin.

The detailed petrological descriptions of field defined formations was carried out to help in the interpretation of well cores and cuttings, a concurrent study being made by the author. The work carried out on the samples included a microscopic examination, calcimetry test on the carbonates and heavy mineral separation.

DIAGRAMS

In order to facilitate the comparison of the studied rocks, they have been arranged in a stratigraphical sequence and their observable properties have been marked on a diagram. (Plates 1 and 2).

Vertical Column.

The intervals of the different formations on the diagrams depend purely on the number of studied samples and are not in any relation to their actual thickness.

Horizontal Column.

From left to right:- geographic area refers to the name of the 1:250,000 scale geological maps in the Amadeus Basin and to geological cross sections located on the locality map (Fig. 1).

- stratigraphy refers to the current formation and group names as defined for the Amadeus Basin in several B.M.R. reports.

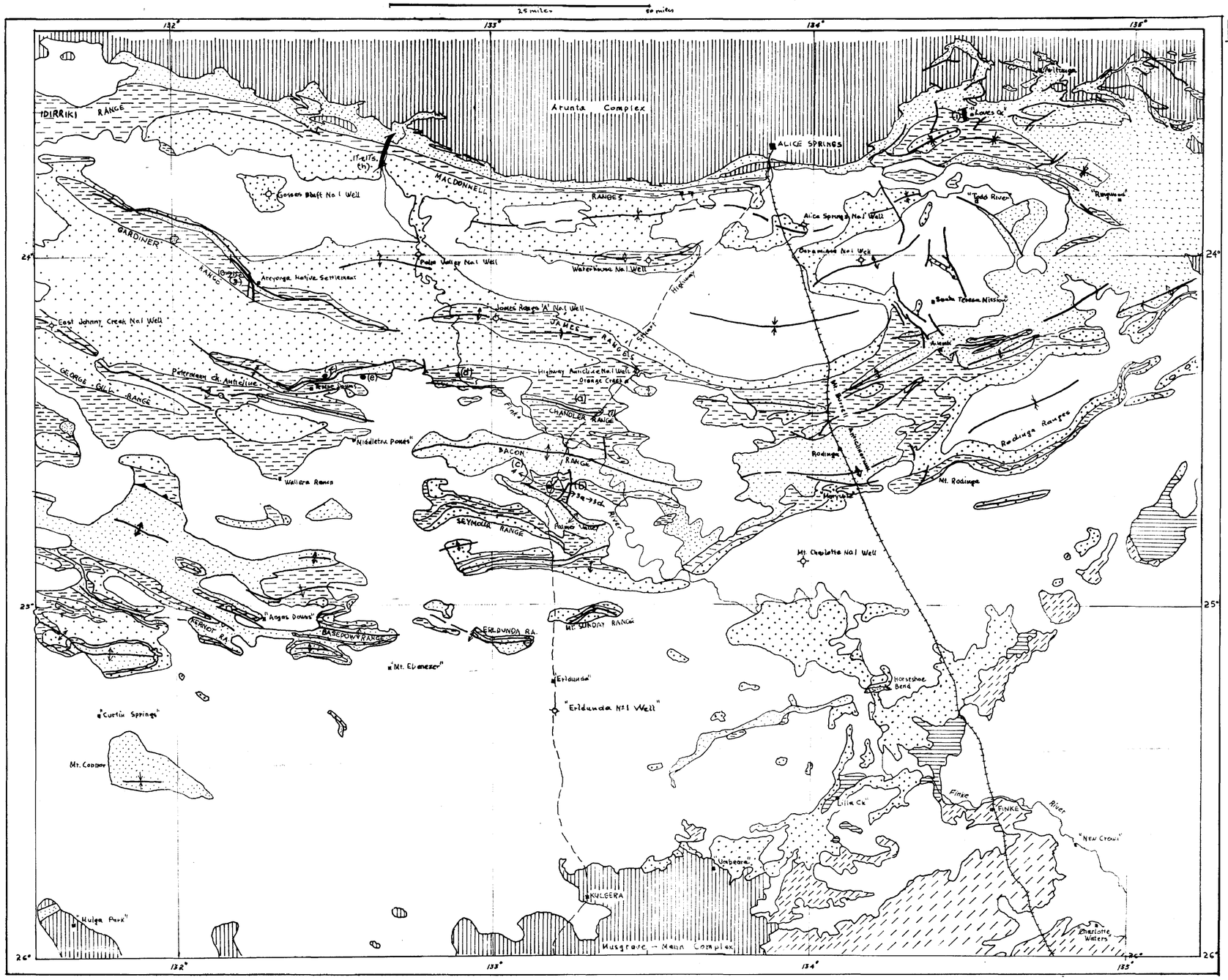
-No. of samples refers to the hand specimen numbers of samples collected by B.M.R. field parties and indicated on the geological map e.g. L.A. 571 is a sample collected on the Lake Amadeus 1:250,000 Sheet area. Additional samples collected by the author in the Amadeus Basin are indicated on the included locality map (Fig. 1).

Locality map and Regional Geology of the Central Amadeus Basin.

FIGURE:1

scale:

25 miles 50 miles



Legend

- CAINOZOIC
- MESOZOIC
- PERMIAN
- MIDDLE PALAEOZOIC
- LOWER PALAEOZOIC
- UPPER PROTEROZOIC
- ARCHAEAN
- ANTICLINE
- SYNCLINE
- FAULT

Reference to samples collected by G. Schmerber I.F.P.

(a) Chandler Range 1
(b) Bacon Range 3a→3d
(c) –"– –"– 4
(d) Running Water 6a→6b
(e) Quandong Creek 7a→7b
(f) Quandong 8
(g) Gardiner Range 10→15c
(h) Ellery Creek 17→17s
(i) Ross River 18a→19

Geology after: Bureau of Mineral Resources.

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- the representation of the angularity and the grain size variations is similar to the previous petrological reports; in the grain size column, the length of the horizontal line gives an idea of the sorting summarized in the appropriate column by well-medium-poor; a point signifies the main mode.

- the composition of the samples has been estimated with a visual percentage chart; the error is smaller in low percentages. A calcimetry test has been made on the carbonate rocks and the percentage of calcite and dolomite indicated.

- the sedimentary structures have been represented as observed in the hand specimen and in thin section.

- in the column headed maturity indices (Pettijohn 1956, p. 508) the ratios quartz/feldspar and quartz and chert/feldspar and rock fragments represent the ratio of the visual estimated percentage of quartz and all feldspars; the term rock fragments includes all kinds of lithic particles such as mica schist, sericitized rock fragments etc..

- the accessories have been estimated: e.g. 10 means 10% of the total mineral composition of the sample.

+	presence	less than 1%	visual estimation
0	rare	about 1%	
⊖	common	about 2-5%	
●	abundant	about 5%	

- in the column "cement", the secondary quartz, in form of quartz overgrowths, has been included in the percentage of sedimentary quartz.

- in the column "heavy minerals", the tourmaline, zircon and rutile, which are the most common have been counted and their relative percentage is indicated; if the total amount has been less than 100 grains, only a visual estimation has been given.

LITHOLOGIES

The whole sampling has been concentrated mostly on sandy facies but the calcareous facies of some formations are also described. In spite of the restricted number of samples, a first glance at the diagrams shows that the variations of the different parameters are not purely accidental, but that the formations are typified and distinguished by several combined features. Although the diagrams are self explanatory, the main trends and observations are given in the following paragraphs.

Heavitree Quartzite (Ellery Creek section) see plate 1.

This is the oldest sediment cropping out in the Amadeus Basin. This rock represents a white and clean, bimodal, completely silicified orthoquartzite with a very high maturity index. Rare muscovite flakes and a very poor development of sericite rims occurs around the detrital grains.

Bitter Springs Formation (Gardiner Range & Ellery Creek) see plate 1.

In these areas the Bitter Springs Formation consists mainly of cherty dolomite with minor amounts of siltstone and shale.

The carbonate rocks are bedded to compact, laminated, locally haematitic, micaceous, sandy or pelletic cryptocrystalline to microcrystalline calcitic dolomite and dolomitic limestone. Brownish-grey, banded, prediagenetic chert laminae are plentiful. Stromatolites are very abundant in the Gardiner Range near Areyonga Settlement. This lithology is very similar to the Loves Creek Member as described in the Ooraminna No. 1, Mt. Charlotte No. 1 and Erldunda No. 1 wells.

Areyonga Formation (Gardiner Range) see plate 1.

These grey to brownish, medium to poorly sorted lithic or feldspathic sandstones are characterized by low maturity indices; the feldspars comprise only altered orthoclase and microcline and the lithic fragments are sedimentary chert and some metaquartzite; silica overgrowths and very rare tourmaline and zircon are present. These samples are as described in Ooraminna No. 1 well; they show a direct correlation with the Inindia Beds in Erldunda No. 1 well.

Pertatataka Formation (Gardiner Range) see plate 1.

The sediments are greenish-grey sandstone interbedded with greenish shale and siltstone. Slumping has been noticed in outcrops.

The samples represent very fine grained, well sorted, micaceous, chloritic and pyritic sandstone; significant accessories are the high muscovite and greenish biotite content and the presence of apatite.

Winnall Beds (Bacon Range) see plate 1.

Light grey, thick bedded, in places cross-bedded, fine to coarse silicified orthoquartzite.

In Erldunda No. 1 well the sandstones contain more mica and have a chloritic and phosphatic cement.

Quandong Conglomerate (Type locality) see plate 1.

This is a sequence of thin to thick bedded, cross bedded, ferruginous, poorly sorted sandstone and polymictic conglomeratic sandstone characterized by its content of sedimentary and metamorphic chert with pebbles up to 10 mm, and by the presence of detrital kaolinite, sericite and rutile.

Arumbera Sandstone (Ellery Creek & Ross River) see plate 1.

This formation is composed mainly of very ferruginous, cross-bedded sandstone alternating with micaceous and ferruginous siltstone and some quartz conglomerate lenses.

The sandstone is fine to coarse grained, well to poorly sorted and feldspathic, characterized by a rather low maturity index in the Ross River section and a very low index (less than 10) in the Ellery Creek section.

The association of high haematite content with mica, especially greenish biotite, glauconite, strong secondary silica overgrowths and locally carbonate, kaolinite, and sericite content is characteristic for this formation. The heavy mineral assemblage is composed of dominant tourmaline, zircon, rutile, rare apatite, anatase and epidote.

Very similar lithologies from the formation have been noticed in Ooraminna No. 1, Alice No. 1 and Waterhouse No. 1 wells.

Eninta Sandstone (Lake Amadeus Sheet area) see plate 2.

This sample represents a well sorted, fine grained protoquartzite with 7% quartzitic rock fragments and very rare altered orthoclase. The accessories and the cement are similar to those of the Arumbera Sandstone.

Todd River Dolomite (Ross River Section) see plate 1.

Pink and grey, mainly thickly bedded and compact, locally slightly sandy, slightly calcitic (10 to 15%) microcrystalline dolomite; some recrystallized biological structures have been noticed. No glauconite occurs in these samples but it has been described from other outcrop samples.

Chandler Limestone (Ellery Creek & Chandler Range) see plate 1.

Pale grey, contorted, thin bedded and laminated dolomitized micritic limestone with numerous interlaminated prediagenetic brownish chert laminae. Strong fetid odour when freshly broken.

In subsurface (Alice No. 1 and Mt. Charlotte No. 1 wells) the formation is mainly salt with slightly dolomitic clay.

Giles Creek Dolomite and Shannon Formation (Ross River) see plate 1.

This is a thick sequence of grey, nodular, dolomitized, microcrystalline limestone with greenish siltstone and shale, thickly bedded, greyish, fine grained dolomite grading into grey dolomite and shale in the upper part; numerous biological structures have been noticed such as trilobites, gastropods and algal fragments. Some yellowish chert is present.

Anhydrite occurs in the formation in Alice No. 1 Well but has not been seen so far in the formations at Ross River.

Jay Creek Limestone (Ellery Creek, Quandong Creek & Bacon Range) see plate 1.

The unit consists mainly of carbonate rocks and interbedded siltstone in nearly equal amount and some rare sandstone. The carbonate rocks are slightly haematitic, commonly very sandy, cryptocrystalline to microcrystalline calcitic dolomite, bioclastic calcarenite and algal limestone; some algal limestones are composed of spherical sections of Girvanella with their longer axes parallel to the bedding. The matrix is strongly recrystallized.

Calcareous and haematitic protoquartzites are characterized by their heavy mineral content: tourmaline-zircon-rutile-garnet-epidote and brookite.

The petrology and the biological structures are similar to those described from the formation in Waterhouse No. 1, Highway No. 1 and Mt. Charlotte No. 1. The spherical biological structures defined in these wells as rosettes may represent recrystallized sections of Girvanella.

Illara and Petermann Sandstones (Gardiner Range - Mount Liebig and Lake Amadeus Sheet areas) see plate 2.

The Illara and Petermann Sandstone samples represent typical cherty submature feldspathic sandstones with rather weak maturity indices (5 to 22); they are generally laminated to cross-bedded, fine to medium grained with a relatively high orthoclase and microcline content, and persistent sedimentary, igneous and metamorphic chert and rock fragments; squeezed muscovite and biotite altered to sericite, kaolinite and chlorite, often in fan shape, and brownish altered glauconite are present.

The high haematite content, quartz overgrowths and the heavy mineral assemblage of tourmaline, zircon, rutile and exceptional garnet are similarly found in the Arumbera submature feldspathic sandstone. However a higher proportion of kaolinite and the heavy mineral assemblage should allow a petrological differentiation between Illara-Petermann Sandstones and Arumbera Sandstone in subsurface. Garnet is commonly found in the Illara and Petermann Sandstones but not in the Arumbera Sandstone.

Cleland Sandstone. (Lake Amadeus, Mount Liebig, Bloods Range and Mount Rennie Sheet areas) see plate 2.

These samples represent fine to coarse grained, well to poorly sorted mature protoquartzite and some feldspathic sandstone; they show very variable, but high maturity indices ($7.5 < Q/F < 92$) and ($7 < \frac{Q + C}{F + R} < 94$; average 55).

The lithic fragments consist of chert, granoblastic quartz, microquartzite, very rare sedimentary sandstone, mica schist and altered rock fragments.

Muscovite and biotite are present in variable amount; they show all stages of weathering indicating that the alteration is not due only to diagenetic actions but is primary. It must be emphasized that the presence of mica is related to the grainsize and the sorting; it is mainly confined to fine grained well sorted sandstones.

Haematite occurs as primary matrix generally in the form of coatings; kaolinite is present in numerous samples as fine detrital granules and vermicules in association with rather cleaner sandstones. Elsewhere the development of kaolinite after mica suggests that in this formation kaolinite may have also a secondary origin. Sericite and/or illite occurs in minor amount. A poorly developed calcareous cement in some samples is considered to have a late stage diagenetic origin.

The accessories are mainly tourmaline, locally with diagenetic overgrowths, zircon, rutile, apatite, very rare garnet, anatase and brookite; epidote occurs in minute diagenetic crystals; the percentage of the most common and stable minerals (tourmaline, zircon-rutile) is nearly 99% of the total heavy mineral amount.

Goyder Formation (Ellery Creek & Running Water) see plate 1.

The samples represent fine to coarse, clean orthoquartzite with high maturity indices, rare orthoclase, chert and exceptional muscovite. Deposition of a thin coating of haematite was followed by intense secondary silification and development of secondary chlorite. Primary glauconite pellets are present.

In Alice No. 1 and Highway No. 1 wells the sandstones in the Goyder Formation are feldspathic.

Pacoota Sandstone (Ellery Creek & Running Water)

These typical sandstones of the formation are thickly bedded, cross bedded, fine to medium grained, locally bimodal orthoquartzites with very high maturity indices (> 90). Kaolinite and phosphate occur locally.

Stairway Sandstone (Ellery Creek & Kulgera Sheet area) see plate 1.

These samples consist of clean orthoquartzite and protoquartzite with 8% chert, a high to very high maturity index, exceptional mica and some phosphate and kaolinite.

Carmichael Sandstone (Ayers Rock & Kulgera Sheet areas) see plate 1.

The Carmichael Sandstone samples are clean to ferruginous orthoquartzites with a very high maturity index (71 to 90), very rare chert, but characterized by the importance of vermicular kaolinite. The heavy mineral assemblage is very poor. Sample K24 is mapped as doubtful Mereenie Sandstone but differs very little in composition from the Carmichael Sandstone samples.

CONCLUSIONS

The investigation of a relatively restricted number of surface samples of sandstones and carbonate rocks from the Amadeus Basin and the detailed representation of as many as possible parameters in diagrams have shown that:

- each formation is characterized by the association of several parameters such as mineralogical composition, maturity index, biological structures etc..

- identification between the formations defined during field mapping and the subsurface units or formations is possible in this area by detailed petrological studies.

- some parameters, such as angularity, grain size analyses and the heavy minerals are of poor value for correlation work because the angularity and the grain size are related only to the particular rock sample and not the formation. The fact that the heavy minerals are represented only by the very stable mineral species does not allow any correlation. However they are related directly to the maturity of the light fraction. The detrital sedimentation in the Amadeus Basin is composed of submature to very mature arenites.

In order to corroborate these conclusions it would be necessary to collect more surface material and to study it in a quantitative way.

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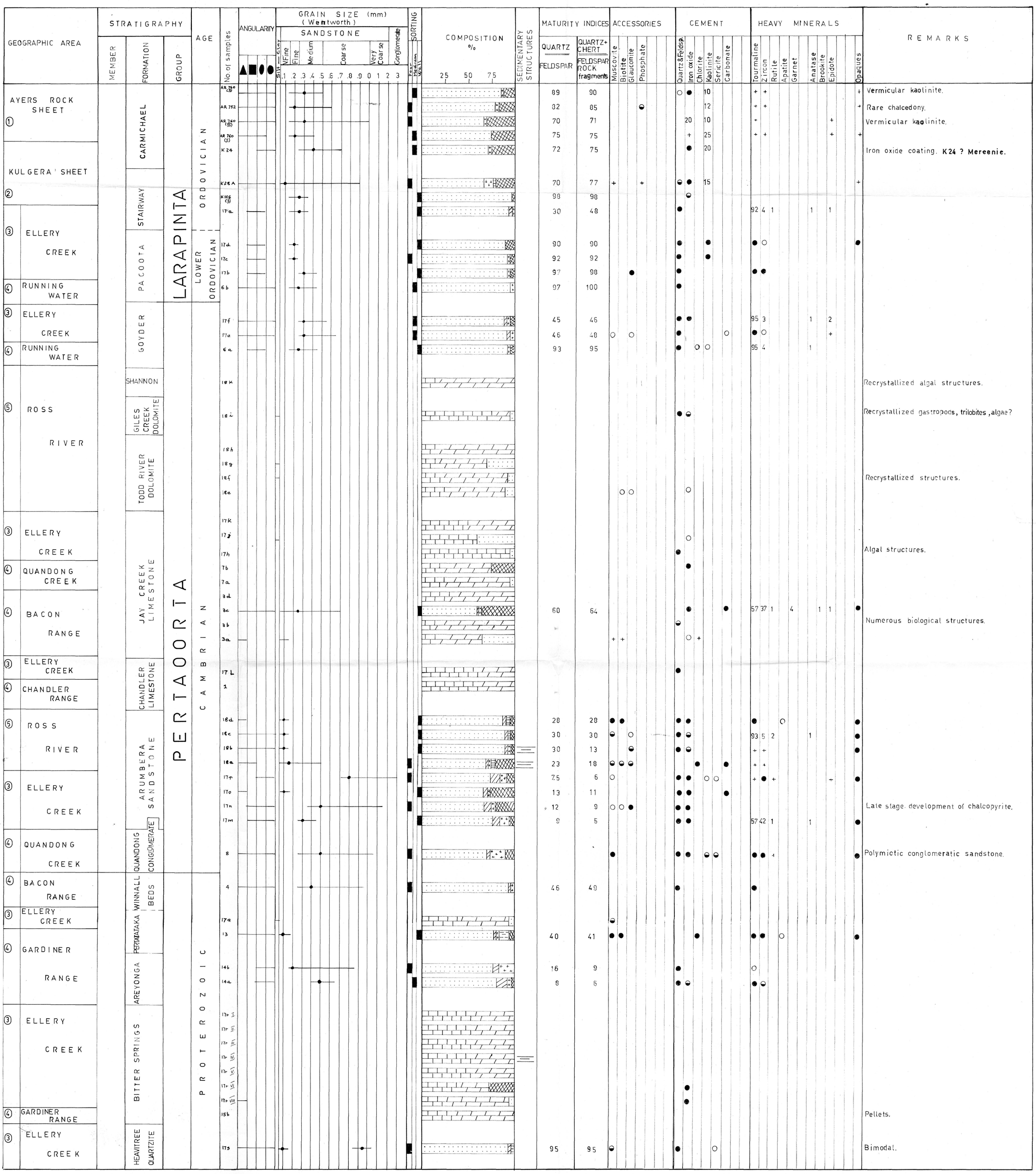
PETROLOGY of FIELD SAMPLES from AMADEUS BASIN N.T.

Legend

① AYERS ROCK SHEET
② KULGERA SHEET
③ HERMANNSBURG SHEET
④ HENBURY SHEET
⑤ ALICE SPRINGS SHEET

QUARTZ + sec SILICA
FELDSPAR (orthoclase + microcline)
LITHICS (igneous + metamorphic + chert)
MICA (muscovite + biotite)
CEMENT
UNDIFFERENTIATED (completely altered feldspar + rock fragments)
CALCITE
DOLOMITE
LAMINATED

+ PRESENCE
○ RARE
◒ COMMON
● ABUNDANT



B.M.R. RECORD 1966/206

GEOLOGIST: G.SCHMERBER I.F.P.
DRAWN BY: S.OZIMIC I.F.P.

PETROLOGY of FIELD SAMPLES from the AMADEUS BASIN N.T.

Legend

- QUARTZ +sec. SILICA
- FELDSPAR (orthoclase+microcline+albite)
- DOLOMITE
- CALCITE
- CEMENT
- UNDIFFERENTIATED (completely altered feldspar+rock fragments)
- LITHICS (igneous+metamorphic+chert)
- MICA (muscovite+biotite)
- LAMINATED
- △ △ BRECCIA
- + PRESENCE
- O RARE
- ◒ COMMON
- ● ABUNDANT

GEOGRAPHIC AREA	STRATIGRAPHY: MEMBER	FORMATION	GROUP	AGE	No. of samples	REMARKS
LAKE AMADEUS SHEET					LA 571	Muscovite and Biotite altered to Kaolinite and sec. silica.
					LA 572	Muscovite and Biotite altered to Kaolinite.
					LA 511	
					LA 570	Muscovite and Biotite altered to Kaolinite.
MOUNT LIEBIG SHEET					ML 138(i)	
					ML 127	Muscovite and Biotite altered to Kaolinite and sec. silica.
					ML 26A	
					ML 135(i)	
					ML 138(ii)	
					ML 26 B	
					ML 135(iii)	
					ML 14C(i)	
					ML 13C(iii)	
					ML 13(i)	
					ML 14	Haematitic and slightly silicified.
BLOODS RANGE SHEET					BR 25(i)	Muscovite and Biotite altered to Kaolinite.
					BR 36(i)	Altered Muscovite.
					BR 22	
					BR 22(i)	Altered Biotite.
MOUNT RENNIE SHEET					BR 27	Siltstone and altered Mica.
					MR 13	Silty Shale and altered Mica.
LAKE AMADEUS SHEET					LA 30	Altered Glauconite, Mica and Illite.
					LA 4	Glauconite and Mica altered to Kaolinite.
					LA 31b	Altered Biotite.
					LA 31a	Haematite laminations.
GARDINER RANGE SHEET	HENBURY	ILLARA Sandstone	CLELAND	Cambrian	12c	Carbonate clasts.
					12d	
					12c	Glauconite pellets locally altered. Topaz and Fibrolite.
					12b	
					12a	
					12	
LAKE AMADEUS SHEET		PETERMANN Sandstone			10b	Altered Biotite. Barite.
					10a	
					LA 33	
MOUNT LIEBIG SHEET					ML 14C	Altered Biotite.
LAKE AMADEUS SHEET		ENNINTA Sandstone			LA 27	Chloritized and sericitized Glauconite and Biotite.

No. of samples	Quartz / Feldspar	Quartz+Chert / Feldspar+Rock fragm.
LA 571	12	12
LA 572	85	28
LA 511	80	41
LA 570	90	94
ML 138(i)	30	19
ML 127	41	12
ML 26A	50	52
ML 135(i)	75	7
ML 138(ii)	92	49
ML 26 B	77	26
ML 135(iii)	28	18
ML 14C(i)	26	18
ML 13C(iii)	23	17
ML 13(i)	20	14
ML 14		
BR 25(i)	60	65
BR 36(i)	80	85
BR 22	90	92
BR 22(i)	16	14
BR 27		
MR 13		
LA 30	22	13
LA 4	11	8
LA 31b	13	10
LA 31a	13	10
12c		
12d	8	6
12c	8	8
12b		
12a		
12	10	10
10b	6.5	5
10a	17	10
LA 33	10	10
ML 14C	11	10
LA 27	67	40

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