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COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1963/47

REGIONAL GEOLOGY OF THE BLOODS RANGE SHEET, SOUTH-WEST AMADEUS BASIN

by

D.J. Forman

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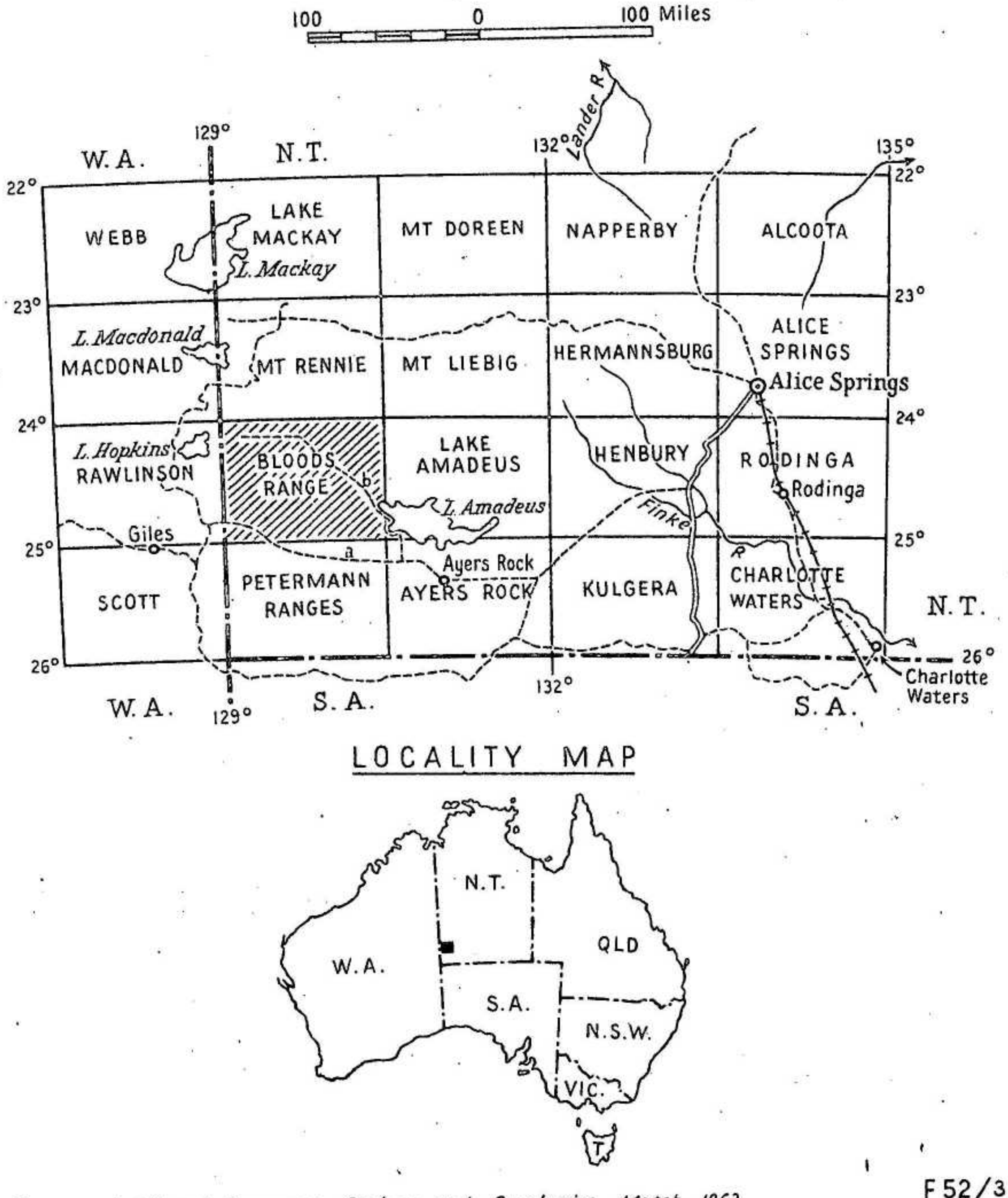
Fig. 1

POSITION OF AREA DEALT WITH IN REPORT AND REFERENCE TO AUSTRALIAN 1:250,000 AND 1:253,440 MAP SERIES



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REGIONAL GEOLOGY OF THE BLOODS RANGE SHEET, SOUTH-WEST AMADEUS BASIN.

SUMMARY

The Bloods Range Sheet contains rocks of Precambrian and Palaeozoic age. The oldest rocks of undifferentiated Precambrian age crop out on the southern half of the sheet. Very coarse rapakivi granite and quartz-feldspar porphyry are overlain unconformably by a thick sequence of extrusive basalt. The basalt is intruded by granite and quartz-feldspar porphyry and is overlain probably unconformably by the Bloods Range Beds of sedimentary and volcanic origin. Quartz-feldspar porphyry is associated with the Bloods Range Beds. The rocks of undifferentiated Precambrian age are overlain unconformably by Upper Proterozoic quartzite, dolomite and limestone. The quartzite forms the main body of the high ranges in the southern half of the sheet area and is correlated on stratigraphic position and lithology with the Heavitree Quartzite. The dolomite and limestone formation is similarly correlated with the Bitter Springs Limestone. The quartzite, dolomite and limestone on the southern half of the sheet area are infolded into the undifferentiated Precambrian rocks and have been metamorphosed.

During and after this folding sediments were deposited in the Amadeus Basin over the northern half of the sheet area. The sediments of Upper Proterozoic age are poorly outcropping sandstone, siltstone, algal dolomite and limestone. At Souths Range these sediments are overlain unconformably by a thick sandstone and siltstone unit of Upper Proterozoic or Cambrian age, while farther north-east this unconformity is not evident.

These rocks were folded adjacent to the southern margin of the basin and a deltaic sandstone of Cambrian age was deposited over them. During a marine transgression in the Ordovician the Larapinta Group was deposited conformably over the deltaic sandstone in the north; to the south outliers of the marine Ordovician rest on metamorphosed Precambrian rocks. Following a recession of the sea the continental sandstone and siltstone of the Mereenie Sandstone and Pertnjara Formation were deposited. These were the last sediments before the final folding in the Amadeus Basin. After folding, weathering and erosion of the rocks produced superficial deposits of Tertiary conglomerate and Quaternary travertine, evaporites, alluvium and aeolian sand.

INTRODUCTION

General

The Bloods Range 1:250,000 Sheet area (SG52/3) was mapped by D.J. Forman and A.J. Stewart of the Bureau of Mineral Resources during May to September 1962. This formed part of a programme of regional mapping in the Amadeus Basin.

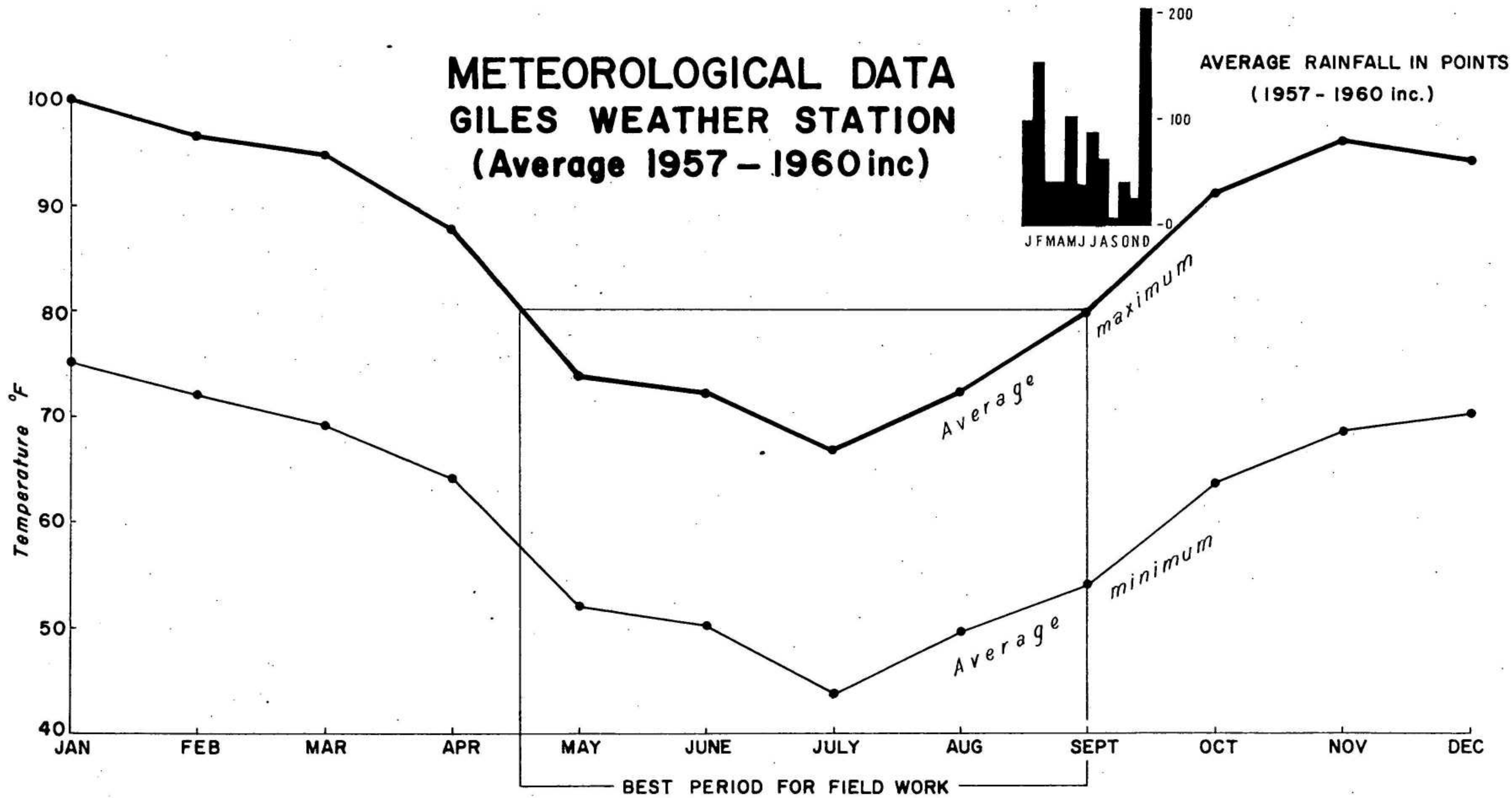
Location and access

Fig. 1 shows the location of the area and access to it. Access is by a vehicle track between Ayers Rock tourist resort, Northern Territory, and Giles Meteorological Station, Western Australia (track a). The northern part of the area was reached by following track (b). Neither of these tracks is suited to 2 wheel drive vehicles.

Giles Meteorological Station is operated by the Bureau of Meteorology but maintained by the Weapons Research Establishment. Permission to visit Giles has to be obtained from the Controller, Weapons Research Establishment and is conditional on the applicants' having conformed with the medical and character requirements of the Aborigines Department of South Australia and the Western Australian Department of Native Affairs.

The Bloods Range Sheet area lies within an Aboriginal reserve and permission to enter this reserve has to be obtained from the Department of Native Welfare, Northern Territory Administration.

Fig. 2



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Climate

Fig. 2 is a graph of mean maximum and mean minimum temperatures (°F) for Giles between 1957 and 1960 inclusive. Average monthly rainfall figures for the same period are set out in the histogram (Fig. 2).

Assuming average maximum temperatures above 80°F are not suited to sustained field work a comfortable field season could run from early May to middle September without serious risk of work being held up by rain.

Development

The Bloods Range Sheet area is undeveloped except for the vehicle tracks shown in Fig. 1. Water has to be obtained from either Giles Meteorological Station or Ayers Rock.

Survey Method

Mapping was carried out by 4 to 5 day Landrover traverses from two base camps. The northern half of the area was covered from a base camp situated between Lake Neale and Lake Amadeus. From this base camp a track was made along the northern side of Lake Neale to within 15 miles of the Western Australian border. Traverses made from this track ran parallel to the sand dunes and across the strike of the sedimentary rocks. The second base camp was on the Hull River in the Petermann Ranges. Two one day helicopter traverses were made to remote outcrops on the northern half of the sheet area.

The geology was plotted on aerial photographs at a scale of approximately 1:46,500 and then transferred to transparent controlled mosaics at photo scale. The mosaics were reduced photographically to a scale of 1:250,000 and the final map was drafted at this scale.

PREVIOUS GEOLOGICAL INVESTIGATIONS

Mapping of the Bloods Range Sheet area had not been attempted before 1962. A number of prospecting expeditions have visited the area but only minor signs of mineralization were found.

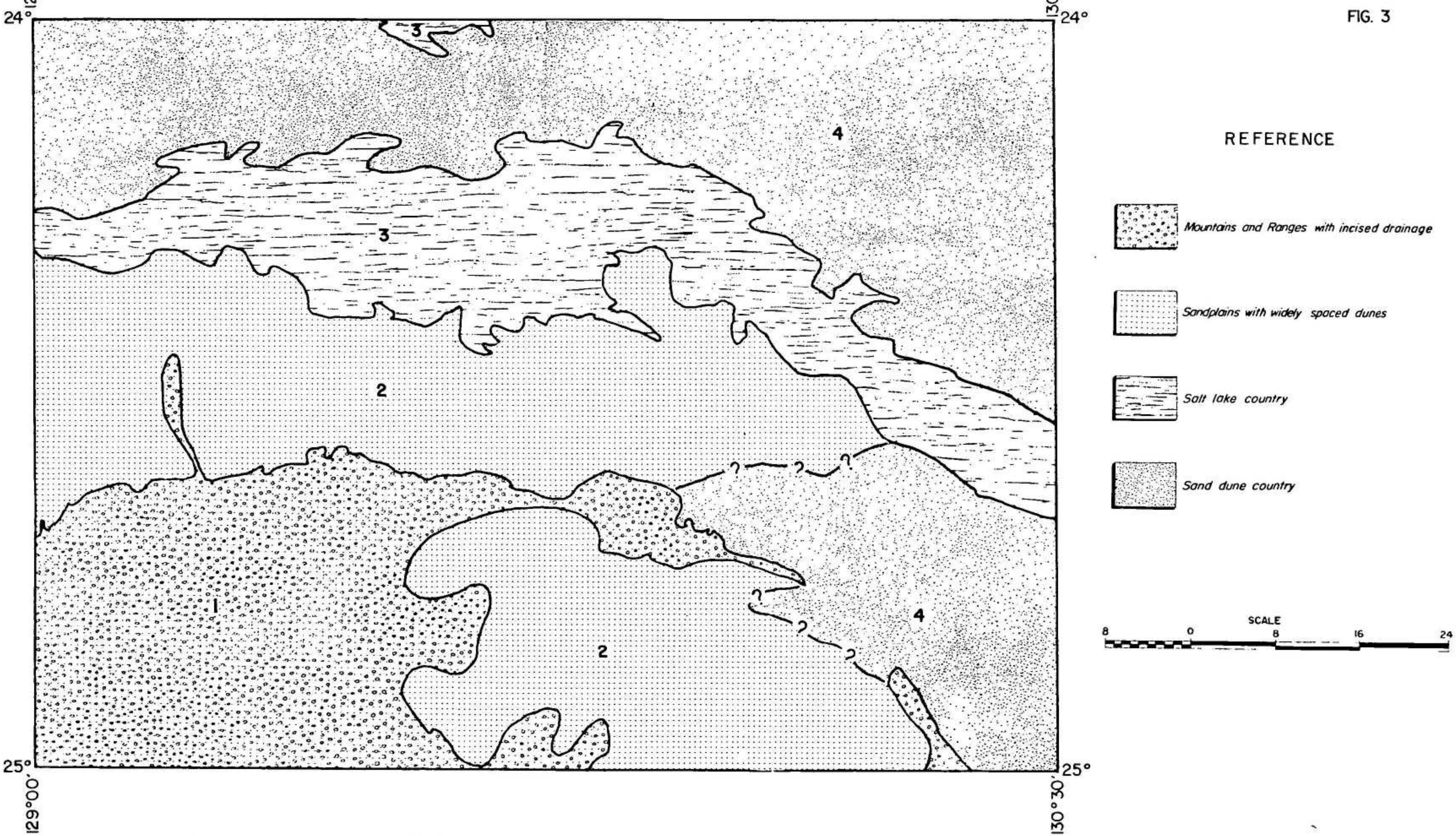
The explorer Ernest Giles (1889) traversed parts of the Bloods Range Sheet area on three expeditions which took place during parts of 1872 to 1874 and 1876. During 1902 R.T. Maurice (Murray 1904) traversed through the area and recorded gypsum and dolomitic limestone at Mount Murray. F.R. George (1907) led a government prospecting expedition to the Petermann Ranges and Bloods Range in 1905. He produced a geological sketch plan showing the granite and quartzite exposures along their route. In 1926 H. Basedow accompanied D. Mackay on an expedition to the Petermann Ranges and Bloods Range and made a geological report on the Petermann Ranges (Basedow 1929). In 1936 H. Ellis accompanied a private expedition through the Petermann Ranges in search of 'Lasseter's Reef' (Ellis, 1937). In 1951 G.F. Joklik (1952) accompanied a similar expedition and made geological notes in the Petermann Ranges - Bloods Range area. Frome-Broken Hill Co. Pty Ltd (Gillespie, 1959) carried out the most extensive survey of the area between Souths Range and the Petermann Ranges in 1958.

Between the 21st and 26th October 1960, the geophysical section of the Bureau of Mineral Resources flew one aeromagnetic traverse from Alice Springs to Giles (Fig.17). In September 1962 a helicopter borne gravity party from the Bureau of Mineral Resources covered the Bloods Range Sheet area in their programme of regional gravity measurements in the Amadeus Basin (Fig. 18).

The geological mapping of the Bloods Range Sheet area in 1962 succeeds the mapping of the following Sheet areas in the Amadeus Basin: Hermannsburg (Prichard and Quinlan, 1962, Rawlinson and Macdonald (Wells, Forman and Ranford, 1961), Mount Rennie and Mount Liebig (Wells, Forman and Ranford, 1962). During 1962 another geological party from the Bureau

PHYSIOGRAPHIC DIVISIONS- BLOODS RANGE SHEET

FIG. 3



Bureau of Mineral Resources, Geology and Geophysics April, 1963 To accompany Record 1963/47 G 52/3/2 LK

Figure 4. Lake Neale: showing salt lake with islands of travertine.

Figure 5. Sand dunes, looking south-west over Lake Neale to Bloods Range in the far distance.

Fig. 6

TENTATIVE CORRELATION OF ROCK UNITS

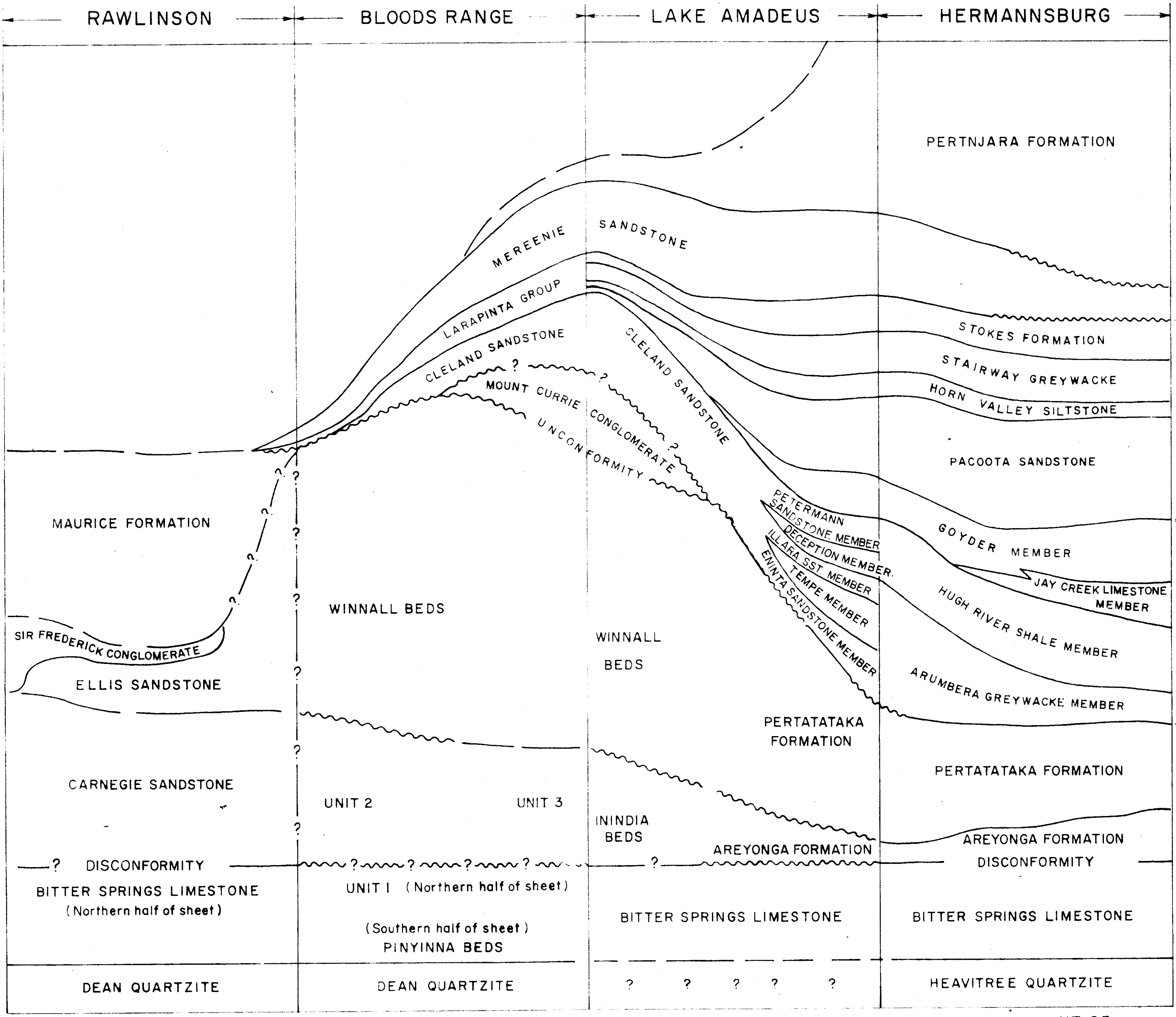


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TABLE 1

AGE	UNIT	MAP SYMBOL	LITHOLOGY	CORRELATED WITH	REMARKS
Quaternary		Qs Qa Qt Ql	Sand Alluvium Evaporites Travertine		
Tertiary		Tc	Conglomerate		Adjacent to high ranges.
Undifferentiated Palaeozoic	Portnjara Formation	Pzp	White siltstone		Very poor outcrop. Only base of unit exposed.
	Moreenie Sandstone	Pzm	Brown and white fine-grained sandstone. Large and moderate scale cross bedding		Lithologically similar to Winnall Beds. Conformable on Larapinta Group.
	Mount Currie Conglomerate	Pzc	Conglomerate		Possibly Cambrian, ?unconformable over Winnall Beds and more strongly folded than the Ordovician rocks.
Ordovician	Undifferentiated	O	White sandstone, pipe rock, conglomerate, dolomite and siltstone. Some marine fossils	Larapinta Group	Shallow marine sedimentary outliers from the Amadeus Basin. Some phosphatic sediments.
	Larapinta Group	Ol	Sandstone, siltstone and limestone. Marine fossils.		Several thin beds of oolitic hematite.
Cambrian	Cleland Sandstone	Ꞓc	Red-brown and brown, medium to coarse-grained, poorly sorted, angular, sandstone and conglomeratic sandstone. Entirely cross bedded.	Part of Pertaoorrta Formation	Deltaic sandstone. Uppermost beds may be Ordovician in age.
	UNCONFORMITY				
Upper Proterozoic	Winnall Beds	Ꝑuw	Brown and white, medium and coarse-grained sandstone, pebbly sandstone. Cross bedded. Poorly outcropping siltstone. Some worm trails. 2000 ft +	?Pertatataka Formation	Some lithologies similar to Moreenie Sandstone. Crops out as ridges. Could be Lower Cambrian or Upper Proterozoic.
	? UNCONFORMITY ?				
		Ꝑu³	Red-brown micaceous siltstone with thin interbeds of brecciated chert and dolomite with some stromatolites.	Inindia Beds and ?Areyonga Formation. ?Carnegie Sandstone.	Unconformity not exposed on Bloods Range Sheet. Tightly folded.
		Ꝑu²	White, medium and coarse-grained, laminated and thin-bedded, feldspathic and kaolinitic sandstone and sandstone. Cross bedding common. Some pebbly beds. Interbedded with siltstone.	?Ꝑu³	Crops out at Souths Range where it is unconformably overlain by the Winnall Beds. Stratigraphic position uncertain.
	? UNCONFORMITY ?				
		Ꝑu¹	Grey, white, pale-yellow-brown, pale pink, laminated, partly foetid dolomite. Three outcrops of gypsum with dolomite.	Bitter Springs Limestone	In northern half of Sheet area. Isoclinally folded.
	Pinyinna Beds	Ꝑui	Grey, white, pale yellow-brown, pale pink, laminated, partly foetid dolomite with rare stromatolites, and siltstone. Recrystallized in most outcrops. Apparently intruded by dolerite on Petermann Range Sheet.	Bitter Springs Limestone	In southern half of Sheet area. Metamorphosed to slightly altered.
	Dean Quartzite	Ꝑud	White, medium and coarse-grained, laminated and thin-bedded, cross-bedded, hard quartzite and sericitic quartzite.	Heavitree Quartzite	In southern half of Sheet area. Metamorphosed to slightly altered.
	UNCONFORMITY				
Undifferentiated Precambrian		pꞒp	Quartz-feldspar porphyry.		Porphyry associated with Bloods Range Beds and Mount Harris Basalt, but relationship unknown.
	Bloods Range Beds	pꞒb	Arkose, sandstone tuffaceous sandstone, tuff, agglomerate, basic flows, quartz porphyry, siltstone. Copper staining.	Dixon Range Beds	Metamorphosed to sericitic schist and sericite schist.
	UNCONFORMITY				
	Mount Harris Basalt	pꞒh	Green, epidotised, amygdaloidal basalt with minor quartzite, tuffaceous quartzite, tuff and agglomerate. Intruded by medium-grained biotite granite (pꞒg²). Copper staining.	Basalt at Mount Leisler, Mount Rennie Sheet.	Fractured and blocky; zones of chlorite schist.
	UNCONFORMITY				
		pꞒg	Rapakivi granite		Foliated to slightly altered, some shear zones.
	INTRUSIVE CONTACT				
	Mannanana Porphyry	pꞒm	Quartz-feldspar porphyry	?Rawlinson Porphyry	Foliated to slightly altered.

of Mineral Resources mapped the Lake Amadeus Sheet area (Wells, Ranford and Cook, 1963).

PHYSIOGRAPHY

Fig. 3 shows the physiographic divisions of the Bloods Range Sheet. These are:

Mountains and Ranges with incised drainage

The ranges and mountains stand up to 3300 feet above sea level and 1300 feet above the surrounding plain. Typically the ranges are rugged with a steep southern face and a gentle northern slope.

The Docker and Hull Rivers, Chirnside, Shaw and Irving Creeks have their headwaters in the Pottoyu Hills south of the Petermann Ranges and drain northerly through the Petermann Ranges; the Docker and Hull Rivers also cut through Bloods Range. These rivers disperse and lose identity away from the mountains and ranges.

Sand plain with widely spaced dunes

Sand plain with spinifex, desert oaks and light scrub occurs north and east of the mountains and ranges and contains widely spaced sand dunes and low ranges and hills. Further north it grades into the salt lake country.

Salt Lake Country (Fig. 4)

A belt of salt lake country extends in a west north-west direction from Lake Amadeus and Lake Neale to Lake Hopkins (Rawlinson Sheet area). This area which is about 1500 feet above seal level includes salt lakes with islands and fringes of sand and travertine. The south-western part of the division is an area of sand or alluvium covered with scrub.

Sand dune country (Fig. 5)

Sand dune country occurs north of the salt lake country and is characterized by closely spaced east to east-north-east trending dunes with low ridges, hills and peaks of rock. The dunes are of unconsolidated sand, fixed by spinifex. They are up to 40 feet high and of the longitudinal, mesh and braided type. Their trend is parallel to the direction of prevailing wind.

STRATIGRAPHY

General

The southern half of the sheet area contains metamorphosed igneous and sedimentary rocks of undifferentiated Precambrian and Upper Proterozoic age and the northern half contains unaltered Upper Proterozoic and Palaeozoic sediments of the Amadeus Basin. Tertiary and Quaternary sediments cover much of the area.

Unit names, descriptions, correlations and relationships are summarized in table I and figure 6.

UNDIFFERENTIATED PRECAMBRIAN

Mannanana Porphyry

Mannanana Porphyry is the name proposed for the boomerang shaped outcrop of schistose feldspar porphyry and quartz-feldspar porphyry which lies south of the Dean and Mannanana Ranges. The Mannanana Porphyry is intruded by granite and the Dean Quartzite was deposited over it during the Upper Proterozoic.

Mannanana Range is the southernmost range in the Petermann Ranges east of Livingstone Pass.

The porphyry has been dynamically metamorphosed to the greenschist facies and all gradations from almost unaltered porphyry to schist have been found. The least altered rock is a rhyolite porphyry containing pale pink subhedral to anhedral phenocrysts of feldspar up to ½" long in a dark brown, fine-grained matrix. Under the microscope the phenocrysts are microcline microperthite, with up to 50% of albite of probable replacement origin, some glomerophenocrysts and phenocrysts of quartz and a few crystals of accessory ilmenite rimmed with sphene. The groundmass consists of fine-grained, holocrystalline, anhedral quartz, feldspar, iron ore, sphene and biotite. At other localities the rock is a dacite porphyry, with the phenocrysts mostly of plagioclase; microcline microperthite being present only in small quantities.

All gradations between rhyolite porphyry and dacite porphyry have been found and petrographic evidence shows that the potash-soda feldspar has been secondarily replaced by a soda-feldspar with a 'chessboard' twinning pattern. The centre of some sodic plagioclase crystals, is occupied by microcline microperthite. In some of the larger phenocrysts a core of microperthite is mantled by a zone of interlocking plagioclase crystals. Other phenocrysts appear as interlocking aggregates of plagioclase crystals or as aggregates of plagioclase and microcline microperthite. However, in the majority of feldspar crystals it is not clear whether the soda feldspar replaces the potash-soda feldspar or vice-versa. Many large ovoid crystals of feldspar up to 2" in length are composed of microcline microperthite with irregular patches of 'chessboard' plagioclase within them. As the size of the microcline microperthite crystals suggests metasomatic growth due to potash metasomatism, it may be that both potash and soda metasomatism have occurred.

In most exposures the porphyry is sheared, and sericite and biotite have developed as roughly parallel flakes or zones of flakes in recrystallized groundmass quartz and feldspar. The phenocrysts have been broken and granulated and their long axes trend parallel to the schistosity. Many of the fractures in the phenocrysts contain groundmass material, sericite and biotite. In places the porphyry is epidotised. Adjacent to the Dean Quartzite the foliation in the porphyry is parallel to the foliation, and in many places to the bedding, in the quartzite.

Older Granite

The older granite in the area is typically a very coarse, porphyritic rapakivi granite. It crops out south of the Dean and Mannanana Ranges and in the Piultarana-Ilyaralona Range area and farther north and east. It intrudes the Mannanana Porphyry and after erosion the Mount Harris Basalt was deposited over it.

The granite is strongly sheared north of the Mannanana Range but is only slightly sheared south of the Mannanana Range. It forms low hills covered with boulders and tors. The surface of the rock is studded with slightly protruding ovoids of microcline microperthite 1" to 2" long. The rock is coarse, uneven-grained and consists of grey quartz and pink feldspar with less than 5% of other accessory or secondary minerals. The feldspar is predominantly microcline microperthite with differing proportions of potash to soda-feldspar. Typically the potash feldspar comprises 70% of the crystal and an interlocking network of albite veins makes up the remaining 30%. In other crystals, the albite has further replaced the microcline to form jagged intergrowths in the microcline microperthite. Some crystals of microperthite are surrounded by a zone of interlocking crystals of albite. Accessory and secondary minerals are iron ore, biotite, albite, sericite and chlorite.

The granite is medium-grained, porphyritic and granophyric at the contact with the Mannanana porphyry; it changes through a medium and coarse, even-grained phase, within a few hundreds of yards from the contact to the typical very coarse, porphyritic, rapakivi granite. The Mannanana Porphyry contains short one inch to two inch wide dykes of pink, medium-grained, porphyritic granite aplite which emanate from the main granite mass. The rapakivi granite has been found intruding the medium and

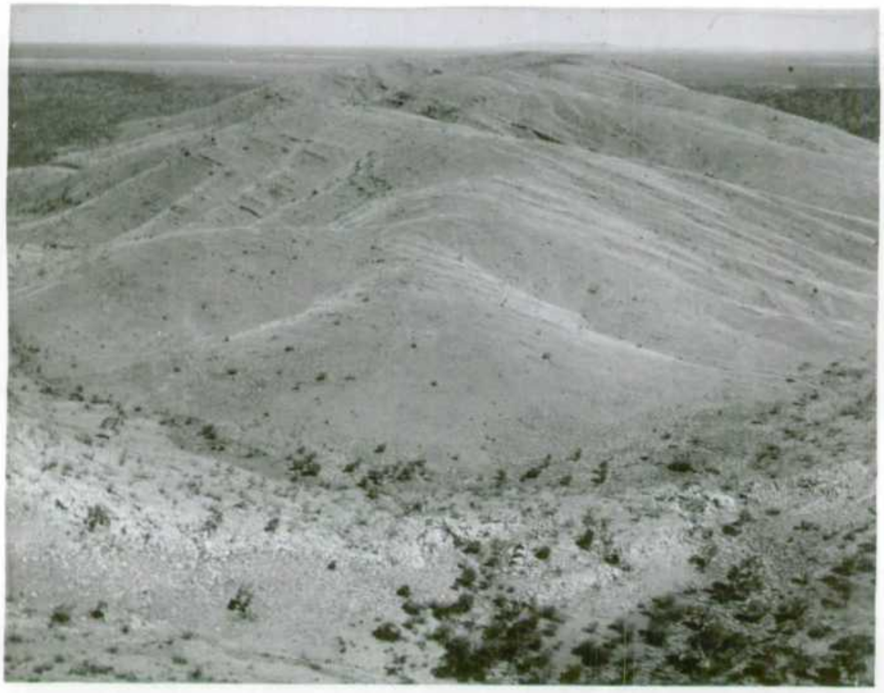

Figure 7. Mount Harris Basalt near Mount Harris. At this locality the Mount Harris Basalt and Dean Quartzite are overturned and flat lying Dean Quartzite (white, foreground) dips flat beneath the basalt in the hill. Looking south toward Petermann Ranges.

coarse-grained border phase of the granite. In other localities the border phase is absent and coarse rapakivi granite is in contact with the Mannanana Porphyry and six-inch wide dykes of coarse rapakivi granite intrude the porphyry. In places numerous equant xenoliths of porphyry occur in the granite close to the contact with the porphyry body. The contact between granite and porphyry is sharp and in some localities the contact zone contains minor pegmatite, aplite and quartz veins.

In many places the granite is sheared along the contact with the porphyry and the lineation in the plane of schistosity pitches 90°. The schistosity in the porphyry is sub-parallel to the granite contact close to the granite contact.

In the Ilyaralona Range - Piultarana Range area the granite is overlain by the Mount Harris Basalt and the Dean Quartzite. The granite in this area is typically very coarse, porphyritic and schistose. The schistosity parallels the schistosity (and bedding) in the Mount Harris Basalt and the Dean Quartzite. In a few places the lineation developed on the plane of schistosity in the granite parallels the lineation on the plane of schistosity in the overlying Mount Harris Basalt or Dean Quartzite. This suggests that the granite has been involved in the same deformation as the younger rocks.

Eight miles south of Mount Harris a coarse-grained, gneissic biotite granite is in contact with brown and grey feldspar porphyry. The porphyry is overlain by the Mount Harris Basalt and is correlated with the Mannanana Porphyry. The granite may be a border phase of the rapakivi granite.

East of Ilyaralona Range the rapakivi granite is strongly sheared.

Mount Harris Basalt

The name Mount Harris Basalt is proposed for the thick sequence of amygdaloidal basalt, tuff and agglomerate with minor sandstone which unconformably overlies the older granite and probably the porphyry eight miles south of Mount Harris. It is overlain by the Bloods Range Beds, with probable unconformity. The basalt is intruded by granite and is associated with brown, feldspar porphyry which may be intrusive or extrusive. The basalt is extensively fractured, faintly foliated, and contains quartz, quartz-hematite and calcite veins.

Mount Harris, near where the unit is well exposed, lies between Bloods Range and the Rowley Range (Fig.7).

The unit crops out in the area between the Ilyaralona Range and Bloods Range. The base of the unit is exposed on the southern and eastern side of this area and contact with the Bloods Range Beds is exposed north of Ilyaralona Range. There is no type section.

The base of the formation crops out in many places as a low ridge. The following lithologies were noted:- arkose - coarse, cross-bedded, pebbly; sandstone - coarse, cross-bedded, pebbly; and sandstone - medium, laminated, cross-laminated, and moderately sorted. This basal unit is up to 100 feet thick and in places is metamorphosed to quartzite, sericitic quartzite, and feldspar-sericite-quartz schist. The basal unit is overlain by a sequence of green and green-grey, amygdaloidal, epidotised basalt with lesser amounts of metamorphosed tuff, chlorite schist, tuffaceous sandstone and sandstone. At many localities the basalt is brecciated. The brecciation may be secondary but could be primary, as in an agglomerate. There is a considerable area of poor outcrop in which fragments of green, epidotised, amygdaloidal basalt occur as scree amongst fragments of green chlorite schist. The chlorite schist is probably derived from shearing of the basalt.

Five miles south-west of Mount Harris the basalt is intruded by a boss of coarse, even-grained, biotite granite and dykes of pink, aplitic granite, porphyritic aplite and rhyolite porphyry. On the northern margin of this intrusion the basalt appears to be little altered. However, thin section examination shows that the basalt has been extensively sericitized. South of the intrusion the basalt has been locally altered to medium and coarse-grained, green-grey, amphibolite and chlorite schist. A quartz vein intruding this rock contains secondary lead and copper minerals, galena and a trace of silver and gold. (specimen No. BR99).

Eight miles south of Mount Harris a body of porphyry in contact with granite along one margin is separated from the Mount Harris Basalt by a thin quartzite bed. This porphyry is probably older than the basalt and of the same age as the Mannanana Porphyry. In other areas where porphyry is in direct contact with basalt the relationship of the basalt to the porphyry could not be determined; these porphyries may intrude the basalt.

It is possible that some of the rocks mapped as Mount Harris Basalt may be a volcanic sequence within the Bloods Range Beds.

Younger Granite

The younger granite crops out 6 miles south-west of Mount Harris where it intrudes the Mount Harris Basalt as a boss one and a half miles long and a half mile wide. It is a medium, uneven-grained, pink biotite granite composed of microcline microperthite, strained quartz, biotite, plagioclase and epidote. Biotite and epidote form about 5% of the rock. The microcline microperthite is a replacement microperthite and many grains are intergrown with quartz forming a micrographic texture. Most of the plagioclase appears to have formed as a replacement of microcline microperthite.

The northern margin of the granite body is exposed at specimen locality BR33 where it intrudes dark greenish-grey, amygdaloidal basalt. Adjacent to the basalt the granite is fine-grained and in places porphyritic. The contact between fine-grained granite and basalt is sharp. The basalt contains dykes of pink, quartz-feldspar porphyry and pink micro-granite. The porphyry contains glomerophenocrysts of quartz and microcline, in a micrographic intergrowth, and iron ore and biotite surrounded by a fine-grained groundmass of quartz and feldspar. The basalt is sericitized adjacent to the intrusion.

Near the southern margin of the intrusion the basalt is partly altered to green-grey and green, medium and coarse-grained, amphibolite. At BR99 an east-west trending quartz vein, several feet thick, contains secondary lead and copper minerals with traces of galena, and gold. The few pounds of specimen collected represented the major part of mineralized rock seen.

Bloods Range Beds

Bloods Range Beds is the name proposed for a sequence of sandstone, arkose, tuff, agglomerate, tuffaceous sandstone and siltstone with inter-bedded basic and possibly acid extrusive rocks. The sequence overlies the Mount Harris Basalt with probable unconformity and is overlain unconformably by the Dean Quartzite. Outcrops of brown feldspar porphyry occur near many outcrops of the Bloods Range Beds; 4 miles north of the Ilyaralona Range porphyry occurs in the Bloods Range Beds. Dynamic metamorphism has produced all variations to sericite-quartz schist, quartz sericite schist and feldspar-quartz-sericite schist. Both acid and basic flows have been sheared; the basic flows are partly epidotized, and many contain malachite.

The sequence is exposed between Bloods Range and the Ilyaralona Range on the western side of the sheet area where it forms low flat-topped ridges. North of the Ilyaralona Range it overlies Mount Harris Basalt at one locality and one mile farther along strike it overlies granite, suggesting an angular unconformity unless the granite is intrusive into the Mount Harris Basalt. Unconformity of the Dean Quartzite over the Bloods Range Beds and older rocks is evident from its regional outcrop pattern but the strongly folded unconformity is difficult to locate.

Poor outcrop and complicated structure did not permit detailed sub-division of the lithologies. North of Ilyaralona Range, the Mount Harris Basalt and granite are overlain by interbedded, sheared, coarse-grained, pebbly, schistose arkose and quartzite of the Bloods Range Beds. Metamorphism of the pebbly arkose has produced a pink, coarse-grained, sericite-feldspar-quartz schist with stretched pebbles of brown feldspar porphyry, vein quartz and possibly quartzite.

The basal beds of metamorphosed arkose and sandstone are overlain by green, medium-grained, epidotised, quartz-sericite schist and sericite-quartz schist; malachite is sparsely distributed in the schist and is also found rimming hematite in quartz stringers. Some of the schist appear to be made up of sheared fragments of basaltic material, and the rock was possibly an agglomerate. The remainder of the schist has the appearance of sheared tuff, tuffaceous sandstone and impure sandstone. The rock overlying these beds is not exposed. Higher in the section is sheared acid porphyry and a metamorphosed sequence of medium to coarse-grained sandstone, tuffaceous sandstone and tuff with thin flows of amygdaloidal basalt containing sparse malachite. The sandstone and tuff are metamorphosed to sericitic quartzite and quartz-sericite schist.

The rocks south of Bloods Range and west of the Hull River are correlated with the Bloods Range Beds but are less metamorphosed. They include brown and yellow-brown sericitic quartzite; brown slate; brown pebbly slate with ?volcanic fragments; pink-brown and pale purple-brown, medium-grained, moderately to poorly sorted, laminated and cross laminated sericitic sandstone; brown feldspar porphyry; epidotized amygdaloidal basalt; purple-brown tuff; pink-brown and pale purple-brown, medium-grained, sericitic, tuffaceous sandstone and agglomerate with fragments typically half to three quarters of an inch across. Thin beds of white quartz porphyry, within the sequence, may be either flows or sills.

All thick sequences of basalt have been mapped as Mount Harris Basalt, but the possibility that some of these may be within the Bloods Range Beds is admitted.

The Bloods Range Beds are tentatively correlated on lithology with the Dixon Range Beds of the Rawlinson sheet area, and with the rocks of the Kathleen Range area on the north-eastern corner of the Scott Sheet.

Quartz-Feldspar Porphyry

Bodies of brown quartz-feldspar porphyry are associated with the Mount Harris Basalt and the Bloods Range Beds. Whether these bodies are intrusive or extrusive is not known. Unlike the Mannanana Porphyry and the porphyry at specimen locality BR44 they are not associated in outcrop with granite.

The porphyry outcrops are up to six miles long and two miles wide and trend in an easterly direction. They abut against the Mount Harris Basalt and the Bloods Range Beds. In some the size of the phenocrysts decreases as the margin is approached but there is no clear evidence that the contact is intrusive. In many places the bodies are sheared and foliation parallels the margins and the foliation of the host beds.

Phenocrysts of pink plagioclase up to half an inch in length, but more typically about quarter of an inch, are set in a brown, fine-grained matrix. Thin sections were examined from BR38 and BR39 south of Bloods Range on the eastern side of the Hull River. Phenocrysts of quartz and plagioclase are set in a fine-grained matrix of quartz, feldspar and iron ore. There is no microcline or microcline microperthite in the phenocrysts but the twinning of the plagioclase is similar to some of the twinning in the plagioclase of the Mannanana Porphyry, suggesting possible replacement of microcline microperthite by plagioclase.

Figure 8. Dean Quartzite in the Dean Range (right) and Mannanana Range (left). Gap between the ranges is Livingstone Pass. Taken looking south-east from vehicle track through the Petermann Ranges.

FIGURE 9. Learmonth Park, in middle distance, looking east-north-east to Mannanana Range. Mannanana Porphyry in foreground and below breakaway in range is overlain unconformably by Dean Quartzite at top of range.

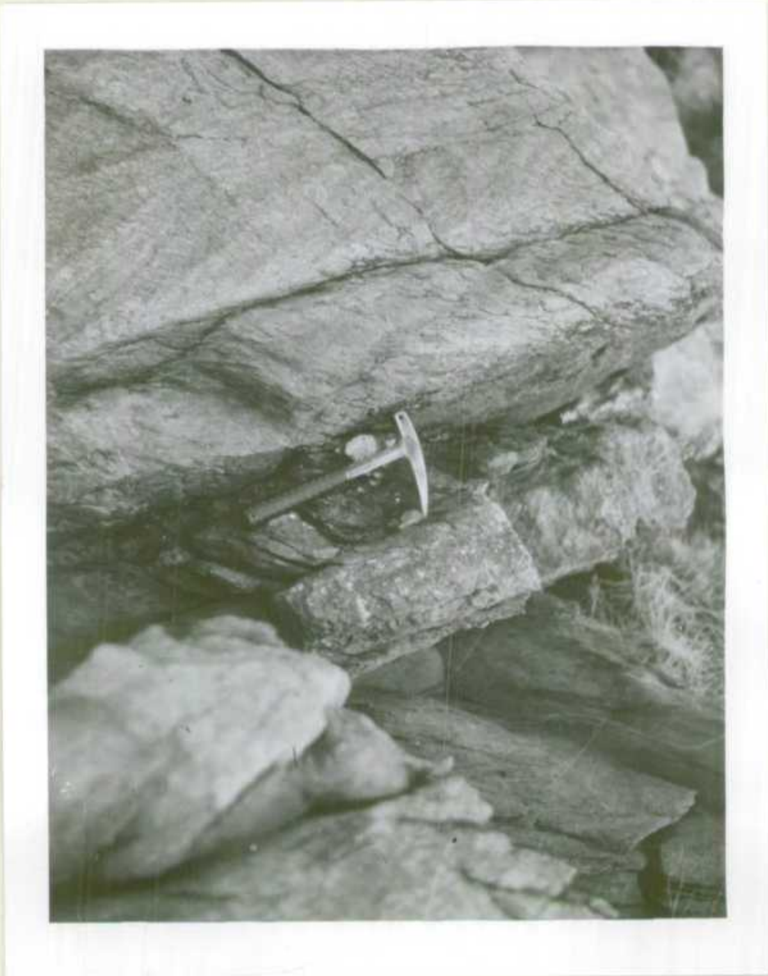

Figure 10. Unconformity between Dean Quartzite (above) and Mannanana Porphyry in Mannanana Range, $\frac{1}{4}$ mile east of Livingstone Pass. Below hammer is thin conglomerate bed at the base of the Dean Quartzite.

The Dean Quartzite was deposited on the porphyry in the Bloods Range area.

UPPER PROTEROZOIC

Dean Quartzite

Dean Quartzite is the name proposed for the sequence of tough, varicoloured, cross bedded quartzite, which lies with angular discordance on the eroded surface of the Mannanana Porphyry, the Mount Harris Basalt, Bloods Range Beds and the older granite and is conformably overlain by the Pinyinna Beds.

The quartzite forms high country in the Dean, Mannanana, Piultarana, Ilyaralona, Bloods, Rowley, Pinyinna and McNichol Ranges and in the Kulapurina, Wailarra and Kulipurra Hills.

The folded unconformity at the base of the quartzite is well exposed in the Dean Range (Fig. 8), Mannanana Range (Fig. 9, 10), Bloods Range and Piultarana Range. The unconformity surface is uneven and is overlain by basal beds of conglomerate, greywacke, sandy siltstone and conglomeratic sandstone of varying thickness and in most places of local extent. Metamorphism of these basal beds has produced sericite-quartz schist. Directly overlying the basal beds or, where these are absent, directly overlying the unconformity, is the tough quartzite and sericite-bearing quartzite which makes up the greater part of the Dean Quartzite.

In the Petermann Ranges the quartzite is tough, closely jointed, lineated, white, pink and pale brown, fine to medium-grained, laminated and cross laminated. It contains a minor amount of sericite.

The quartzite in Bloods, Rowley, Pinyinna and McNichol Ranges is of coarser grain, more pebbly and less metamorphosed. It comprises closely jointed, tough, slightly metamorphosed, partly silicified, white and brown quartzite and quartz sandstone with thin bedding, laminae and cross-laminae. The quartzite and sandstone are predominantly medium to coarse-grained, moderately sorted, moderately rounded and include intervals of very coarse-grained brown sandstone and pebbly sandstone.

Thickness of the Dean Quartzite in the Piultarana Range, calculated from measured dips and photo measurements, is between 1,000 and 1,500 feet. The thickness at Bloods Range and Pinyinna Range is unknown but from outcrop width and dip on air photographs it may be thicker than in the Piultarana Range.

The quartzite is overlain directly by the siltstone and dolomite of the Pinyinna Beds and the boundary is placed at the change from quartzite to siltstone or dolomite. Beds of siltstone apparently in the quartzite are actually infolded basal Pinyinna Beds and siltstone does not occur in the Dean Quartzite.

The Dean quartzite is correlated with the Heavitree Quartzite of Upper Proterozoic age. The two units are lithologically similar, both rest on granite and other basement rocks and both are succeeded conformably by a dolomite and siltstone sequence. The Heavitree Quartzite is metamorphosed in the Chewings, Belt and Amunurunga Ranges and the Dean Quartzite is metamorphosed in the Petermann Ranges.

Pinyinna Beds

The Pinyinna Beds are a poorly exposed sequence of crystalline dolomite, limestone (with a few poorly preserved stromatolites) and siltstone which conformably overlie the Dean Quartzite. The beds are recrystallized to medium-grained, lineated schist or only slightly recrystallized in the Petermann Ranges and are slightly altered in Bloods Range, Pinyinna Range and near Mount Harris.

At Pinyinna Range the beds are unconformably overlain by the Mount Currie Conglomerate. The Mount Currie Conglomerate unconformably overlies undifferentiated Upper Proterozoic sediments (Pu^2) at Mount Currie and east of the Pinyinna Range but the exact relationship of these sediments to the Pinyinna Beds is concealed; however they are considered to be younger than the Pinyinna Beds.

The thickness of the Pinyinna Beds is unknown. On stratigraphic position, lithology and structure the beds are correlated with the Bitter Springs Limestone and accordingly an Upper Proterozoic age is assigned to them. Dolomite, limestone and gypsum north of Bloods and Pinyinna Ranges is also similar to the Bitter Springs Limestone and probably belong to part of the Pinyinna Beds sequence. These are represented on the map by the symbol Pu^1 and described as unit I of the undifferentiated Upper Proterozoic.

The Pinyinna Beds are exposed in the valley between the Petermann Ranges, south-east of Chirnside Creek, on the Petermann Range Sheet and hence the alluviated valley between the Petermann Ranges on the Bloods Range Sheet is also underlain by Pinyinna Beds.

The basal siltstone member is exposed in Bloods Range, near Mount Skene, 5 miles west of Livingstone Pass and also in the Ilyaralona Range in a sequence which appears overturned. The basal siltstone and overlying dolomite and limestone are exposed north of the Piultarana Range, Mount Harris and Pinyinna Range.

North of the western end of Pinyinna Range the basal member is concealed and grey and pink, fine-grained and fine to medium-grained, laminated dolomite and foetid dolomite, grey dolomite with stromatolites and pale grey, fine-grained limestone, crop out about 100 yards north of the range, and dip steep south beneath the Dean Quartzite. The section is overturned. The Pinyinna Beds are unconformably overlain by the Mount Currie Conglomerate which dips north. North of the eastern end of the Pinyinna Range a considerable thickness of grey, brown and white, laminated, micaceous siltstone directly overlies and dips south beneath the Dean Quartzite. Cross bedding in the quartzite proves the overturning.

Near Mount Harris the Pinyinna Beds are grey, red, pink and yellow, laminated, fine and medium-grained, slightly recrystallized limestone and dolomite interbedded with dark grey, laminated, micaceous siltstone and traversed by calcite veinlets. The sequence is here exposed in the core of a recumbent fold (see Fig. 15); at the same locality an isoclinal fold with a horizontal axial trace is exposed on a steep hillslope.

North of the Piultarana Range the Pinyinna Beds crop out in the core of an isoclinal fold. They overlie the Dean Quartzite and are represented by a thin bed of grey and black siltstone and by a thick sequence of varicoloured, fine to medium-grained, foetid dolomite and limestone. These carbonate rocks are sheared, slightly recrystallized and traversed by carbonate veins. Four miles farther along strike to the west-north-west the siltstone at the base of the Pinyinna Beds is about 300 feet thick and is metamorphosed to sericite schist.

Undifferentiated

Three unnamed units of probable Upper Proterozoic age have been mapped. These are represented on the map as Pu^1 Pu^2 Pu^3. Unit 1 consists of crystalline dolomite and limestone associated with gypsum at some localities, unit 2 consists of sandstone and siltstone and unit 3 consists of red-brown siltstone, dolomite and chert. Unit 1 is correlated on lithology with both the Bitter Springs Limestone and the Pinyinna Beds. Unit 3 is correlated lithologically with the Ininidia Beds of the Lake Amadeus Sheet area and the Inindia Beds are correlated with part of the Areyonga Formation by Wells, Ranford and Cook (1963). The lithology of unit 2 is unlike that of any unit previously mapped in the Amadeus Basin. It is poorly exposed at two widely separated localities along the southern margin of the Amadeus Basin. It unconformably underlies the Winnall Beds at one of these localities and the Mount Currie Conglomerate at the other and hence an Upper Proterozoic age is assigned to it. Formal stratigraphic names were not given to these units because their stratigraphic relationships are not clear.

Unit 1:

Unit 1 is a thick sequence of crystalline dolomite and limestone with which gypsum is associated at three localities. The dolomite and limestone are yellow, brown, grey, grey and brown, yellow-brown, grey-brown, foetid, fine-grained, laminated and thin bedded, frequently contorted, brecciated and silicified.

Upper and lower contacts of unit 1 with other units are not exposed.

It is strongly folded and steep dips and overturning are common features. Collenia have been noted at several localities and are absent at other localities.

Gypsum occurs associated with the carbonate at the following localities.

(1) Mount Murray on the Lake Amadeus Sheet. Highly weathered, sheared, laminated gypsum overlain by isoclinally folded, brecciated, dolomite and limestone crops out in the core of an anticline in Upper Proterozoic and Palaeozoic rocks. The isoclinal folding of the carbonate rocks is much smaller and tighter than the main anticline. The gypsum at this locality extends onto the eastern side of the Bloods Range sheet at about latitude 24° 11'.

(2) The north-eastern corner of the Bloods Range Sheet. The gypsum is grey, sheared and contains fragments of dolomite breccia. At specimen locality BR48 a large block of white, fine-grained, stromatolitic dolomite is surrounded by secondary gypsum in which small patches of the primary grey, laminated gypsum can be seen. The gypsum outcrop abuts against moderately dipping Cleland Sandstone at its south-eastern and north-western extremities. This relationship suggests diapiric intrusion of the gypsum.

(3) Specimen locality BR53. The outcrop here is similar to that at BR48. Chaotic blocks of dolomite and limestone, form small peaks surrounded by secondary gypsum and travertine through which the primary grey, laminated gypsum outcrops in a few places. No other rocks crop out near this gypsum mass.

Unit 2:

Unit 2, comprised of sandstone and siltstone, is poorly exposed north of Souths Range and also at the south-east corner of the sheet north of Mount Currie (Mount Currie is on the Ayers Rock Sheet). It is overlain with marked unconformity by the Winnall Beds at Souths Range and by the Mount Currie Conglomerate at Mount Currie. Wells, Ranford and Cook (1963) from regional stratigraphic considerations have correlated the Winnall Beds with part of the Pertatataka Formation. If this is so then unit 2 would be older than the Pertatataka Formation and possibly equivalent in part to the Areyonga Formation (Fig. 6).

Unit 3 which crops out farther north near Lake Neale and Lake Amadeus is lithologically similar to the Inindia Beds which have been correlated with the Areyonga Formation by Wells, Ranford, & Cook (1963). Accordingly unit 2 may be a facies variant of unit 3.

Sandstone of unit 2 at Souths Range is white, medium to coarse-grained, part conglomeratic, laminated, thin-bedded, cross laminated, moderately sorted, subrounded and clean to kaolinitic. Pebbles of the conglomeratic sandstone are of quartzite, chert and siltstone. The more kaolinitic sandstone has prominent grains of feldspar and grades into kaolinitic feldspathic sandstone and arkose. The sandstone is densely

Figure 11. Winnall Beds at Souths Range, looking east.
Base of unit is along left edge of photograph.

jointed, about 200 feet thick, and underlain by poorly outcropping, yellow, travertinized siltstone and fine sandstone.

North-west of Mount Currie on the Bloods Range Sheet the Mount Currie Conglomerate is underlain unconformably by an interbedded sandstone and siltstone sequence of unknown thickness. The sandstone is white, fine, medium and coarse-grained, laminated and thin bedded, cross laminated, moderately sorted, moderately rounded and tough to friable. The siltstone is yellow and yellow-brown, laminated and in part micaceous.

There is some doubt that the outcrops north of Souths Range and north of Mount Currie belong to the same unit.

Unit 3:

Unit 3 is lithologically similar to the Inindia Beds of the Lake Amadeus Sheet. It is best exposed 4 miles north-east of Mount Unapproachable where brown and red-brown siltstone, claystone, shale and thin beds of chert, chert breccia, dolomite and limestone are tightly folded. The unit has only been mapped in the Lake Neale, Lake Amadeus area where it is overlain by the Winnall Beds. The base of the unit was not seen.

The siltstone and shale are poorly outcropping, brown, laminated, thin bedded and cross laminated. The siltstone, shale and claystone are partly micaceous and contain "biscuits" and veinlets of chert and beds several feet thick of vuggy chert and chert breccia. It is clear that chert has replaced the claystone, shale and siltstone which in many places are strongly silicified.

The dolomite and limestone beds up to 50 feet thick are pink, grey and yellow-brown, fine-grained, laminated, and locally foetid, highly brecciated and contorted. Stromatolites occur in many of the beds.

Two closely spaced beds of fine angular conglomerate are interbedded with the red-brown micaceous siltstone south of Long Range at the eastern edge of the sheet.

Unit 3 is correlated with the Inindia Beds of the Lake Amadeus Sheet. The Inindia Beds have been correlated with the Areyonga Formation by Wells, Ranford and Cook (1963). The unit also bears some lithological resemblance to the Boord Formation of the Macdonald Sheet area which interfingers with the Carnegie Formation of the Rawlinson, Macdonald and Mount Rennie Sheet areas (Wells, Forman and Ranford, 1961). All these formations are regarded as Upper Proterozoic in age and unit 3 is probably of the same age.

PROTEROZOIC - PALAEOZOIC

Winnall Beds

The Winnall Beds were defined and described from the Lake Amadeus Sheet by Wells, Ranford and Cook (1963). The formation was described as a sequence of siltstone, sandy siltstone, sandstone and pebbly sandstone which lies probably unconformably above the Inindia Beds and is overlain unconformably by the Pertaoorta Formation, or where this is absent, by the Larapinta Group. The type locality was given as Winnall Ridge. Öpik (pers. comm.) has identified a trace fossil which he considers has many similarities to Syringomorpha (Narthorst) and on this basis Öpik speculates on a Cambrian or possibly even Lower Cambrian age for the Winnall Beds. Wells, Ranford and Cook believe that on this basis and on the basis of stratigraphic position the Winnall Beds are probably in part stratigraphically equivalent to the Pertatataka Formation. They give the thickness of the Winnall Beds as about 7,000 feet.

On the Bloods Range Sheet, the Winnall Beds crop out as strike ridges as at Long Range, Mount Unapproachable and Souths Range (Fig. 11). The sediments in the small structural basins at Mount Cowle and west of the Hull River are tentatively placed in the Winnall Beds.

At Long Range and Mount Unapproachable, the Winnall Beds overlie unit 3, but the contact is not exposed. At Souths Range, the Winnall Beds unconformably overlie unit 2. The unconformity between the overlying Cleland Sandstone and the Winnall Beds was seen on the Lake Amadeus Sheet, east-south-east of Nonane rock hole.

The total thickness of the beds is unknown. At Souths Range two thousand feet of steeply dipping sandstone unconformably overlies unit 1. The basal beds are cross bedded, pebble conglomerate and fine pebble conglomerate. Pebbles of black and white, laminated chert, kaolinitic feldspathic sandstone (or arkose), coarse quartz sandstone and silicified white siltstone occur in a medium to coarse-grained, moderately sorted, moderately rounded, sandstone matrix. The silicified siltstone fragments are angular. The basal beds are overlain by a clean white, medium-grained sandstone which is laminated, extensively cross-laminated on a large, moderate and small scale, moderately sorted, moderately rounded and slightly friable to tough. Some cross bed sets are up to ten feet thick.

Mount Cowle is a basin shaped structure with an outer ring of clean white, medium-grained quartz sandstone which is thinly bedded, well sorted and well rounded. The inner ring at Mount Cowle is composed of interbedded sandstone and siltstone. The sandstone is grey and white, fine to medium-grained, laminated, cross laminated, platy, moderately sorted, moderately rounded, silicified and tough. Another basin shaped structure occurs in a hill 26 miles west of Mount Cowle. The main mass of the hill is composed of white, fine and medium-grained, laminated, cross laminated, moderately sorted, moderately rounded, silicified, tough sandstone with some ripple marking and mud pellets. It is underlain by pale yellow, fine-grained sandstone and grey, laminated siltstone. If these two circular outcrops and South Range all belong to the Winnall Beds then the sequence must be very thick and the greater part of it concealed between Mount Cowle and Souths Range.

Near Lake Neale and Lake Amadeus the formation consists of interbedded red-brown and white, sandstones which are medium-grained, moderately sorted, moderately rounded, laminated and thin bedded, extensively cross bedded and cross laminated, friable to tough, partly silicified, partly ferruginous and partly platy. A few of the sandstone beds are coarse-grained and contain abundant detrital chert. At Mount Unapproachable there are markings on some bedding planes which may be fossil invertebrate tracks.

The age of the Winnall Beds may be Upper Proterozoic, Cambrian or both.

The lithology, structure and stratigraphic relationships of the Winnall Beds suggest a correlation with the Ellis Sandstone on the Macdonald and Rawlinson Sheet areas.

LOWER PALAEOZOIC

Cleland Sandstone

The Cleland Sandstone was described by Wells, Forman and Ranford (1962) as a sequence of fine to coarse-grained and locally pebbly, ferruginous, partly feldspathic and partly micaceous sandstone, which lies conformably beneath the Goyder Formation in the Idiriki Range, and conformably beneath the Pacoota Sandstone in exposures farther west.

The unit crops out as low hills and ridges on the northern half of the Bloods Range Sheet. It overlies the Winnall Beds unconformably and is conformably overlain by the Larapinta Group. It crops out as far west as longitude 129° 25' on the western side of the sheet but is absent in the section farther west. The unit is probably about 2000 feet thick on the eastern side of the sheet and wedges out to the west.

The sandstone is red-brown, yellow-brown, chocolate, medium-grained, poorly sorted, subangular, ferruginous, micaceous and pebbly. It is almost entirely cross bedded and contains slump structures and ripple marks. At some localities the Cleland Sandstone contains conglomerate; this is best exposed north of the western end of Lake Neale as pebble, cobble and boulder conglomerate with ellipsoidal fragments of rounded, sericitic quartzite, vein quartz, quartzite, chert and white, fine-grained, quartz sandstone. The matrix is white, poorly sorted, angular, coarse to very coarse feldspathic sandstone. The phenoclasts have probably been derived from the Dean Quartzite, Pinyinna Beds and Winnall Beds. On the eastern side of the area the top of the Cleland Sandstone is thin bedded and cross bedded and contains poorly outcropping interbeds of highly micaceous, brown and white, laminated, cross laminated, siltstone.

The base of the overlying Larapinta Group may be of Lower Ordovician age and hence the top of the Cleland Sandstone is probably the same age.

Wells, Forman and Ranford (1962) consider that the basal part of the Cleland Sandstone on the Mount Liebig Sheet may be equivalent to the Arumbera Greywacke Member of Upper Proterozoic or Lower Cambrian age. However on the Hermannsburg Sheet the Arumbera Greywacke Member sits conformably on the Pertatataka Formation (Fig. 6). The Cleland Sandstone, on the Bloods Range Sheet rests unconformably on the Winnall Beds and it is unlikely that any deposition took place during the Upper Proterozoic. Hence the Cleland Sandstone is considered to be Cambrian and possibly part Lower Ordovician.

Larapinta Group

The Larapinta Group was defined by Prichard and Quinlan (1962) as consisting of "four formations (in ascending order): Pacoota Sandstone, Horn Valley Formation, Stairway Greywacke, and Stokes Formation. It conformably overlies the Pertaoorta Group and is separated from the overlying Mereenie Sandstone by a regional unconformity." Wells et al, 1962, revised the formal Stairway Greywacke to Stairway Sandstone.

Formations of the Larapinta Group have been mapped from the Hermannsburg Sheet to Mount Liebig, Mount Rennie and Lake Amadeus Sheet areas. These units, with the exception of the Pacoota Sandstone are not clearly recognizable over the entire Bloods Range Sheet where the group was recognized conformably between the overlying Mereenie Sandstone and the underlying Cleland Sandstone.

The sequence is very poorly exposed as low hills and strike ridges in the northern half of the sheet area. The thickest exposed section occurs 12 miles west-north-west of Mount Murray. Maximum total thickness of the unit as calculated from photo measurements and measured dips is about 1000 feet. At the base the Pacoota Sandstone forms a prominent low ridge containing sixty to seventy feet of clean, white, medium to coarse-grained, pipe rock and sandstone which are moderately sorted and rounded, thin and medium bedded, friable, slightly porous and blocky. The pipe rock contains abundant but poorly preserved worm tubes. There are some thin interbeds of apparently bimodal white, medium and coarse-grained sandstone with thin bedding and well rounded grains. The Pacoota Sandstone contains very poorly preserved traces of shelly fossils and at some places there is a very fine conglomerate at the base.

The sediments immediately overlying the Pacoota Sandstone are poorly exposed, mottled yellow-brown, pink and white, fine-grained, laminated, micaceous sandstone, silty sandstone and siltstone with thin interbeds of fine-grained sandstone and medium-grained, oolitic hematite. Beds of oolitic hematite up to four feet thick were seen on the Lake Amadeus Sheet adjacent to the Bloods Range Sheet border about four miles south of Nonane rock hole but on the Bloods Range Sheet most of the oolitic iron ore beds are half an inch to three inches thick. This unit which is about 60 feet thick is correlated with the Horn Valley Siltstone. It is overlain by a bed of clean, white, medium to coarse-grained, fossiliferous quartz sandstone, with thin bedding and moderate sorting and rounding.

The sediments overlying this sandstone ridge are either poorly exposed or concealed everywhere on the Bloods Range Sheet. They include pale green, pink and white, fossiliferous, interbedded siltstone and fine-grained sandstone. J. Gilbert-Tomlinson (pers. comm.) recognised Middle Ordovician fossils from BR12 in this interval. This unit which is at least several hundreds of feet thick is tentatively correlated with the Stairway Sandstone.

A poorly exposed white laminated siltstone with salt pseudomorphs, overlying the sandstone and siltstone at BR12, may be equivalent to the Stokes Formation.

On the north-western part of the sheet area the Pacoota Sandstone is overlain by beds containing oolitic hematite. The beds overlying these are concealed except for outcrops of pale yellow-brown, coarse-grained, laminated and thinly bedded, cross laminated, sandy coquinite; yellow-brown medium-grained, laminated, moderately sorted, subrounded calcareous sandstone; and pink and yellow-brown, fine-grained, laminated limestone or dolomite.

At specimen locality BR22 the Larapinta Group overlies a thin sequence of Cleland Sandstone. Sixteen miles farther west a ferruginous sandstone probably at the base of the Larapinta Group rests unconformably on steeply dipping Upper Proterozoic algal dolomite and limestone.

The age of the Larapinta Group from the contained fossils is Ordovician.

Ordovician (Undifferentiated)

Fossiliferous marine conglomerate, sandstone, crystalline dolomite and limestone, shale and siltstone is exposed on the southern half of the Bloods Range Sheet in strike valleys within the Petermann Ranges and between the Petermann Ranges and Bloods Range, Pinyinna Range, Kulapurina Hills. These sediments are flat lying or gently folded and unconformably overlie the metamorphosed and intensely folded Precambrian rocks. Similar sediments occur on the Rawlinson and Petermann Ranges Sheet areas. They form low mesas.

The sediments are best exposed on the southern side of McNichol Range where they unconformably overlie steeply dipping quartzite and schist. They comprise coarse, brown, angular, unsorted conglomerate, overlain by interbedded, poorly-sorted, angular conglomerate and pale pink-brown, medium-grained, bimodal sandstone containing poorly sorted, angular grains. This sediment is overlain by pipe rock. The pipe rock is overlain by poorly outcropping, pink, medium-grained, laminated sandstone, which is moderately sorted, moderately rounded, with a finely pitted weathering surface. This sequence of conglomerate and sandstone dips southward at a low angle off the range. About four miles farther south interbedded fossiliferous limestone, dolomite, sandstone and siltstone about 50 feet thick crops out. This sequence probably occurs above the basal conglomerate and sandstone. The lithologies exposed in ascending order are: pale brown fossiliferous sandstone, medium-grained, bedded, well sorted, well rounded, clean and friable with two thin beds of red, silty-fossiliferous phosphatic limestone (BR75); red to red-brown, fossiliferous crystalline dolomite; brown micaceous shale with abundant salt pseudomorphys (up to half an inch in size) and thin interbeds of sandstone; white sandstone, medium and coarse-grained, thin bedded, blocky, slightly friable, moderately sorted, moderately rounded, clean, partly calcareous, with some unsorted, angular grains; pale blue-grey crystalline limestone - fine-grained, laminated, platy, interbedded with poorly outcropping shale and siltstone.

The basal conglomerate, pipe rock and sandstone has been found adjacent to the Petermann Ranges four miles north-east of Mount Skene at BR46, south of Mount Sargood on the Rawlinson Sheet, north east of Mount Sargood on the Bloods Range Sheet. The same unit has been tentatively identified on the northern side of Bloods Range west of the Hull River.

At most localities the basal conglomerate extends up the range as far as a terrace which may be an Ordovician wave-cut platform. If this is so then there has been little tectonic activity and erosion in the area since the Ordovician.

Fragmentary molluscs and trilobites from this sequence at specimen locality BR75 were not generically identifiable but indicate an Ordovician age (J. Gilbert-Tomlinson per. comm.).

UNDIFFERENTIATED PALAEOZOIC

Mount Currie Conglomerate

The Mount Currie Conglomerate is a sequence of pebble, cobble and boulder conglomerate unconformably overlying undifferentiated Upper Proterozoic sediments at Mount Currie.

Mount Currie is in the north-western corner of the Ayers Rock Sheet and its flanks extend on to the adjoining Bloods Range and Petermann Ranges Sheets. Murray (1904) first recorded the conglomerate at Mount Currie and Mount Olga; - Blatchford (1932) and Ellis (1937) thought that the beds at Mount Olga might be of glacial origin; - Joklik (1952) regarded them as Lower Palaeozoic in age.

On the Bloods Range Sheet, north and west of the Pinyinna Range and west of Waillarra Hills, the Mount Currie Conglomerate forms low rounded hills. This unit unconformably overlies the Pinyinna Beds in the Pinyinna Range, a poorly outcropping sandstone farther west, tentatively correlated with the Winnall Beds, and unit 2 of the unnamed Upper Proterozoic succession at Mount Currie.

At Mount Currie many ridges are covered by pebbles, cobbles and boulders, but no section through the formation was exposed. At the base there is a thin bed of oligomictic conglomerate with sandstone phenoclasts up to two feet across. The sandstone is similar to the sandstone in the underlying unit 2 and in the Dean Quartzite at Bloods Range. This is overlain by a thick bed of oligomictic conglomerate with brown, quartz-feldspar porphyry phenoclasts up to 18 inches across of which a few are rounded, the rest angular. These basal beds are overlain by a polymictic conglomerate with rounded to angular, poorly sorted phenoclasts up to four feet across. The biggest blocks are quartzite similar to the Dean Quartzite. Other rock types in this bed are brown, quartz-feldspar porphyry, ?epidotized rhyolite, epidotized amygdaloidal basalt and sandstone like that of the Winnall Beds. The typical sericite bearing quartzite of the Dean Quartzite in the Petermann Ranges was not seen.

In the outcrop six miles north-west of Mount Currie the conglomerate contains subrounded and subangular phenoclasts of sandstone and quartzite up to 2 feet across. The lithology of these phenoclasts is similar to the Dean Quartzite at Bloods Range.

At Pinyinna Range the conglomerate unconformably overlies the Pinyinna Beds. It is a poorly sorted, subangular pebble, cobble and boulder conglomerate with a sparse, coarse-grained and poorly sorted sandstone matrix. The phenoclasts are of Dean Quartzite; to the east boulders of brown, fine-grained, igneous rock are also present.

The age of the Mount Currie Conglomerate is not known. Other conglomeratic units in the Amadeus Basin are the Sir Frederick Conglomerate (Rawlinson Sheet area) and the Pertnjara Formation along the northern margin of the basin (Fig. 6). A correlation with the Sir Frederick Conglomerate of the Rawlinson Sheet area is preferred because it lies nearer the southern margin of the basin and contains boulders dominantly of Dean Quartzite. However the Sir Frederick Conglomerate is laterally equivalent to the Ellis Sandstone and the Ellis Sandstone has been tentatively correlated with the Winnall Beds which are unconformably overlain by the Mount Currie Conglomerate.

On the Bloods Range Sheet the conglomerate sequence is moderately dipping whereas the Ordovician deposits nearby are flat lying. It is therefore considered probable that the conglomerate was tilted and eroded before an Ordovician marine transgression.

The Mount Currie Conglomerate is therefore placed in the Cambrian stratigraphically between the undifferentiated Ordovician sediments and the Winnall Beds of Upper Proterozoic or Cambrian age.

Mereenie Sandstone

The Mereenie Sandstone was first named by Madigan (1932). Prichard and Quinlan (1962) define it as a quartz sandstone formation overlying the Larapinta Group with a regional unconformity and succeeded, again with a regional unconformity, by the Pertnjara Formation.

On the Bloods Range Sheet the Mereenie Sandstone apparently conformably overlies the Larapinta Group. It is overlain by white siltstone at one locality and this siltstone is mapped as Pertnjara Formation. Sediments overlying the Mereenie Sandstone elsewhere are concealed by Quaternary sand.

The Mereenie Sandstone forms low hills and ridges across the northern half of the sheet and extends westward onto the Rawlinson Sheet. It crops out extensively on the Mount Rennie, Mount Liebig and Lake Amadeus Sheets.

The unit has a lithology similar to the fine-grained sandstone in the Winnall Beds. It is a fine-grained, white, pale brown, clean and friable quartz sandstone which is thinly bedded and laminated, extensively cross bedded and cross-laminated, moderately sorted and moderately rounded. Ripple marks and current striations occur on some bedding planes. Cross bed sets are up to six feet thick and both low and high angles of repose are visible.

Thickness of the Mereenie Sandstone was not measured but from its dip and outcrop width on aerial photographs it may be about 2,000 feet thick.

No dianostic fossils have been found in the sandstone. As it conformably overlies the Larapinta Group of Ordovician age it is probable that at least the basal Mereenie Sandstone is Ordovician. Wells, Ranford and Cook (1963) report a "Cruziana" from the Mereenie Sandstone eight miles north-west of Inindia Bore on the Lake Amadeus Sheet; this supports an Ordovician age for the basal unit in this area. Age of the upper part of the Mereenie Sandstone is unknown.

Pertnjara Formation

Prichard and Quinlan (1962) defined the Pertnjara Formation as "the sequence of sandstone, quartz greywacke and conglomerate that overlies the Mereenie Sandstone with a regional unconformity. .... Its upper limit is not known".

Wells, Forman and Ranford (1962 p.60) demonstrated the existence of an old syncline in which the Pertnjara Formation is exposed close to the northern margin of the basin (Mount Rennie, Mount Liebig area). Conglomerate of the Pertnjara Formation occurs north of the synclinal axis and sandstone and siltstone occurs to the south.

The detritus was derived from the north and it is possible that the old syncline represents the keel of the down warped area in which the Pertnjara was deposited. If this hypothesis is correct then the Pertnjara should thin and become finer-grained to the south. Mapping on the Bloods Sheet bears out this hypothesis as the only outcrop of probable Pertnjara Formation is white siltstone directly overlying the Mereenie Sandstone. There is room for a considerable additional thickness of sediment over the Mereenie Sandstone in the tight sand covered syncline south-west of Mount

Murray (Mount Murray lies on the Lake Amadeus Sheet.

Age of the Pertnjara Formation is unknown except that it is younger than the Mereenie Sandstone.

TERTIARY

Piedmont deposits occurs on the flanks of the high ranges and hills in the southern half of the Sheet area. They have a primary dip at angles up to 10° away from the range and beneath alluvium or wind blown sand. Many small creeks dissect the deposits. The conglomerate of these deposits is angular, poorly sorted with the largest boulder sized fragments nearest the ranges or hills. Where the conglomerate dips beneath the sand it is of pebble grade and better sorted and rounded than nearer the ranges. The components are invariably derived from the more resistant rock in the adjacent ranges or hills.

The deposits are tentatively regarded as Tertiary and are correlated with similar deposits on the Rawlinson Sheet area.

QUATERNARY

Deposits of aeolian sand, alluvium, travertine and evaporites cover the greater part of the Sheet.

Travertine and evaporites form a thin grey to white crust on the dry floor of the lakes. The water soluble components in a sample from this crust have been determined by S. Baker as Cl. 12.3%; SO_4 10.8%; Ca 0.58%; Mg 0.32%; Na 12.8%; K 0.1%; Nitrate not detected. The material underlying the crust has not been analysed. It is a red-brown, sandy, gypsiferous silt. In places near the lake shore sand has been blown over the evaporite crust. Travertine, and some gypsum, borders the lake and occurs as "islands" within it (Fig. 4). The edges of the "islands" form steep faces from which travertine and gypsum have crumbled onto the evaporite crust. The "islands" are capped by yellow-brown, crystalline limestone and travertine which overlies a light grey, gypsiferous silt. It is probable that these originally formed a continuous bed which has since been eroded. The lake bed is now probably composed of the gypsiferous silt with ground water, wind blown sand and weathered limestone.

Sand dunes overlie the travertine on top of the "islands" and on the margins of the lake. The greater portion of the Bloods Range Sheet is covered by orange-brown aeolian sand and sand dunes. The sand is unconsolidated but is fixed by a cover of light vegetation. The dunes rarely extend more than ten miles and they are branching with braided tops.

Alluvium occurs in the beds and flood plains of the Docker and Hull Rivers, Chirnside and Shaw Creeks. Alluvium also occurs adjacent to high ranges and hills where local run-off has distributed pebbly sand around the Tertiary Conglomerate which flanks the ranges.

STRUCTURAL INTERPRETATION

Fig. 12.

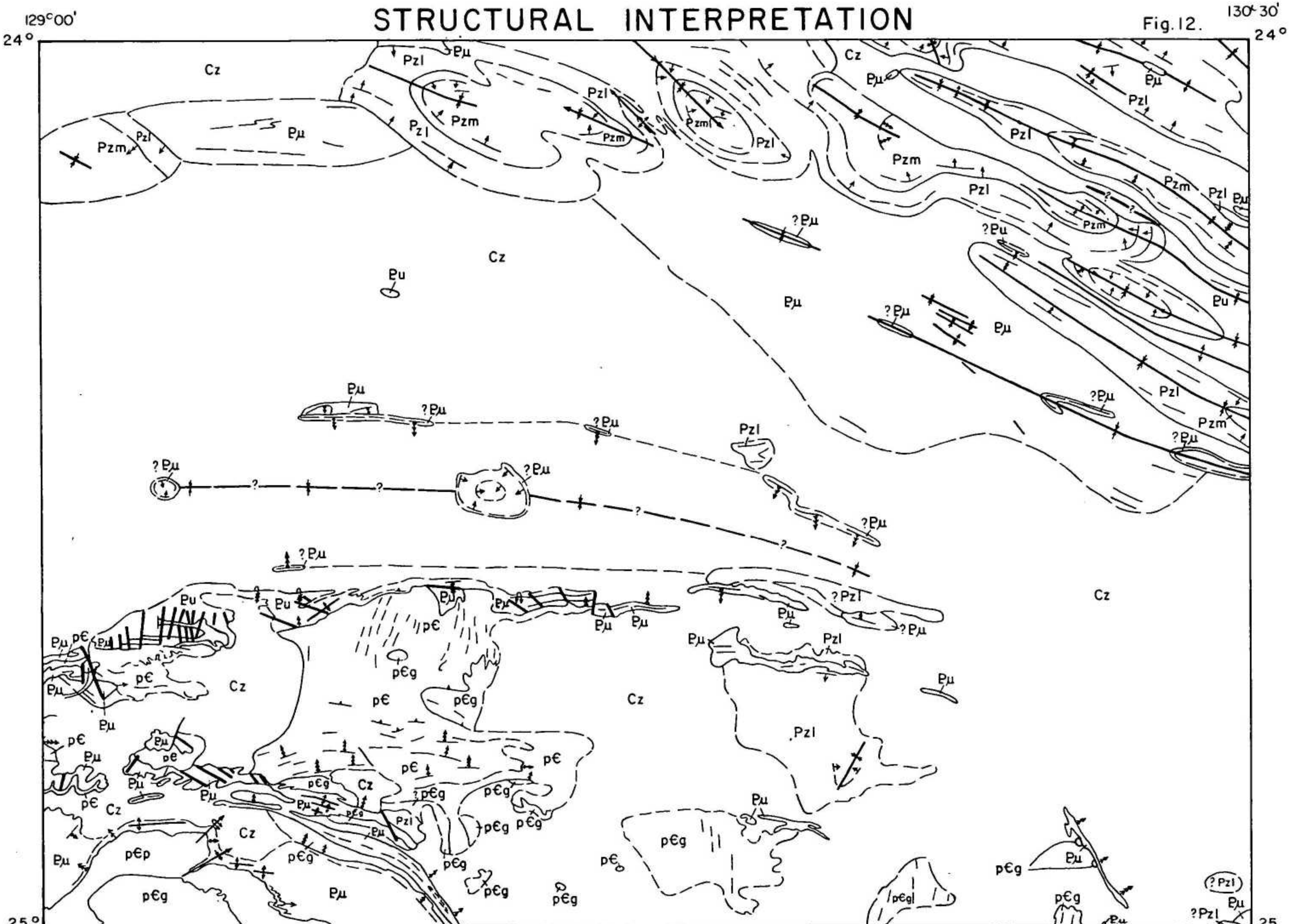

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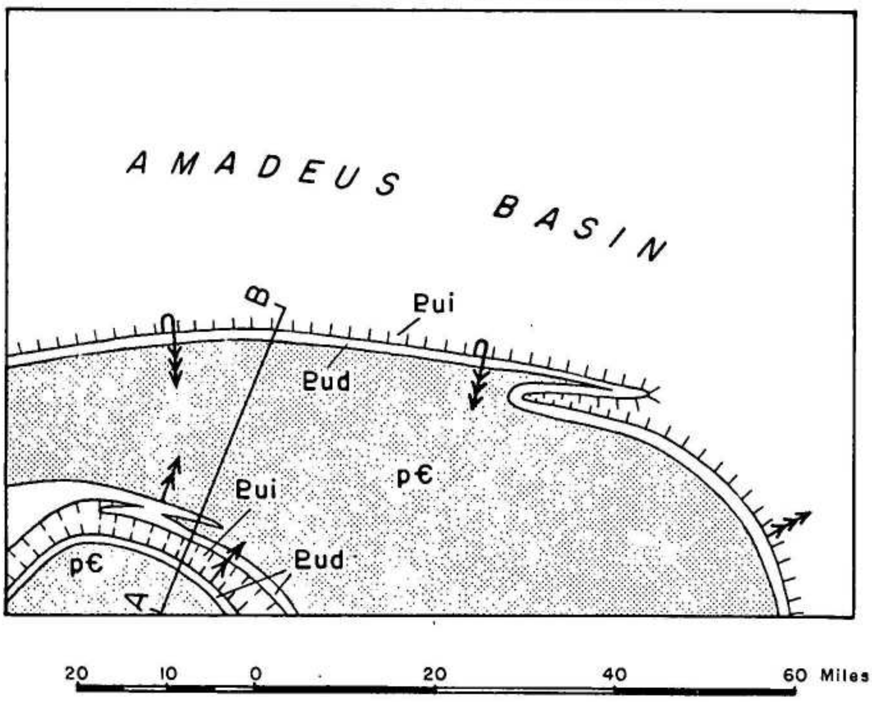
Fig. 13.

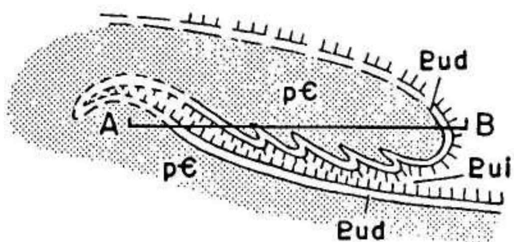
PETERMANN RANGE FOLDING– ALTERNATIVE INTERPRETATIONS.

BLOODS RANGE SHEET

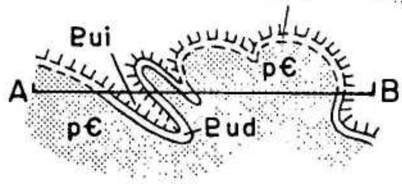


ALTERNATIVE INTERPRETATIONS SECTION A-B.

(1) Recumbent anticline



(2)



Ꞓui	Pinyinna Beds
Ꞓud	Dean Quartzite
p€	Undifferentiated Precambrian

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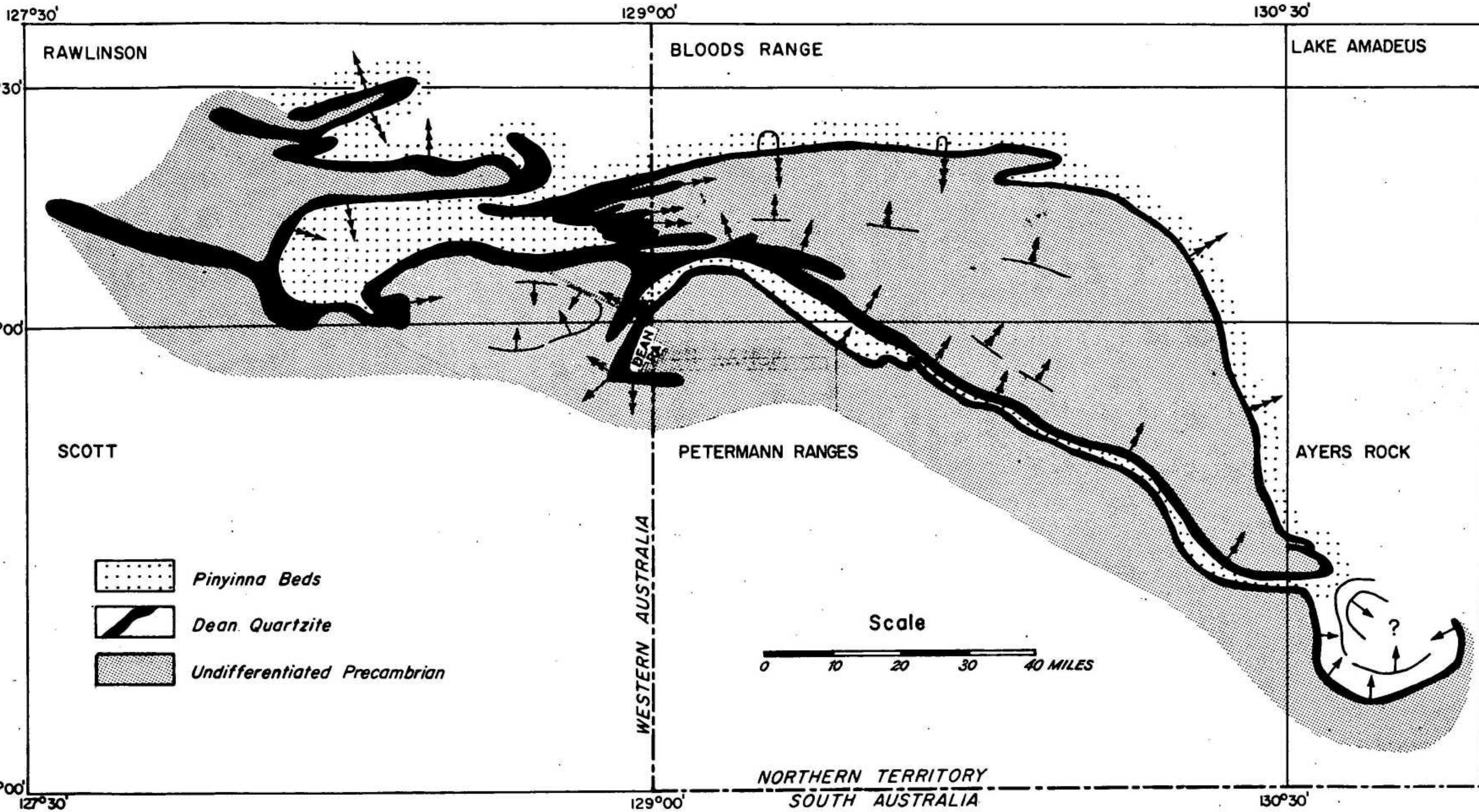
REGIONAL DISTRIBUTION AND STRUCTURE OF THE DEAN QUARTZITE

Fig. 14



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STRUCTURE OF THE UPPER PROTEROZOIC AND PALAEOZOIC ROCKS

Three main foldings of the Upper Proterozoic and Palaeozoic sediments are inferred from mapping on the Bloods Range Sheet: See structural interpretation (Fig. 12), geological map, and sections. The first is represented by isoclinal and recumbent folding and metamorphism of the Dean Quartzite and Pinyinna Beds; the second by tight folding of the Winnall Beds and older Upper Proterozoic sediments; and the third by the broad, and rarely tight, folding of the Cleland Sandstone, Larapinta Group, Mereenie Sandstone and Pertnjara Formation. A fourth period of folding which preceded deposition of the Pertnjara Formation on the northern margin of the Amadeus Basin is not developed on the Bloods Range Sheet.

The first two of these foldings are well developed on the Bloods Range Sheet and are here named after geographical features on it. The third folding is well developed throughout the Amadeus Basin and is here named after the basin.

Petermann Range folding

The Petermann Range folding dynamically metamorphosed the Dean Quartzite, Pinyinna Beds, Mount Harris Basalt, Bloods Range Beds and the granite and porphyry in the southern half of the sheet area. The age of the folding is probably Upper Proterozoic for the following reasons -

(1) Only the Dean Quartzite, Pinyinna Beds and older rocks are isoclinally folded and metamorphosed; (2) The Cleland Sandstone of probable Cambrian age contains boulders of metamorphosed Dean Quartzite; (3) The rocks of the Petermann Ranges and Bloods Range area are overlain unconformably by Ordovician sediments; (4) There is an unconformity between the Areyonga Formation and the Bitter Springs Limestone on the Lake Amadeus Sheet. (This unconformity is not exposed on the Bloods Range Sheet area).

For these reasons the Petermann Range folding is believed to have started after deposition of the Bitter Springs Limestone; it was probably responsible for a change in land relief along the southern margin of the basin and for the change from carbonate to clastic deposition in the Amadeus Basin.

The Petermann Range folding caused the deformation of the Dean Quartzite, Pinyinna Beds and older rocks in the southern half of the Sheet area. Two interpretations of the structure can be made. One invokes a regional recumbent anticline the other explains the structure without regional overturning.

Figure 13 shows diagramatically the difference in the two structural interpretations.

Recumbent Anticline Hypothesis:

The recumbent anticline hypothesis is best portrayed on the geological maps of Rawlinson and Bloods Range in conjunction with a photo-interpretation of Scott, Petermann Ranges and Ayers Rock Sheets. Figure 14 illustrates diagramatically the interpreted distribution and structure of the Dean Quartzite which is compatible with the regional recumbent anticline hypothesis. The hypothesis will be further tested by the mapping of adjoining sheet areas which will be undertaken in 1963. The following evidence is in favour of the recumbent anticline hypothesis:

(1) In Bloods Range:

(a) Overturning along the northern side of the range from Pinyinna Range to west of the Hull River.

(b) Isoclinal and local recumbent folding at Mount Harris (Fig. 15) and Bloods Range east of the Hull River (Fig. 16).

(c) West of the Hull River, the Dean Quartzite in Bloods Range is highly folded, probably recumbently, but the structure is too complicated for reliable interpretation.

(2) Between Bloods Range and the Petermann Ranges:

The eastern ends of four hills near the western side of the Sheet area were mapped as easterly plunging, downward facing, anticlines.

(3) In the Ilyaralona and Puiltarana Range:

The Dean quartzite, Pinyinna Beds and the underlying rocks are isoclinally folded but in most cases plunges could not be determined. Consequently it is not known whether the folds are downward or upward facing. In the western cliffs of the Ilyaralona Range a number of isoclinal anticlines and synclines were seen. The cores of two of these anticlines contained siltstone similar to the siltstone at the base of the Pinyinna Beds. Hence the Ilyaralona Range is interpreted as a downward facing antiform.

(4) West of the Dean Range and in the Rawlinson Range:

Recumbent folding was seen in cliff faces in the Dean Quartzite.

(5) Six miles west of Livingstone Pass: The Dean Quartzite is underlain by grey siltstone containing carbonate veins. The siltstone is probably the base of the Pinyinna Beds and if so then the sequence is overturned.

(6) The valley between the Petermann Ranges: The Pinyinna Beds occupy this valley on the Petermann Range Sheet south-east of Chirnside Creek.

(7) Four miles east of the eastern end of Ilyaralona Range:

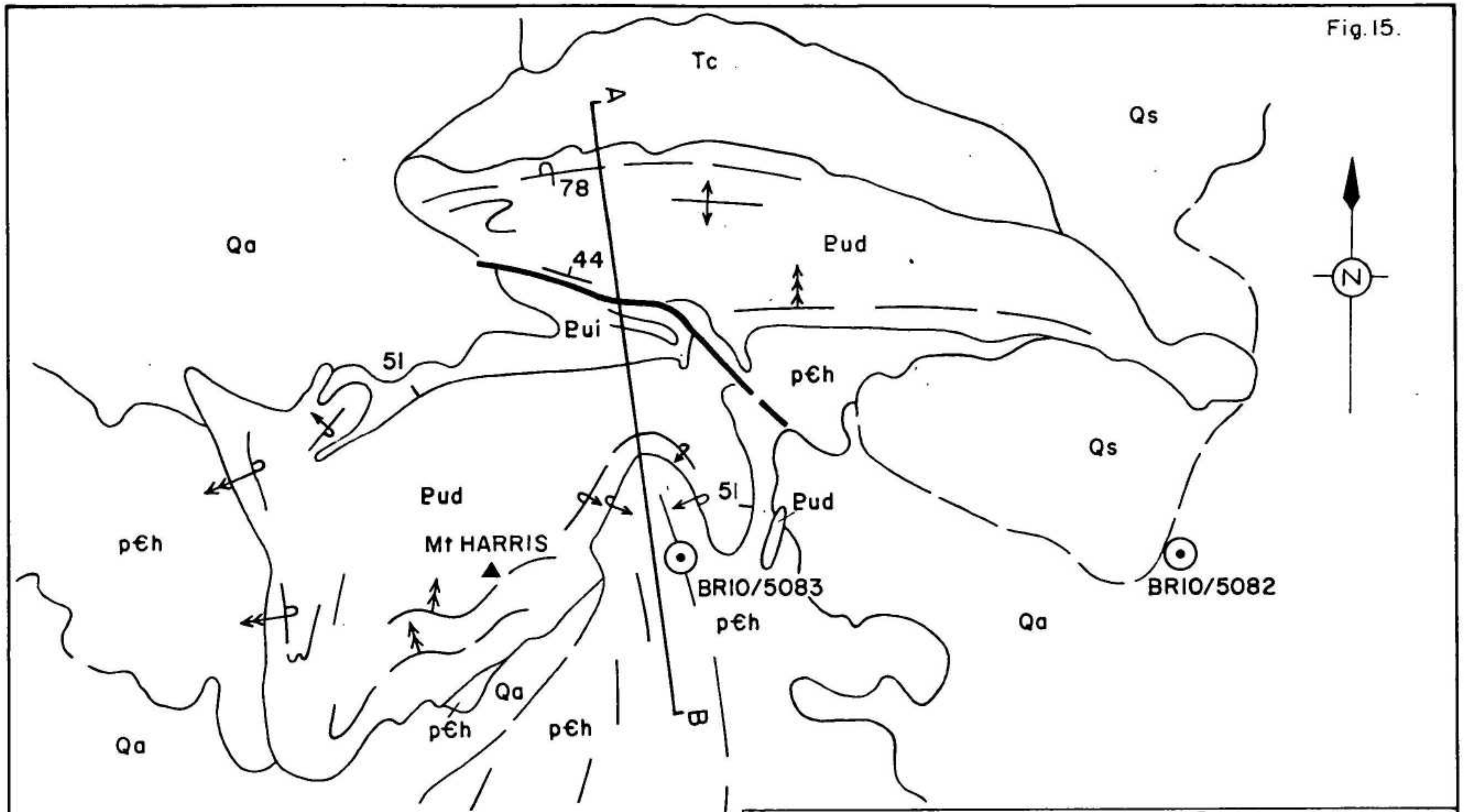
Folding of a recumbent nature may be seen in the contact between granite and the Mount Harris Basalt.

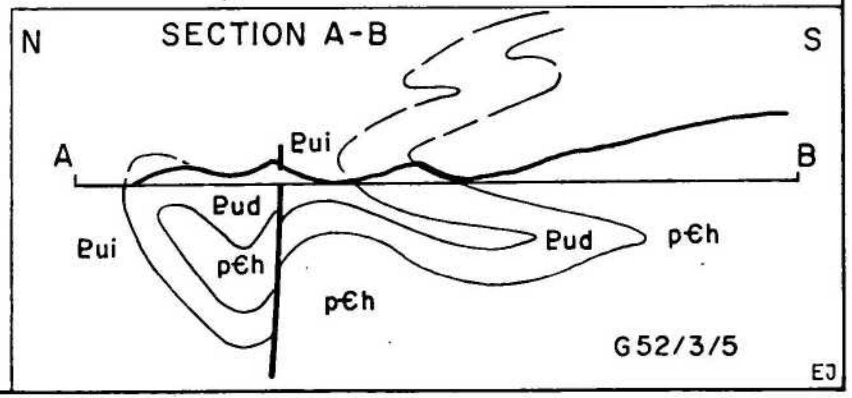
(8) The Dean Range area on the Scott and Petermann Range sheets (Fig. 14): The structure in this area suggests the root zone of a recumbent fold.

(9) The metamorphism of the Dean Quartzite and Pinyinna Beds in the Dean, Mannanana, Piultarana and Ilyaralona Ranges can be conveniently explained by deep burial by recumbent folding.

Alternative hypothesis

An alternative to the recumbent anticline hypothesis is shown on figure 13. This theory does not admit the interpreted downward facing anticlines and the antiform (Ilyaralona Range) and would require metamorphism of the Dean Quartzite, Pinyinna Beds and older rocks without deep burial; possibly by a rise in the geothermal gradient. The hypothesis gains its main strength from the difficulty in explaining the origin of such a large recumbent anticline with a dominantly sedimentary and volcanic core in the west and a crystalline granite core in the east. Further difficulty derives from the shallow depth at which the crystalline core must have been deformed. The shearing and dynamic metamorphism within the core of the postulated recumbent anticline is consistent with such drastic tectonics. The basement rocks beneath the fold are considerably less sheared.



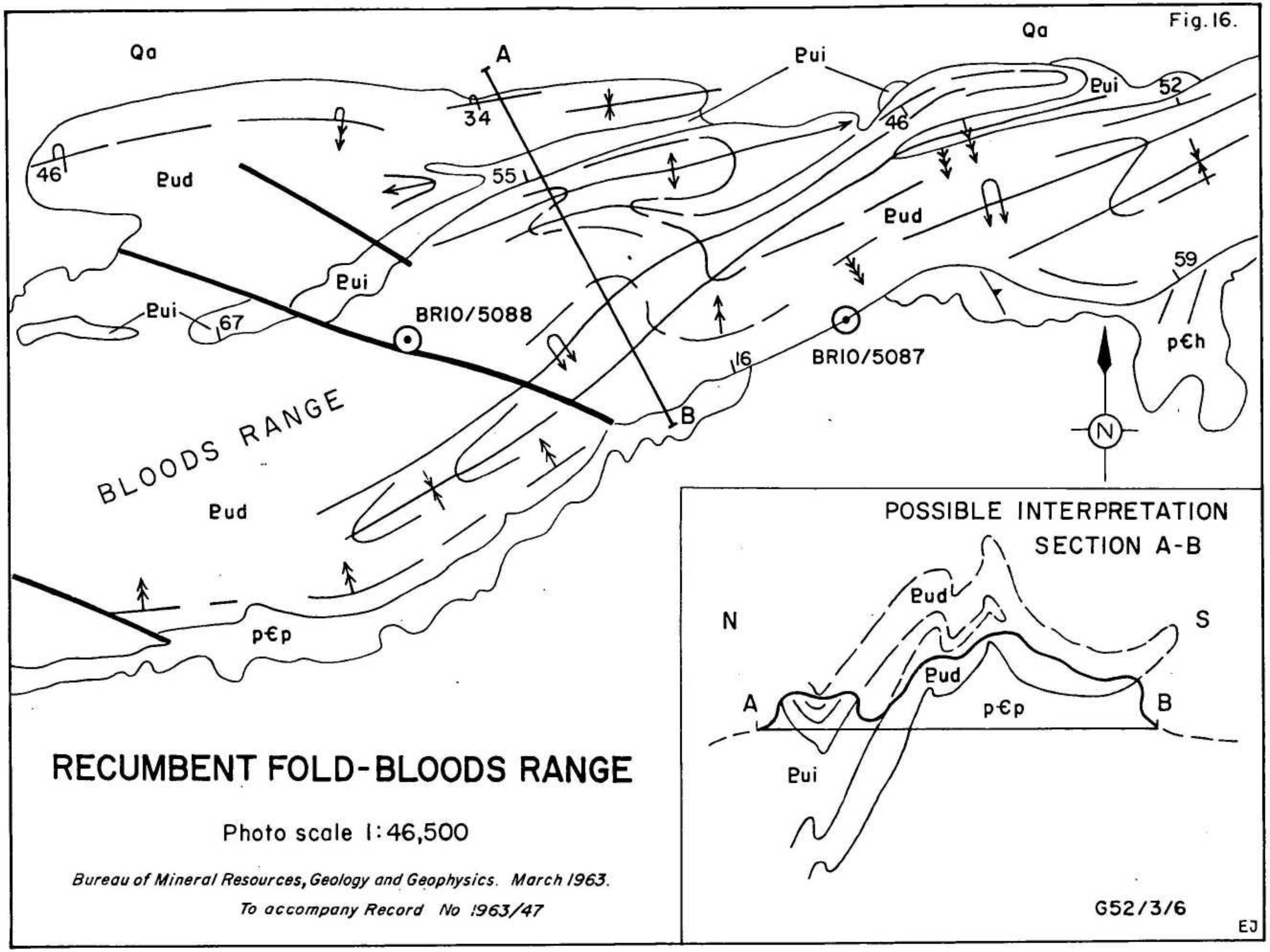


RECUMBENT FOLD-MOUNT HARRIS

Photo scale 1:46,500

Bureau of Mineral Resources, Geology and Geophysics. March 1963.

To accompany Record No 1963/47



RECUMBENT FOLD-BLOODS RANGE

Photo scale 1:46,500

Bureau of Mineral Resources, Geology and Geophysics. March 1963.

To accompany Record No 1963/47

Further mapping of the Petermann Ranges may provide evidence either in support of or against the hypothesis of a regional recumbent anticline. Until this mapping is completed any theories on the structure of this complex part of the Amadeus Basin must remain open. At present it is only certain that there was a period of strong folding and metamorphism in the Petermann Ranges during the Upper Proterozoic.

The Petermann Range folding was accompanied by faulting and intense jointing. The fault zones are marked by brecciation of the quartzite and an intensification of the joint system nearby. A prominent fault direction is north-west to west-north-west and in Bloods Range west of the Hull River the faults trend northerly.

A considerable amount of shearing is associated with the folding and overturning of the sediments and igneous rocks; This has caused a metamorphic foliation. Lineation on the plane of foliation in most places pitches close to 90° suggesting a-lineation.

Lake Neale folding

The Lake Neale folding is best exposed in the Lake Neale-Lake Amadeus area of the sheet where unit 3 (Inindia Beds equivalent) and Winnall Beds are tightly folded. Rocks involved in the Lake Neale folding are unconformably overlain by the Cleland Sandstone. As this unconformity is not present farther north-east it may be inferred that the Lake Neale folding did not extend on to the Hermannsburg Sheet or eastern side of Mount Liebig Sheet. Another unconformity beneath the Winnall Beds at Souths Range and again on the Lake Amadeus Sheet (Wells, Ranford and Cook, 1963) suggest that the Lake Neale folding is reflected by at least two unconformities in the sedimentary succession. The unconformity beneath the Winnall Beds is more marked than farther north suggesting that the folding was initiated in the south and extended northwards, subsequently, and ended with the strong folding in the Lake Neale-Lake Amadeus area.

The Winnall Beds at Mount Unnapproachable and unit 3 farther north have undergone typical Lake Neale folding. Unit 3 is tightly folded into a series of anticlines and synclines with flat plunges. The younger Winnall Beds are preserved as canoe shaped outcrops in tight synclines with flat culminations and depressions of the axis. At Long Range both limbs of one of these synclines dip steeply; the northern limb is overturned. In the Souths Range - Mount Cowle area the same type of structure is preserved on a much larger scale and plunge reversals of the axis have produced the basin shaped structures of Mount Cowle and its twin west of the Hull River.

In many places the Lake Neale folding has produced numerous joints but no major faults have been found in either the Winnall Beds or Unit 3.

Amadeus Basin folding

The Amadeus Basin folding succeeded the Lake Neale folding after a period of stability. It is the folding which followed deposition of the Pertnjara Formation except near the Macdonnell Ranges where it commenced before and continued after deposition of the Pertnjara Formation.

On the Bloods Range Sheet the Amadeus Basin folding is characterized by broad anticlines and synclines with gentle plunge reversals. A tight syncline with an overturned northern limb south of Mount Murray is also included in the Amadeus Basin folding. The tightness of this syncline is probably related to the presence at depth of incompetent gypsum such as is exposed in the adjacent anticline to the north. All anticlines on the sheet area are breached to Upper Proterozoic sediments which are poorly exposed.

The gypsum exposed in structures produced during the Amadeus Basin folding suggests that an incompetent gypsiferous sequence at depth may have given rise to diapiric and decollement tectonics. The interpreted fault structure 8 miles west of Mount Murray may be the product of such tectonics.

GEOLOGICAL HISTORY

The order of geological events may be summarized thus.

(1) Batholithic intrusion of very coarse porphyritic granite and possibly comagmatic Mannanana Porphyry into Precambrian rocks which are not exposed on the sheet area.

(2) Erosion.

(3) Volcanic activity including the extrusion of Precambrian basic lavas of the Mount Harris Basalt.

(4) Intrusion of the younger Precambrian granite and associated quartz-feldspar porphyry.

(5) Erosion

(6) Dominantly subaqueous deposition of Precambrian arkose, impure sandstone, tuff, agglomerate, basalt flows and possibly acid flows.

(7) Probable intrusion of Precambrian quartz-feldspar porphyry.

(8) Erosion.

(9) Deposition of the Upper Proterozoic Dean Quartzite and Pinyinna Beds in a relatively stable, epicontinental, shallow marine environment.

(10) Petermann Range folding accompanied by low grade dynamic metamorphism of granite, porphyry, Mount Harris Basalt, Bloods Range Beds, Dean Quartzite and Pinyinna Beds.

(11) Southern half of sheet area became a tectonically unstable Upper Proterozoic land mass during Petermann Range folding and contributed sediment to the Amadeus Basin farther north.

(12) Deposition of unit 1 and unit 3 of the Upper Proterozoic sequence. Deposition was probably more rapid near the southern margin of the basin.

(13) Lake Neale folding commenced near the southern margin of basin during the Upper Proterozoic or Cambrian.

(14) Winnall Beds deposited - probably thickest near southern margin of basin.

(15) Deposition of Mount Currie Conglomerate during Lake Neale folding.

(16) Lake Neale folding moved farther north and raised the northern area above sea level.

(17) Erosion of newly raised Cambrian land surface and deposition of the Cleland Sandstone in deltaic and paralic environments along its northern edge.

(18) Marine transgression. Shallow Ordovician sea spread over all of the sheet area except the Petermann Ranges and Bloods Range which were islands or peninsulas.

(19) Recession of sea, reworking of sediment by wind and shallow water (non marine) to form Mereenie Sandstone.

(20) Monoclinal warping along northern margin of basin caused development of a post Ordovician basin to the south which was probably occupied by a large lake. The northern part of Bloods Range Sheet was on the tectonically stable southern side of this basin and received only a fine-grained development of the Pertnjara Formation.

(21) Amadeus Basin folding was initiated near the northern margin of the basin and subsequently moved farther south. Some of the fault and fold structures were accentuated by diapiric intrusion and pinching and swelling of incompetent beds at depth.

(22) Weathering and erosion.

(23) Tertiary pluvial period when conglomerates were deposited near ranges and the water table may have emerged over the low lying areas now occupied by Lake Neale and Lake Amadeus.

(24) Limestone and gypsiferous silt were deposited in low lying areas.

(25) A period of aridity when the water table dropped and chemical erosion of limestone began. Alluvial sand reworked by wind into sand dunes.

(26) Sand dunes became stable.

ECONOMIC GEOLOGY

No economic deposits are known on the Bloods Range Sheet.

Copper

Malachite occurs in the Mount Harris Basalt and the Bloods Range Beds at a number of localities on the southern half of the sheet area. Most of the occurrences discovered have been in sheared basalt, tuff and agglomerate of the Bloods Range Beds. None of these deposits is of economic size at the surface and none have been tested at depth. These surface showings are not sufficiently encouraging to warrant drilling.

Lead, silver and gold.

Secondary lead minerals, galena, silver and gold were found with secondary copper minerals in vein quartz intruding the Mount Harris Basalt at specimen locality BR 34. None of these minerals occurred in economic quantities and the outcrop of mineralized vein quartz was very small.

Phosphate.

A sample of red, sandy, phosphatic limestone was obtained at specimen locality BR 75. Two thin phosphatic limestone beds no more than an inch thick occur at this locality and the phosphate content of the specimen was between 10 to 20% as determined by spectroscopic analysis.

Underground water

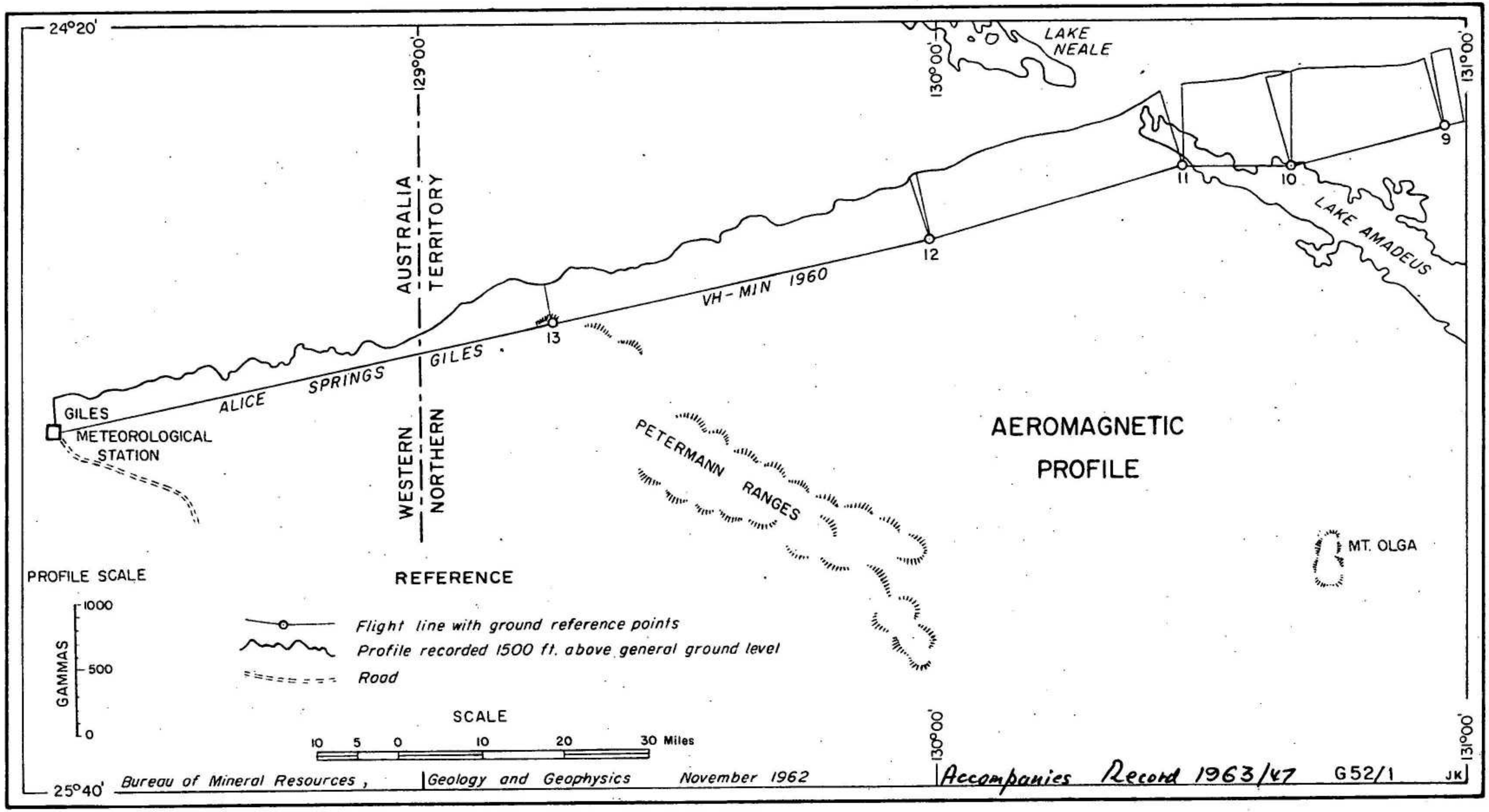
The area is untested for supplies of underground water. The alluvial area of Learmonth Park gives reasonable promise of providing shallow underground water supplies.

Petroleum prospects

The Pertnjara Formation, the Mereenie Sandstone and the Cleland Sandstone have no source rock potential. The marine sediments of the Larapinta Group could be considered as source rocks but the prospects of petroleum accumulation in this group are negligible as it is widely exposed and all anticlines are broached to the Upper Proterozoic. Any search for oil would have to be directed at source and reservoir beds in the Upper Proterozoic succession within which the Pinyinna Beds, unit 1 and unit 3 may contain source rocks and any sandstone units stratigraphically above or laterally equivalent to these could be a reservoir rock. Fracture porosity reservoirs may also be present.

No closed anticlinal structure or other suitable traps for oil have been mapped; they may be present under the sand cover. The petroleum prospects of the area are poor.

Fig. 17.



24°20'
129°00'
130°00'
131°00'
LAKE NEALE
LAKE AMADEUS
AUSTRALIA
TERRITORY
WESTERN
NORTHERN
VH-MIN 1960
GILES
ALICE SPRINGS
GILES METEOROLOGICAL STATION
PETERMANN RANGES
MT. OLGA
13
12
11
10
9
AEROMAGNETIC PROFILE
PROFILE SCALE
1000
500
0
GAMMAS
REFERENCE
Flight line with ground reference points
Profile recorded 1500 ft. above general ground level
Road
SCALE
10 5 0 10 20 30 Miles
130°00'
131°00'
25°40'
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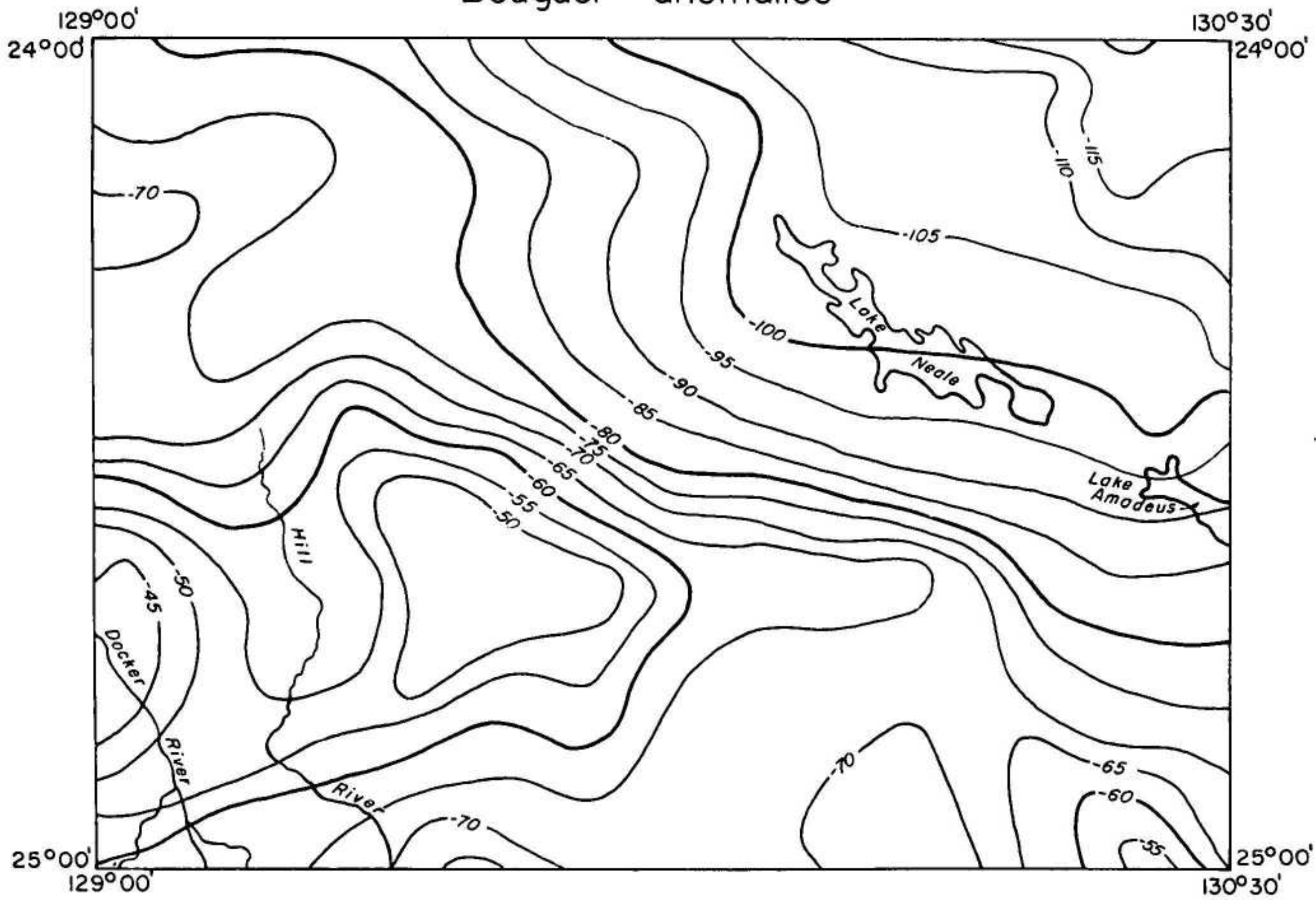
Fig. 18

Bouguer anomalies



-65 — -60 — *Isogals*

Isogals from preliminary Bouger Anomaly Map prepared by Geophysical Branch BMR. Helicopter gravity survey 1962

10 0 10 20 30 MILES

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GEOPHYSICAL DATA

The geophysical section of the Bureau of Mineral Resources have flown and completed one aeromagnetic traverse across the Bloods Range Sheet (fig. 17) and regional gravity coverage at one station per 50 square miles (fig. 18).

Goodeve (1961) estimated depth to magnetic basement greater than 10,000 feet along part of the traverse between Lake Amadeus and McNichol Range.

The preliminary Bouguer anomaly map of the Bloods Range Sheet has a linear positive gravity anomaly along the southern margin of the Amadeus Basin, that is along Bloods Range, Pinyinna Range, McNichol Range, Kulapurina Hills and Wailarra Hills. This suggests a zone of high density rock north of the ranges which is denser than the basement rock to the south. This zone corresponds to the area where steeply dipping, Pinyinna Beds should occur and dolomite and limestone from the Pinyinna Beds with a specific gravity near 2.8 is probably responsible for the gravity anomaly.

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AUSTRALIA 1:250,000

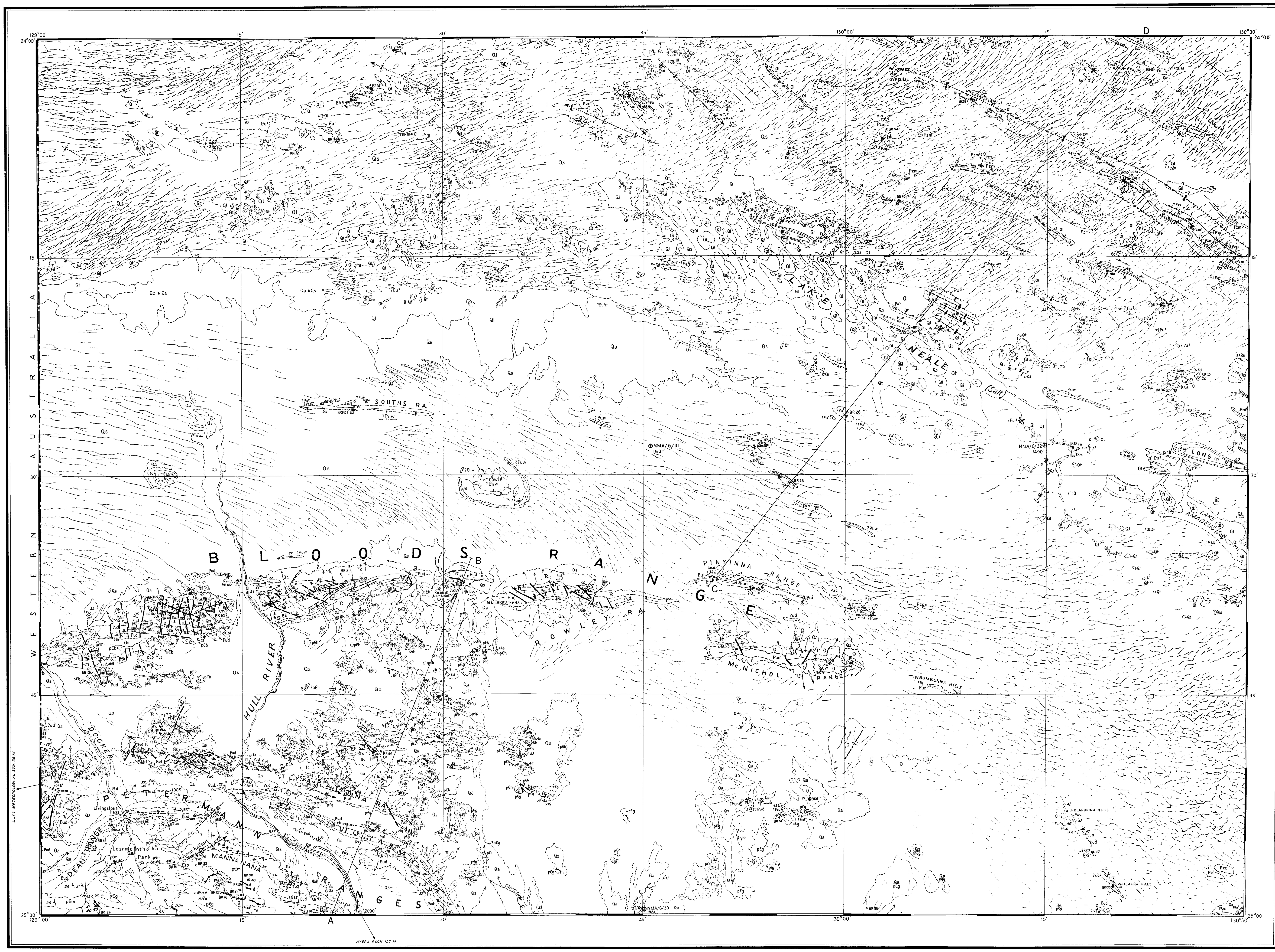
BLOODS RANGE

NORTHERN TERRITORY

1:250,000 GEOLOGICAL SERIES SHEET SG 52-3

PRELIMINARY EDITION, 1963

SUBJECT TO AMENDMENT



Reference

CAINOZOIC	QUATERNARY		Qs	Sand
			Qa	Alluvium
			Qt	Evaporites
			Ql	Travertine
	TERTIARY		Tc	Conglomerate
PALAEOZOIC	UNDIFFERENTIATED	Pertnjara Formation	Pzp	Siltstone
		Mereenie Sandstone	Pzm	Brown and white sandstone. Large scale cross bedding
		Mt. Currie Conglomerate	Pzc	Conglomerate
	ORDOVICIAN	Undifferentiated	O	White sandstone, pipe rock, conglomerate dolomite, and siltstone, some marine fossils
		Larapinta Group	Ol	Sandstone, siltstone, rare limestone. Marine fossils
	CAMBRIAN ?	Cleland Sandstone	€c	Crossbedded sandstone and pebbly sandstone, siltstone
PRECAMBRIAN	UPPER PROTEROZOIC	Winnall Beds	Puw	Brown and white sandstone, pebbly sandstone, crossbedded siltstone
			Pu³	Red siltstone, dolomite, chert. Algal stromatolites
			Pu²	Sandstone and siltstone
			Pu¹	Crystalline dolomite. Algal stromatolites
		Pinyinna Beds	Pui	Dolomite and siltstone. Algal stromatolites
		Dean Quartzite	Pud	Quartzite and conglomeratic quartzite, sandstone
	UNDIFFERENTIATED		p€p	Quartz and feldspar porphyry
		Bloods Range Beds	p€b	Sandstone, arkose, tuff, agglomerate, basalt and acid porphyry
			p€g²	Granite
		Mount Harris Basalt	p€h	Epidotized amygdaloidal basalt
			p€g	Coarse porphyritic granite
		Mannanana Porphyry	p€m	Quartz-feldspar porphyry
		Undifferentiated	p€	Granite, schist

Geological boundary

Syncline, showing plunge

Syncline, overturned

Anticline, showing plunge

Anticline, overturned, showing plunge of axis

Fault

Where location of boundaries, folds and faults is approximate line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes

Strike and dip of strata

Vertical strata

Overturned strata

Dip <15° (air-photo interpretation)

Dip 15° - 45° (air-photo interpretation)

Dip > 45° (air-photo interpretation)

Trend lines (air-photo interpretation)

Joint pattern (air-photo interpretation)

Strike and dip of bedding and plunge of lineation

Strike and dip of foliation

Strike and dip of foliation and plunge of lineation

Vertical joint

Macrofossil locality

×BR 84 Text reference to specimen locality

Dyke or vein: q = quartz, d = dolerite

Minor mineral occurance

Pb Lead

Cu Copper

P Phosphate

•RH Rockhole

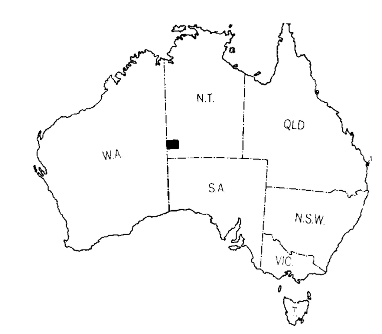
Sand dunes

Vehicle track

⊕NMA/G/30 Astronomical station

·1514′ Height in feet, instrument levelled; datum: mean sea level, Port Augusta, S.A.

Compiled and published by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base compiled by the Division of National Mapping, Department of National Development. Aerial photography by Adastra Airways Pty. Ltd., 1957; complete vertical coverage at 1:46,500 scale. Transverse Mercator Projection.



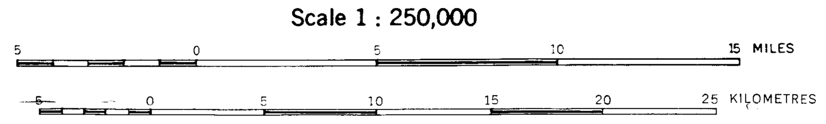
INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

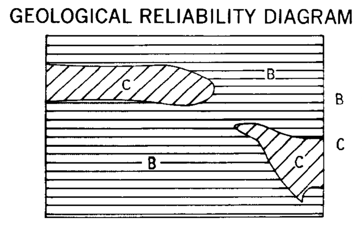
WILSON SF 52-9	WEBB SF 52-10	LAKE MACKAY SF 52-11	MT. DOREEN SF 52-12	NAPPERBY SF 53-9
RYAN SF 52-13	MACDONALD SF 52-14	MT. RENNIE SF 52-15	MT. LIEBIG SF 52-16	HERMANNSBURG SF 53-13
COBB SG 52-1	RAWLINSON SG 52-2	BLOODS RANGE SG 52-3	LAKE AMADEUS SG 52-4	HENBURY SG 53-1
BENTLEY SG 52-5	SCOTT SG 52-6	PETERMANN RANGES SG 52-7	AYERS ROCK SG 52-8	KULGERA SG 53-5
TALBOT SG 52-9	COOPER SG 52-10	MANN SG 52-11	WOODROFFE SG 52-12	ALBERGA SG 53-9

ANNUAL CHANGE 1′E

Scale 1 : 250,000



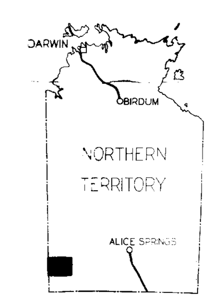
GEOLOGICAL RELIABILITY DIAGRAM



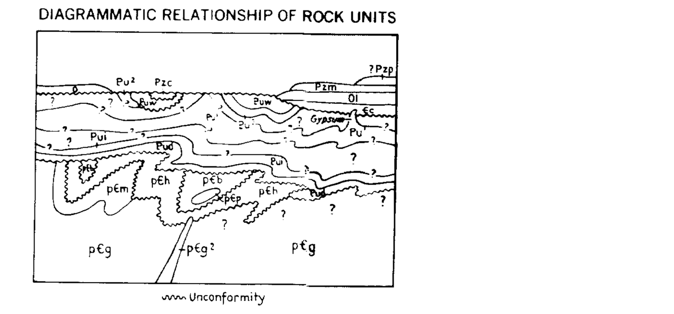
B Reconnaissance-traverses and air-photo interpretation

C Air-photo interpretation

Geology, 1962, by: D.J. Forman, A.J. Stewart
Compiled, 1962, by: D.J. Forman, A.J. Stewart
Drawn by: E.H.J. Feeken

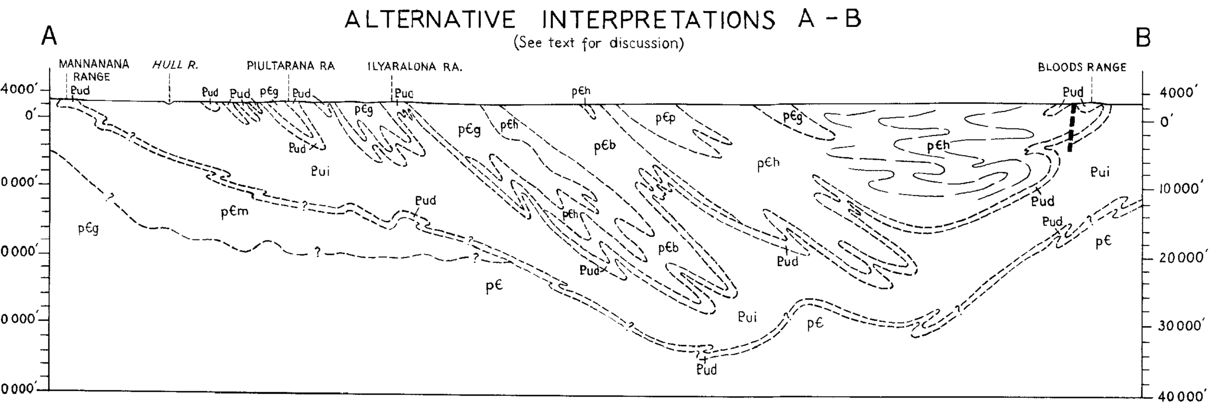


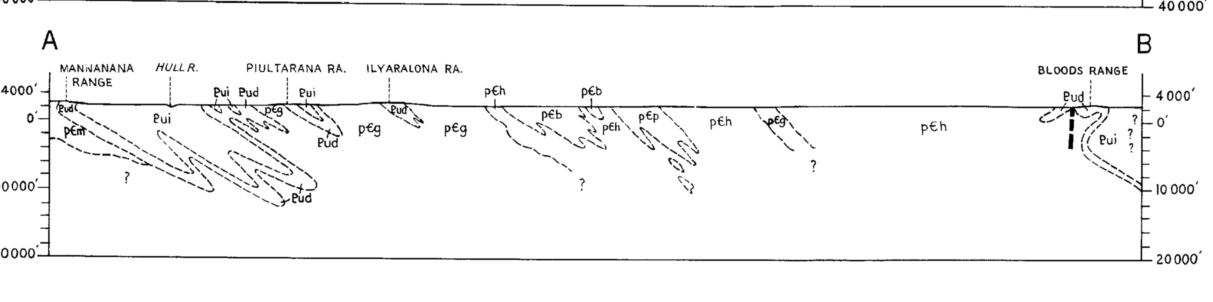
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



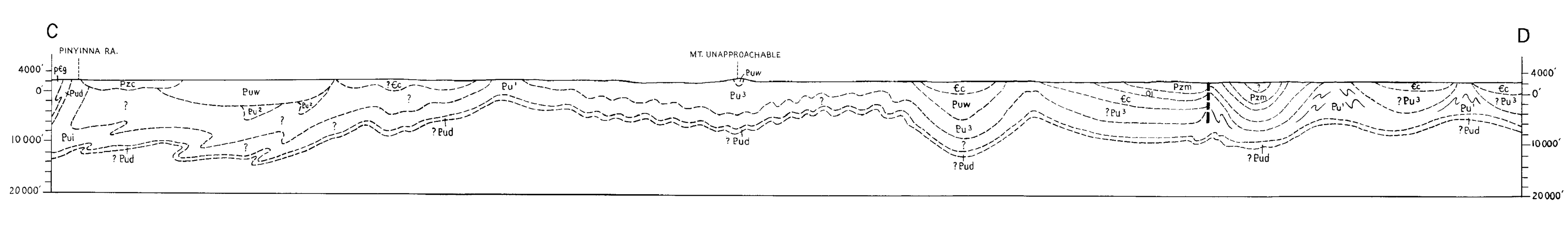
ALTERNATIVE INTERPRETATIONS A - B

(See text for discussion)





Sections



BLOODS RANGE

SHEET SG 52-3