# REPORT ON SOME OBSERVATIONS MADE ON A JOURNEY FROM ALICE SPRINGS, N.T., TO THE COUNTRY NORTH OF THE RAWLINSON RANGES IN W.A., VIA THE MUSGRAVE AND PETERMANN RANGES IN 1936 (WITH PLANS).

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PLANS.



PHOTOGRAPHS.

A collection of photographs of post card size, illustrating many of the topographic features of the country passed through, has been added to the Geological Survey Departmental Collection.

## INTRODUCTION.

A claim to the discovery of a very rich gold-reef (popularly known as "Lasseter's Reef") in Western Australia, north of the Rawlinson Range and close to the Western Australia-Northern Territory border, in approximate Longitude 128° 10′ E. and Latitude 24° 24′ S., afforded the writer the opportunity for making the above journey.

As a representative of the Western Australian Department of Mines, he accompanied the expeditions financed by Border Gold Reefs, Ltd., Sydney, which were despatched under the leadership of the alleged discoverer and another person who purported to know where the "reef" was, to the alleged locality of the reef during the period April-July, 1936.

The results of these expeditions form the subject-matter of a separate report, but briefly stated, information was obtained which enabled a conclusion to be reached that the reef does not exist. The peculiar circumstances attendant upon accompanying an expedition into uninhabited desert country, when the leader of that expedition was the alleged discoverer of the non-existent gold reef, and had financial interests at stake and was being asked to substantiate his claim by showing the writer the "reef," seriously affected the nature of the scientific observations able to be made.

It is hoped, however, that even the incomplete observations which were made, will prove of value to those interested in geology and prospecting.

In view of the fact that considerable geological work has been done and much has been written on the country between Alice Springs and Erldunda Station, reference will not be made to that section of the route traversed. The information given in this report will have reference only to that section of the country passed over between Pearce's Sheep Camp, situated some 70 miles west by south of Erldunda Station, and the alleged locality of the "reef" north of the Rawlinson Range, in approximate Longitude 128° 10′ E. and Latitude 24° 24′ S. in Western Australia

## THE ROUTE TRAVERSED BY THE EXPEDITIONS.

Two expeditions set out from Alice Springs to proceed to the West Australian Border, but both followed the same route. From Alice Springs, the main overland track between that town and Adelaide was followed as far south as Erldunda Cattle Station, a distance of about 150 miles. Ordinary four-wheeled motor transport was used, and sand-mats were carried but seldom used.

From Erldunda Cattle Station, a station motor-track was followed westwards for 70 miles to Pearce's Sheep Camp, across flat, well-grassed plain country with some salinas and small clay-pans and sand-ridges towards the western end of the track. Pearce's Sheep Camp is the most westerly occupied pastoral holding in this latitude, the country to the west, south-west and south in this portion of the Northern Territory, being not selected or forming portion of a large Aboriginal Reserve. Mt. Connor, a large table-topped remnant with sharply defined bluffs, forms a prominent land-mark about 20 miles distant W. 11° S. from the homestead.

From Pearce's Sheep Camp, the old tracks of the 1935 Border Gold Reefs Expedition were followed across flat and undulating red sandy-loam country, through thick mulga scrub, in a general southerly direction for a distance of about 45 miles to the vicinity of Erandirrinna Bluff, the most northerly portion of the Musgrave Ranges in this vicinity, situated about 6 miles north of the southern boundary of the Northern Territory.

The northern flank of the Musgrave Ranges was then followed in a general westerly direction to about the 131st Meridian of Longitude, the track following along the sandy loam flats bordering the somewhat tortuous northern front of these ranges in this latitude. This section of the route lies sometimes in the Northern Territory, and sometimes in South Australia. The main mass of the Musgrave Ranges terminates approximately in Longitude 131° E., and Latitude 25° 50′ S., immediately to the north of the Mounts Morris and Woodward, and about 10 miles north of the southern boundary of the Northern Territory. The route in this locality passed immediately south of a low quartzite-capped hill named Quartz Hill, from which point Mt. Olga, Ayer's Rock and Mt. Connor are visible, bearing 321°, 1° and 70° true bearing respectively.

Westwards from this point rapid progress was able to be made in a general north-westerly direction across mulga and grass flats and occasional long stretches of sandy flat and undulating spinifex desert country, keeping fairly close in along the northern side of the Olia Chain. The Olia Chain consists, as the name suggests, of a chain of isolated hills and ridges stretching from the western end of the Musgrave Ranges to Mt. McCulloch, which topographically, is regarded by the writer as being the south-

# GEOLOGICAL SKETCH PLAN
OF
# PORTIONS OF CENTRAL AND WESTERN AUSTRALIA
## Showing Route Followed by Expedition
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*Scale 3½ Miles to an Inch*

eastern end of the Petermann Ranges. After leaving Quartz Hill, the track goes west to Gordon Hill, and on passing to the north of this conspicuous landmark, Foster's Cliff comes boldly into view in the north-west, and the track followed, passes close by this cliff on the southern side. From Foster's Cliff the remainder of the Olia Chain (Butler's Dome, Stevenson's Peak and Katamala Cone) are seen away to the west as the route passes through sandy spinifex flats and sand-hill country some distance out from these features in a general north-westerly direction. After crossing the dry sandy bed of the Armstrong River, the south-eastern end of the Petermann Ranges is entered at Piltardie Rock-hole, the course having been a little north of west, on well grassed mulga flats between the Armstrong and Piltardie Rock-hole.

The hills now become more numerous, but good gravelly or sandy loam surfaces were available from Piltardie Rock-hole to Mt. Bowley Aerodrome, following a general north-west by west course as far as the Chirnside River, where a sharp turn to the south was made, and the track followed up the western bank of the sandy river bed to the Aerodrome. Leaving Mt. Bowley Aerodrome, a general north-west by west course was taken passing to the north of Mt. Miller and Mt. Curdie, and running along on the eastern and northern bank of the Hull River to the sandy crossing in its bed, just south of the gap in a quartzite range through which it emerges onto the desert to the north.

Continuing westerly from this crossing, around the northern flank of the Ruined Ramparts on very heavy sandy spinifex and desert-oak flats, the next point reached was Livingstone Pass the gap through which the Docker River leaves the Petermann Range on its north-westerly course out into extensive sandy loam flats. Going south through Livingstone Pass and turning south-east by east, a dry watercourse was followed up to a water hole situated about 2 miles south-west of the Ruined Ramparts. There is a landing ground here known as the Ruined Ramparts Aerodrome, cleared by Mr. D. Mackay in 1930 during his Aerial Survey Expedition in the Petermann Range in that year.

Livingstone Pass is very close to the West Australian border, and after returning through this pass from the south side of the Ruined Ramparts, the sandy loam flats on the eastern side of the Docker River were followed north-west to the Docker Gap, and at about 7 miles out from Livingstone Pass on this course, it is estimated that the route crossed into Western Australia.

The dry sandy bed of the Docker River cuts through a strong quartzite range at the Docker Gap, and trends north-north-west out into true desert country to ultimately fade out some distance out from the hills.

At the Docker Gap, the tracks made by the 1935 Border Gold Reef Expedition ended, and as the locality in which the alleged "reef" had been indicated was situated some 56 miles by air-line W. 29° N. of this gap, a general north-west by west course was followed across sandy spinifex flats and many sandhills to the sandstone ridges in the desert north of the Robert Range. These ridges proved to be the alleged "reef."

The return journey was made on the out-going tracks, hence no new country was traversed on the way in to Alice Springs.

The following table of distances between the more important places, and the waters used on this journey, is compiled from speedometer readings and therefore represents the distance along the track in each instance.

TABLE OF DISTANCES.

| Places. From. | Places. To. | Miles measured along the track. | |
|---|---|---|---|
| Alice Springs | Owen Springs (water) | 39·5 | |
| Owen Springs | Doctors Stones (water) | 33·5 | |
| Doctors Stones | Henbury Station (water) | 20·0 | |
| Henbury Station | Erldunda Station (water) | 50·5 | |
| Erldunda Station | Collata Spring (water) | 27·5 | |
| Collata Spring | Two Wells (water) | 16·5 | |
| Two Wells | Pearce's Sheep Camp (water) | 28·8 | |
| Pearce's Sheep Camp | Erandirrinna Bluff | 45·0 | |
| Erandirrinna Bluff | Indultna Soak (water) | 29·0 | |
| Indultna Soak | Quartz Hill | 98·0 | 205-mile dry stage. |
| Quartz Hill | Gordon Hill | 30·0 | |
| Gordon Hill | Foster's Cliff | 22·0 | |
| Foster's Cliff | Armstrong River Crossing | 41·0 | |
| Armstrong River Crossing | Piltardie Rock-Hole (water) | 14·0 | |
| Piltardie Rock-Hole | Mt. Bowley Aerodrome | 29·0 | |
| Mt. Bowley Aerodrome | Mt. Curdie | 16·0 | |
| Mt. Curdie | Livingstone Pass | 31·0 | |
| Livingstone Pass | Water Hole 2 miles S.W. of Ruined Ramparts (water) | 7·0 | |
| Water Hole 2 miles S.W. of Ruined Ramparts | The Docker Gap | 19·6 | |
| The Docker Gap | Locality of Alleged Reef | 70·0 | |
| | Total | 667·9 | |

It is thought that a few remarks on the general technique of travel with motor transport in desert country may not be out of place here, and the writer offers the results of his experiences in the paragraphs below, hoping that they may prove useful to those who have not made journeys in the arid sandy regions of Central Australia.

The use of motor transport in this class of country is costly, and when not supported by camels, is unsafe. Large quantities of water are consumed by low-clearance vehicles, though trucks fare better on account of the height of the radiator above the general level of grass seeds. It becomes a very difficult matter to know what spare parts to carry, and though the obvious essentials such as a few spare tyres and inner tubes, main spring-leaves, axles, tail-shafts, universal joints and clutch linings will suffice to meet the probable replacements necessary on such travelling, many other parts of the vehicles are liable to give out under the very trying conditions they have to work under.

With the exceptions of those portions of the route lying between Pearce's Sheep Camp and The Musgrave Ranges, Mt. Bowley Aerodrome and Mt. Curdie, and The Docker Gap and the locality of the alleged "reef," the travelling surfaces were good, consisting mostly of open grass and spinifex plains, sandy loam mulga flats, or gravelly surfaces. Many dry, sandy watercourses, some up to 150 yards wide, had to be negotiated, and experience with motor transport in this class of travelling is necessary to avoid being bogged in the loose sandy gravel.

The secret of negotiating sand-hills and sandy crossings lies in possessing as much momentum as possible at the instant of entering them. Partially deflated tyres are an essential, and the engine needs to be in bottom gear during the approaching run up to the sand-hills or into the crossing. It pays to spend time making an approach to these obstacles rather than on or in them later on. A fast approach in bottom gear will take the vehicle a long way through the sand.

When progress is halted on a sandy patch, if possible, back the vehicle in its tracks and go forward again. The constant use of the hands or a shovel to scoop the sand from behind or in front of the wheels before starting in sand is absolutely necessary if the clutch lining is to be preserved.

It may be necessary to run up and back a sand-hill several times, cutting a little bit more track each time before the crest is finally reached. It is quite useless attempting to change gears after the sandy patch has been reached and the vehicle is losing momentum. Some types of sandy crossings and sand-hills are more easily negotiated with the greater momentum obtainable by using the second gear. This saves the radiator water but is applicable only to narrow crossings or short sand-hills.

Keeping the tyres hard in country where there is much dead timber on the ground minimises the danger of staking, and having them partially deflated in sandy, hummocky, spinifex country greatly aids progress. A thin layer of spinifex packed into the wheel tracks on the upper portion of the tracks on a sand-hill when it has been found necessary to back down from it once or twice, will give the wheels the additional grip to preserve momentum to carry the vehicle through the unbroken sand higher up. A long handled shovel and a forked mulga stick are excellent tools for gathering spinifex for this purpose.

When selecting a road through saucer-shaped sand-hills on which it is intended to return, due regard must be paid to the slopes on the side from which the return trip will be made. It is often easy to negotiate a sand-hill from one slope and impossible to return up the other slope even though a track has been cut down it on the outward trip.

The fitting of a small engine-operated air pump to a truck engine, with about 15 feet of armoured air hose as a lead from the pump, makes the inflation of tyres an easy process, and the knowledge that the tyres can be easily inflated again tends to the more frequent use of the most suitable tyre-pressures in the various classes of country encountered. With this air hose and a short piece of iron pipe for inserting in a mallee or "desert oak" charcoal fire, high temperature can be reached, and a weld can be made in a broken part if necessary. This air hose is also extremely useful for cleaning grass seeds from a radiator when used from the fan side. In a country where water is precious, good radiation is necessary in a car engine, and a piece of wire gauze of about 100 mesh to the square inch, wired in front of the radiator, saves a lot of grass seed and husks from entering the core spaces in the radiator, which prevent free air-circulation.

Not one clutch facing was burnt out on this trip, and this is attributed to the judicious handling of the vehicles, paying due regard to the hints given above.

A useful aid to progress in very heavy sand when it is impossible to make a good approach to it, is the use of sand mats. These consist of two lengths of coir matting, 18 inches wide and about 40 feet long. They roll up into a neat parcel and are easily carried on a load or on the bumper bar or mudguards.

When halted by sand, all four wheels are cleared in front and a length of mat laid down in the wheel tracks on both sides. The rear end of each mat must be tucked firmly under the front of the rear wheel and the mat stretched out so as to pass in front of the front wheel, under which it is tucked laterally as far as possible, taking care to have a bend in the mat immediately in front of the front wheel. When the rear wheels start to grip they pull the mat straight, and if the forward portion has been correctly tucked under the front wheels, this end becomes anchored by the weight of the car in front and the car moves forward on the mat.

The writer has tried other devices invented for use on wheels in sandy country in Central Australia, but the sand mats have proved the most efficient, and are in universal use by all users of motor transport in Central Australia to-day.

There are often several bad sandy patches close together, but separated by good surfaces. To save time, the mats need not be rolled up after the first patch has been crossed but can be tied on behind with a suitable tie and dragged behind the car to the next patch.

Engine sump oil needs frequent changing when much low gear work has to be done, since high engine temperatures are reached and the water in the radiator is frequently boiling. It is not an infrequent occurrence to have to travel for a week at a time with the engine in bottom, reverse, and second gear only.

## CLIMATE, FAUNA AND FLORA.

*Climate.*—The average annual rainfall of the country between Alice Springs and the Rawlinson Range in Western Australia ranges from 0 to 10 inches. There are no recording stations over the major portion of this area and the value of 10 inches is that applicable to the country in the immediate vicinity of Alice Springs. The rainfall is of the Summer type mostly, but occasional winter rains do sometimes fall both in Alice Springs and in the vicinity of The Petermann and Rawlinson Ranges. The entire area is subjected to prolonged droughts, when for several years no germinating rains will be known to fall.

In February of 1936, up to 5 inches of rain fell over the eastern portion of the area, but it was found that out in the western portion of the Northern Territory and in the eastern part of Western Australia, north of the Petermann and Rawlinson Ranges, the country had been subjected to a prolonged drought. Even the spinifex was browned off and was green only at the base.

In the summer months high temperatures and occasional high relative humidity prevail, and "dry" thunderstorms are of frequent occurrence. The bulk of what rain does fall in the western section of the area is precipitated during this season, mostly accompanying thunderstorms, and general rain is more the exception than the rule.

The winter months are normally free from rain and are characterised by bright sunshine, cold south-east winds, and cold nights and mornings. Heavy frosts are frequent both in Alice Springs and in the Petermann Range during June and July, and their occurrence is chiefly welcomed in so far as the cold conditions render the flies inactive. The flies in the summer time are extremely troublesome and add much to the already rigorous conditions attached to travel in this country.

Unquestionably, the most suitable time of the year for travelling in Central Australia is during the winter months, from May to September, when provision should be made for fairly cold conditions. Natural water supplies are then more likely to be more frequent and more copious after the usual summer rains, and climatic conditions are at their best while the flies are, though not altogether absent, in their least numerical strength.

*Fauna.*—Bird and animal life is, on the whole, scarce, though in the vicinity of the permanent waters, local concentrations of birds and animals are to be found. Among the birds seen on the journey and recognised were crows, eagles, sparrow-hawks, black cockatoos, wild turkeys, butcher-birds, emus, "wax-bills" (a variety of finch frequenting permanent waters in large numbers) and a bird which had the appearance and habits of a "Willy-Wag Tail" but seemed larger than those in the South-West of Western Australia. Two varieties of pigeons, one of which is locally termed a "rock pigeon," were seen near the various water supplies.

Animal life is scarcer than bird-life and the following animals were seen:—Kangaroos (red and grey), rock wallabies, a species of small marsupial inhabiting spinifex flats and locally termed a "desert rat," foxes, dingoes, wild cats (domestic species gone wild and much sought after by natives as a food) and rabbits.

No snakes were seen, and only small varieties of lizards were occasionally observed.

Numerous ant species were noted and a number of "trap-door" spider holes were also seen. Rabbits occur throughout the whole area, being particularly numerous in the Petermann and Musgrave Ranges. Their tracks were seen in the desert sand-hill country north of the Robert Range in Western Australia, and the rabbits which inhabit this locality must be producing a particularly hardy species, as succulent vegetation suitable for providing the necessary moisture for these animals is extremely scarce here.

Judging from the numerous warrens that have been dug out by the natives (the female aborigines do this work), the rabbit must be regarded as a welcome addition to their diet.

*Flora.*—Practically the whole of the country travelled through from Pearce's Sheep Camp to the Western Australian Border can be included in the vegetational divisions characterised by "Desert with spinifex and belts of low shrubs" and "Mulga bush." In some places the former type predominates and in others the latter, but a mixture of the two types would be a better classification.

In the sand-hill country north of the Musgrave Ranges, large areas of grey mulga scrub are to be seen, while over the border in Western Australia, mulga scrub is scarce, and spinifex, stunted mallee and desert oak are the predominant species.

Wide "buck-bush" and mulga flats are frequent on the northern flanks of the Musgrave and Petermann Ranges, and in the alluviated flats which extend for long distances into these ranges many varieties of herbaceous plants are to be found with grasses, ironwood trees, Bloodwood gums, white barked river gums, etc.

Extensive areas of "Park-lands" (open Mulga, Desert Oak, Kurrajong, Quandong and Mallee growth, with spinifex and sparsely distributed grasses and shrubs), are characteristic of much of the area.

All of the prominent dry water courses such as the Britten Jones, the Opparinna, the Armstrong, the Irving, the Chirnside, the Hull and the Docker Rivers are thickly lined with white barked eucalypts, and not infrequently the river beds are also studded with the same gums.

At the Docker River there are numerous Bloodwood trees on the flats, and occasional trees of the same species occur further east in the Petermann Ranges.

The variety of spinifex commonly known as "Porcupine Spinifex" and which grows in strong rounded isolated clumps and is particularly obnoxious to travel through, does not occur west of Quartz Hill. The greater portion of the spinifex seen belongs to the "soft" variety which when burnt is edible by stock. In latitudes further north than those visited, the "Porcupine" spinifex predominates.

"Native Fig" trees are numerous on the low gneissic and granitic hills of the Musgrave and Petermann Ranges, and a species of "Fir Tree" is nearly always associated with them in these localities. A dark-green leaved shrub with a habit of growing in clumps on the more elevated portions of the low gneissic hills, and possessing numerous, fairly straight main stems coming up from the base is locally termed a "Spear tree." It has a pithy centre and has a light white wood. The stems of this shrub are straightened by fire and used by the natives as spear shafts.

Parakylia is plentiful on the sandy loam mulga flats between Pearce's Sheep Camp and the Musgrave Ranges. Myoporium (poison for camels), saltbush, beefwood, prickly acacia, wind-grass, and a number of wildflowers of a leguminous species and daisies were also noted on the journey. The Sturt Pea was not observed to occur in this part of the interior, though further south, in the north of South Australia, it is fairly common.

## WATER SUPPLIES.

From Pearce's Sheep Camp onwards it will be noticed from the Table of Distances appearing in an earlier part of this report, that only three waters were used by the expedition. The information able to be offered about this all-important subject is therefore very limited, since, with the exception of a soak dug at the eastern side of the bed of the Docker River at 2.3 miles north-west of Livingstone Pass, the writer saw no other waters.

Indultna Soak (Indulka on South Australian maps) at 74 miles out along the track from Pearce's Sheep Camp can be regarded as a permanent water. It is called a "soakage" but is in reality a gravity spring. The water issues from sheared and crushed gneiss on the eastern side of some low gneiss hills, which latter are sufficiently jointed and broken to absorb rain water falling on them. Mitchell's Knob lies about 4 miles due south of it and is an unmistakable landmark in this locality. The water is excellent when the old water lying in the excavation at the spring has been baled out and a fresh supply allowed to make.

Piltardie Rock-Hole, 205 miles along the track from Indultna Soak, was the next water used. This is a well-known and well-used series of rockholes in a gorge in a quartzite ridge in the Petermann Ranges. A cairn has been erected on the ridge on the eastern shoulder of the gap close to the water, and cannot very well be missed by a traveller. These rockholes can be relied on at all times as they are deep and well shaded, and hold a large quantity of water. The water is of excellent quality.

Warrapzuza Water-hole, 83 miles further out along the track from Piltardie Rock-hole, and about 2 miles south-west of the Ruined Ramparts, was the next water used, and though containing plenty of good water at the time of our visit cannot be relied on as a permanent water.

About 2 miles north-west of Livingstone Pass there is a very good soakage in the bed of the Docker River on the eastern side. The water is good, and a fair supply could be relied on even in the driest of seasons.

There are undoubtedly many permanent waters in the Petermann Ranges, but they are difficult to find without the help of local natives. The natives are not always willing to supply information about their water supplies, and it is sometimes necessary to use methods other than those based on vocal and sign principles to obtain the desired information.

In the 3¾ mile to the inch map accompanying this report, a number of waters located and used by Messrs. Talbot and Blatchford during a camel journey into the Petermann and Rawlinson Ranges in 1931 are shown. For information concerning water supplies in the Musgrave, Petermann and Rawlinson Ranges, reference may be made to the following published reports (with plans):—

Reports on Prospecting Operations in the Musgrave, Mann and Tomkinson Ranges (with plans), by L. A. Wells and F. R. George. South Australian Parliamentary Paper No. 54, 1904.

Journal (with plans) of the Government Prospecting Expedition to the South-Western Portions of the Northern Territory, by F. R. George, South Australian Parliamentary Paper No. 50, 1907, Vol. III.

Extracts from Journals of Explorations, Fowler's Bay to Rawlinson Ranges (with plans), by R. T. Maurice. South Australian Parliamentary Paper No. 43, 1904.

These Parliamentary Papers are available at the Perth Public Library.

The geological formation of the Musgrave, Petermann and Rawlinson Ranges is particularly favourable to the formation of rock-holes in the dry watercourses cut in the steep sided hills. A number of sandy creek beds on the flat country immediately adjacent to the hills also afford likely spots for creekbed soakages.

Many ideal well sites were seen on the fringe of the ranges, and it would be possible to provide artificial waters at very frequent intervals from Erandarrina Bluff in the Musgrave Ranges right out to the Western Australian Border.

A few remarks about the transporting of water supplies, etc., when using motor transport, may be of value to those not already experienced in this matter.

Mostly all natural surface waters suffer from pollution by organic matter, both animal and vegetable, and will not stand being closely confined in full drums or containers for periods of over three days. It is a good practice to only three parts fill the containers and to remove the plugs every night. This permits a free access of air with the necessary oxygen to prevent destruction of bacteria and their subsequent putrefaction. It is possible on long inland journeys to drink only boiled water; a little extra organisation is necessary to insure this, but the added safety from sickness is well worth the trouble.

Half inch rubber hose in lengths of 8 or 10 feet is useful for siphoning water from large containers, and a filling funnel of large size with a gauze diaphragm is indispensable when filling from limited supplies or in a strong wind. Water has frequently to be carried from rockholes, access to which is very difficult, and provision should be made in the equipment for closed containers of 4-gallon capacity only, with which to do this work. Forty pounds is about as much as a fairly strong man will carry with safety out of many of the places where rockhole water is usually found.

## NATIVES.

The south-western corner of the Northern Territory has always been a stronghold of the inland aborigines, the good pastoral country and permanent waters of the mountainous area affording excellent feeding grounds for native game. During recent years a rectangular area of some 28,300 square miles of country embracing the Petermann Ranges, the Olia Chain, and portion of the Musgrave Range, has been set aside in the extreme south-western corner of the Northern Territory by the Commonwealth Government as an Aboriginal Reserve. A Western Australian Aboriginal Reserve joins this reserve on the west. Permission must be obtained from the respective Governments concerned to enter these reserves for any purpose.

On the outward journey no natives were met with, though their tracks and the smoke from the hunting fires were frequently seen. On the return journey about 200 of both sexes including men, women and children were encountered in three individual parties. Two small parties encountered at Piltardie Rock-hole and near Gordon Hill were quite friendly disposed towards the party though they knew no word of English. These natives were entirely nude and were in reasonably good physical condition.

A larger party of some 100 in number were camped at Indultna Soak, and some of these were partially clothed and were, on the whole, rather poor physical specimens. This particular assemblage of natives was gathered at Indultna Soak in order to trade dingo-scalps with European dingo-trappers ("Doggers") who operate in the Musgrave Range to the south.

The only weapons seen in the possession of the males were mulga-tipped spears and womeras—the boomerang and shield do not appear to constitute part of this tribe's weapons. Of possible anthropological interest may be the observance of two long-bearded female aborigines amongst a party seen at Piltardie Rock-hole in the Petermann Ranges. Another interesting feature about this tribe of natives is the extraordinary size of the "coolimans" used by the females as containers of water and carried on a hollow circular pad of human hair on their heads. Several of these "coolimans" seen would be about 4 feet long, 18 inches wide and 1 foot deep in the deepest part.

The expedition was not molested in any way by the natives, and it has been the writer's experience in many other parts of the Northern Territory as well as on this trip, that providing a few simple laws are obeyed by the party, little trouble need be anticipated from the natives. It is very advisable not to camp close to the water supply; bush natives come into water much the same as do wild animals, and the presence of a camp on the water may disturb them. Natives should never be permitted to come into the camp on any pretext, and likewise their camps should not be disturbed by the white man.

## PHYSIOGRAPHY.

The two most prominent features of the physiography of this portion of Central Australia are the isolated hills and continuous ranges of hills, and the wide level areas of flat to undulating sandy country surrounding them.

The country travelled through from Alice Springs to west of the Western Australian border forms portion of the great inland plateau which extends well up into the Northern Territory, eastwards into Queensland, southwards into South Australia, and westwards to near the north-western coast of Western Australia. Near Alice Springs the general elevation of the plain country is about 1,900 feet above sea-level, whilst further to the south, a little to the north of the Musgrave Ranges, it is in the vicinity of from 1,500 to 1,600 feet above sea-level. The heights of the hills and ranges rising out of this plateau vary from 50 to 2,000 feet.

The Musgrave Ranges are composed of high rough hills and spurs of gneissic and granitic rocks rising to a height of about 2,000 feet above the level of the surrounding country. They present a bold scalloped front to the north, and the differences in composition of the vast mass of mainly gneissic material composing them are very prominently displayed in the remarkable strike lines of the various beds seen to be folded along axes having mostly an east-west trend. Rugged massiveness is suggested by the topography of these ranges, and there is no individual outstanding formation which controls their topographic expression.

Numerous ravines are cut into the slopes of these ranges, and every here and there a wide alluviated valley extends through them from north to south. The drainage from the ranges is carried out a few miles only, in sandy creek and river beds, dry for the greater part of the year, to be absorbed into the sandy spinifex and mulga country to the north and south.

Further west the topographic forms change, and the massive forms of the Musgraves give place to the picturesque dip-slopes and erosion escarpments of the cuestas in the south-eastern end of the Olia chain. In this section of the country several thick quartzite bands occur in the gneissic series, and it is these bands which dominate the topographic forms in the Olia Chain, the Petermann Ranges and the Rawlinson Ranges. Flanked on both sides, as they frequently are, by less resistant weathering material in the nature of basic and acidic gneisses, and being folded into steeply dipping beds, the hogback type of ridge becomes prevalent, and the Petermann Ranges are largely composed of quartzite dip-slopes, erosion-escarpments, residual cappings, and hogbacks. The gneissic and granitic rocks form a gently rounded type of hill and are confined to low rises and hills in the flat sandy country immediately flanking the ranges.

The Rawlinson Ranges were not visited, but many miles of broken ranges extending westwards from Livingstone Pass near the Western Australian border have the same topographic expression, and from information contained in the chapter in this report dealing with the geology, it will be seen that these hills are continuous with the Rawlinson Ranges and that the latter are composed of the same rocks as the Petermann Ranges.

Blood's Range and South's Range, north of the Petermann Range and visible from it, appear to trend more nearly east and west than the Petermann Range, which has a north-west by west trend. The sky-line of these ranges suggests gentle dipping sedimentary beds only, and other observers report that Blood's Range is entirely quartzite and South's Range is composed of sandstone.

Hogbacks of quartzite occur as far north as the Docker Gap, and then to the north-west by west of this point the Walter James Range is seen as a long, high, flat-topped mass suggestive again of quartzite, which is dipping only fairly gently, and surrounded by flat sandy desert country with numerous sand-hills. South from the Walter James Range and separated from it by sand-hills and sandy spinifex country, the northern front of Mural Crescent forms a striking feature running east and west. This structure has a similar topographic expression to that of the western end of the Petermann Ranges, and is probably composed of quartzite and gneiss apparently dipping steeply to the north.

A little north of west from the Walter James Range and separated from it by a comparatively short stretch of desert country (12 to 14 miles) lies the Robert Range, and it appears to be formed largely of red sandstone dipping to the south at a high angle. From the outline of this range there is a suggestion of quartzite being interbedded with the sandstone.

At a distance of 8 to 9 miles north of the Robert Range, a series of low broken sandstone ridges runs north and south and has a fairly even sky-line with well-defined bluffs at its northern end and at intervals along it. This formation was visited and, as was expected from its topographic expression, proved to be sandstone dipping gently in various directions.

The hills of the Petermann Ranges do not rise as high above the general level of the surrounding country as do those of the Musgrave Ranges, 1,500 feet being possibly the maximum height attained. Even so this brings the general level of the crests of the Petermann and Rawlinson Ranges somewhere near 3,400 feet above sea level. A 1934 map of the Northern Territory shows the Petermann Ranges at 4,000-3,500 feet above sea level, but this is probably excessive. There is no trigonometrical survey of this part of Central Australia and the figures quoted above are estimates only. An altimeter on one of the aeroplanes attached to the expedition showed the height of Mt. Bowley landing ground in the Petermann Ranges as 2,000 feet above sea level.

The outstanding feature of the topography of the Petermann Ranges and that portion of the Rawlinson Ranges extending westwards from the Western Australian border, is the dominating influence exercised on it by the quartzite beds which appear to cap the gneisses. These quartzite beds are up to 300 feet thick in places, and are particularly noticeable at "The Ruined Ramparts" near Livingstone Pass in the Petermann Ranges.

The sand-hill country encountered between Pearce's Sheep Camp and Erandirrina Bluff in the Musgrave Ranges and north-west of the Docker Gap in Western Australia, calls for some comment. In both instances the sand ridges bear no direct relation to the direction of the prevailing winds and are, for the most part, covered with mulga or spinifex growths.

The binding action of the roots of this vegetation and the protection afforded the sand by the top growth, prevents the extensive formation of new sand ridges or the migration of those already existing, under present climatic conditions. It would appear then, that these sand ridges had been formed under more arid conditions than those prevailing to-day. There are some sand ridges in these localities completely devoid of vegetation, and others on which the lower slopes only are covered, but speaking generally, the presence of thick growths of vegetation on the sand-hill country gives rise to the thought that existing flora and climatic conditions could not very well have prevailed at the time of the formation of the sand-ridges.

The drainage of the whole area is, of course, of the inland type, and although many dry water-courses are to be seen extending northwards from the northern flank of the Petermann Ranges, none of them goes very far before dying out in the sandy desert.

That portion of Western Australia visible to the north and west from the low sandstone hills north of the Robert Range, presents a low even horizon, and as far as the eye can see, consists of spinifex covered sand-ridges and flats, with occasional patches of mulga and sparsely distributed desert oak (*Casuarina decaisnéana*). To the south and south-west the view is limited by the bold broken skyline of the Rawlinson Ranges, running in a general east and west direction for some 60 miles.

## GEOLOGY.

In a recent paper by Dr. C. Chewings[1] on Central Australian Geology, the most recent conceptions of the stratigraphical sequence compiled from the writings of H. Y. L. Brown, Professor R. Tate, J. A. Watt, Dr. L. K. Ward, Professor W. Howchin, Sir Edgeworth David, Sir Douglas Mawson and Dr. C. T. Madigan are set out in Table No. 1.

The conception of the existence of a great sunkland between two shields of Archaean rocks is brought forward and amply justified by detailed structural and palaeontological evidence.

The observations made by the writer of this report during recent journeys in portions of the area discussed by Dr. Chewings were, for reasons mentioned in the introductory chapter to this report, of a very cursory nature. They do not produce any conclusive evidence in rebuttal of Dr. Chewing's findings, although it will be found necessary to make some remarks which do not strengthen his conception with respect to the Pre-Pertatataka rocks.

A westerly continuation of the Ordovician beds, which are a feature of the Amadeus Sunkland, into Western Australia, which Chewings states[2] may possibly be the case, was found to be a reasonable assumption, and quartzites and sandstones which probably belong to the Ordovician series were found as far west as 50 miles inside the Western Australian border.

The chief point on which the writer differs with Dr. Chewings and most other observers of the Pre-Pertatataka Series (the Pre-Nullagines of Western Australian nomenclature) in Central Australia is in the breaking up of this series into the Pertaknurra (Older Proterozoic) and Arunta (Azoic-Archaean) Series on structural grounds.

The type locality of the Pertaknurra Series is the southern flank of the Heavitree Gap Range in the Macdonnell Ranges, two miles south of Alice Springs. Most observers have regarded the erosion escarpment of a highly jointed, southerly dipping quartzite bed in this locality as being the base of the Pertaknurra Series, and although several ages have been

[1] The Pertatataka Series in Central Australia, With Notes on The Amadeus Sunkland: Trans. Roy. Soc. South Aust., Vol. LIX., 1935.

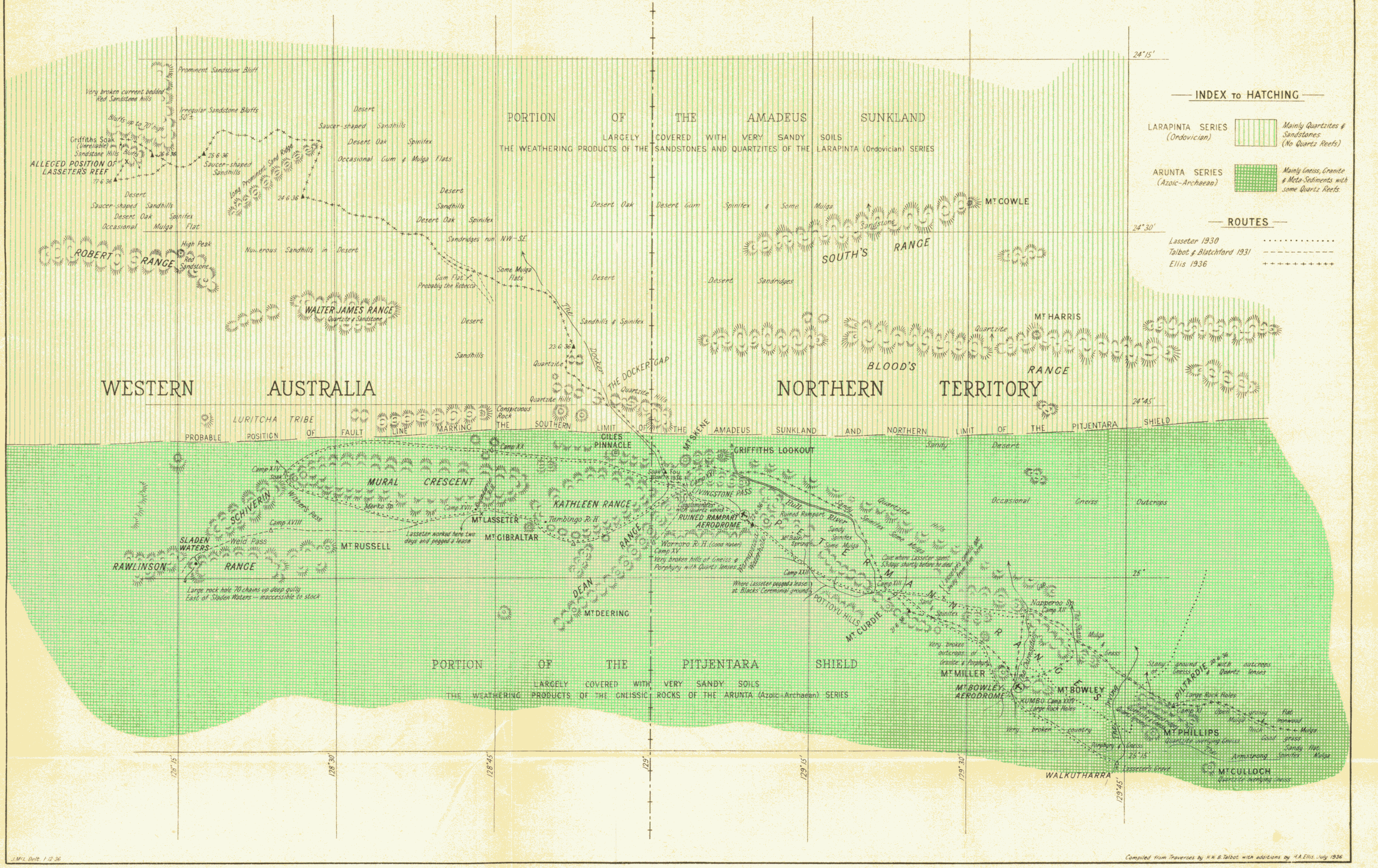
[2] Op. Cit., p. 151, para. 1.

PLATE No V

# GEOLOGICAL SKETCH MAP
OF
# COUNTRY IN VICINITY OF THE PETERMANN AND RAWLINSON RANGES
# CENTRAL AUSTRALIA

To accompany report by H.A. Ellis; G.S.W.A. Annual Report, 1936

Scale 8 Miles to an Inch



assigned to these beds by different observers, their unconformable junction with the underlying gneissic rocks has generally been accepted. Ward[3] and Chewings[4] have both concluded that this quartzite bed is a basal bed on an unconformable surface of rocks of Achaean age.

The Arunta complex as exposed in the Macdonnell Ranges consists of ortho- and para-gneisses, very many varieties of basic schists, garnetiferous and quartz-mica schists, slates, quartzites, dense silicified metamorphosed argillaceous sediments with garnets, graphitic schists, granite, pegmatite and basic dykes. Metamorphosed lavas and pyroclastics also occur to a minor extent.

It is in this complex of basal rocks in which gold, wolfram, tin and mica deposits occur in Central Australia. No mineralisation is known to have taken place in any of the rocks of younger age, and in this respect the series conforms to the Pre-Nullagine metalliferous rocks of Western Australia.

Considering now the relation of this supposed quartzite bed (Chewings' No. 1 quartzite) to the underlying rocks. The rough hilly stretch of country surrounding the town of Alice Springs is composed mainly of gneiss, some it very finely banded and the rest of it coarsely banded. Judged by the even thickness and considerable length, 2 to 3 miles in places, of certain finer banded portions of it, the conclusion that these stretches are paragneisses is reasonable. Some bouldery hills when viewed closely do not present a gneissic appearance, but when seen from a distance in the correct lighting give a very distinct indication of a weathered, coarsely gneissic mass. These are the gneissic granites of the series. Other bouldery granitic hills do not present any suggestion of gneissification, and these, in the writer's opinion, are the weathered surfaces of an intrusive granite which has not been subjected to folding, and which may probably be the granite from which the mineralising solutions have been derived.

Observations on the strike and dip of the planes of gneissosity in all the gneissic material, whether that immediately underlying the quartzite bed or further away from it in the gneissic granite to the north, show that the strike and dip of this quartzite band conforms with that of the planes of gneissosity in the beds below.

Careful investigations were made in the finer grained basic gneisses immediately below the quartzite band in the Heavitree Gap Range, with the object of ascertaining whether the planes of gneissosity or schistosity could be seen to be cutting across bedding planes, but with a negative result.

The coincidence in strike and dip of the bedding planes in the quartzite and underlying gneisses and schists must therefore be recognised.

Viewing this striking erosion escarpment from the north, the even nature of the junction line between the quartzite and the beds below is very marked, and were the underlying beds portion of an unmetamorphosed sedimentary series an unconformity would not even be thought of. The contact must be regarded as a conformable one on the topographic evidence available here.

There are thick quartzite beds in the recognised Arunta complex, notably at Winnecke, and in Western Australia at Chittering, a short distance north of Perth, and south of Southern Cross in the Yilgarn Goldfield, and the evidence quoted above points to the Heavitree Gap quartzite being a bed in a conformable series.

The break in succession in the Pertaknurra Series must lie much lower down in the succession than is generally conceived, and if the margins of the coarsely gneissic granite could be mapped, possibly an unconformity could be shown to exist there.

Shifting the scene of the discussion now to the Petermann Ranges, where, on evidence gathered from other observers, Dr. Chewings premises the existence of the Pertaknurra quartzite, it will be shown that the writer was unable to recognise the unconformity between the Pertaknurra quartzite and the Arunta complex forming the southern or Pitjentara Shield.

The rocks of the Pitjentara (southern) Shield are essentially the same in nature and origin as those of the Arunta (northern) Shield, i.e., they are crystalline rocks of a granitic, gneissic, or schistose habit, and are rightly regarded as being of the same age, namely, Azoic-Archæan.

A similarity in the geology of the two shields is apparent, and in the Petermann and east Rawlinson Ranges the striking topographical features of the Macdonnell Ranges are reproduced, only on a smaller scale. The quartzite bed so prominent at the Heavitree Gap Range near Alice Springs, dominates the structure in the Petermann and Rawlinson Ranges, and it is here seen folded and warped, forming hogback ridges, cuestas, and domes. It is invaded by frequent quartz reefs and agrees in all manners with Dr. Chewings' No. 1 quartzite or basal bed of the Pertaknurra Series.

As in the vicinity of Alice Springs, the strike and dip of this quartzite bed was found to be the same as the strike and dip of the planes of gneissosity or schistosity in the underlying gneisses and schists, and the junction of the two types was seen to be conformable.

In the nest of hills of which Gordon Hill is the most prominent, at the south-eastern end of the Olia Chain, several horizons of quartzite in the gneissic series are plainly visible, and the strike and dip of the bedding planes in the quartzite and of the planes of gneissosity are concordant. The hogback in which is situated Piltardie Rockhole is composed of one main band of steeply dipping quartzite with one minor parallel band separated by coarse basic gneissic material. These quartzites are unmistakably part of a conformable series, and in every instance where their contact with the underlying beds could be observed in the western section of the Petermann Ranges, it was found that the junction was even, and that the strikes and dips of the two rock types were concordant.

Great difficulty has been experienced in Western Australia when seeking to find an unconformity in the Pre-Nullagine rocks. They have been classified into series, viz., Yilgarn, Kalgoorlie, Mt. Barren-

[3] Ward, L. K., Notes on The Geological Structure of Central Australia: Trans. Roy. Soc. South Aust., Vol. XLIX., p. 62 (bottom of page).

[4] Op. Cit., p. 143.

Stirling Range Series, etc., purely on lithological or geographical grounds, but no conclusive evidence of the existence of a major unconformity in the Pre-Nullagine rocks has yet been established. The writer prefers to regard the Pertaknurra Series of the Macdonnell Ranges and the Petermann and Eastern Rawlinson Ranges as consisting predominantly of quartzite, forming an horizon in a great series of metamorphosed unfossiliferous rocks. The foundation rocks are included in this series, and it is thought that a close examination of the boundaries of the more coarsely crystalline gneissic portions of it might reveal an unconformity.

The route followed on the expedition did not permit of an examination of Ayer's Rock or Mt. Olga, the nearest point of approach being some 30 miles to the south. Dr. Chewings considers[5] that these two very prominent topographic features are remnants of the Pertatataka (Nullagine) Series resting on the basement rocks of the southern or Pitjentara Shield, and that the southern fault line of the Amadeus Sunkland lies to the north of them.

An opportunity will be availed of here to quote a description of the rocks composing the Mt. Olga line of residues made by Mr. T. Blatchford, sometime Western Australian Government Geologist, as a result of his inspection of them in 1931, and kindly made available to the writer in a personal communication. They are, he states, "composed entirely of rounded boulders, cemented together in a silicified matrix of grit. Viewed from the west, the western end presents three high rock knobs, separated by two narrow chasms which are wide enough to be passable by man. From the eastern aspect there are quite a number of smaller knobs, but none approaching in height those of the western end. The boulders comprise a most varied assortment of granites, porphyries, pegmatites and quartz. Quartzite boulders are rare. Amongst the more basic varieties, the most common are porphyrites, basalts, vesicular basalts, dolerites and gabbros. The size of the boulders varies enormously; some of the largest would probably weigh one or two tons but such are exceptional, the greater proportion being of the weight of a few ounces up to say fifty pounds."

"Many of the boulders have flattened sides, which, coupled with the extraordinary collection of different rock types, suggest that the deposit is the result of glacial action. Unfortunately we were unable to obtain samples which were definitely faceted or deeply grooved, but there were so many polished faces that I consider there is little doubt that the deposit has been transported and dumped by a glacier. We found no other occurrence of a conglomerate with the same characteristics."

Assuming Dr. Chewings' classification of the Mount Olga residues to be correct, namely, that they are of the Pertatataka (Nullagine) Series, then Blatchford's observations indicate a glacial period in the Nullagine (Pertatataka) sequence. This possibility does not seem to have been noticed in any of the many exposures of Nullagine rocks in Western Australia. The Mt. Olga beds have been described by other observers as boulder conglomerates, and the suggestion of a glacial origin does not seem to have been made before. The occurrence of a glacial period in Newer Proterozoic (Nullagine or Pertatataka) times is inferred from the presence of tillites in the Adelaide Series (Newer Proterozoic) [Pertatataka (Central Australia) or Nullagine (Western Australia)] in South Australia. In discussing the Pertatataka (Nullagine) Series, Dr. C. T. Madigan[6] comments as follows:—

> "The Pertatataka (Nullagine) seas were very extensive. They stretched from the Macdonnell Ranges southward to cover most of South Australia, and eastward to an unknown distance. No evidence of a glacial period, to correspond with the Sturtian tillites of the Adelaide Series, has been found, though this was specially sought in the western Macdonnells. The basal beds of the Nullagine, in lower latitudes, are doubtfully placed as fluvio-glacial. but the highlands shedding the ice responsible for the Sturtian tillite appears to have lain to the far south-south-west of the Macdonnells in the neighbourhood of the present Gawler Ranges in South Australia."

The presence of such rocks as vescicular basalts and dolerites in the Mt. Olga assemblage is noteworthy, since igneous rocks are not known to occur in the known Nullagine (Pertatataka) formation in Central Australia.

The Nullagine formation so extensively developed in the north of Western Australia has a considerable intrusive and extrusive igneous facies, and in North Australia the basalts of the upper Victoria River, which are so strongly developed in the vicinity of Catfish Yard, in all probability belong to the Nullagine (Pertatataka) formation.

In the same personal communication as mentioned above, Mr. Blatchford states that between Mt. Olga and Piltardie Rock-hole in a distance of about 60 miles on a west by north course, two low sandstone and quartzite ridges were crossed. The presence of this sandstone may have some structural significance, but as the details of its occurrence are not known to the writer, nothing of value can be gained by discussing it further.

From the description of the country passed over by F. George, from the Musgrave Ranges to the north of Mt. Olga[7], it would seem that the Pitjentara (southern) Shield extended north of Mt. Olga, and that the southern margin of the sunkland lay therefore somewhere to the north. The Larapinta Series (Ordovician) occupies the country north of a line drawn to pass roughly through Goyder's Springs, north of Mt. Connor, Ayer's Rock and Mt. Olga, and its probable westerly continuation will now be considered.

Dr. Chewings[8] describes the Larapinta succession in Central Australia as follows:—

"1. Marena red sandstone and quartzite beds 400 to 900 feet thick, form the upper portion of the Larapinta Series. These rest upon
2. Marena Valley shales and mudstone, 400 to 700 feet thick with calcareous fossiliferous bands at the base, where the quartzite starts.
3. Stairway quartzite and sandstone, over 1,000 feet thick. These beds weather into serrated forms that suggest the name.
4. Stairway Valley beds are fossiliferous at the top, immediately under the quartzite, in thin calcareous bands, below which are 400 feet of shale and slate.

[5] Op. cit., p. 150 (bottom of page).

[6] Madigan, C. T., The Geology of The Eastern Macdonnell Ranges, Central Australia: Trans. Roy. Soc. South Aust., Vol. LVI., p. 107.

[7] George, F. R., Prospecting Operations in The Musgrave, Mann and Tomkinson Ranges, by L. A. Wells and F. R. George (with plans); South Aust. Parl. Paper No. 54, pp. 6-8, 1904.

[8] Op. cit., p. 143.

5. No. 4 quartzite, the basal beds, at Ellery's Creek over 3,000 feet thick with a narrow flagstone band in one place.

Note:—Larapinta beds are the special feature of the sunkland and owe their preservation to having been faulted down *en masse*. Subsequently the beds were folded, and erosion has exposed many fossil localities."

He premises the probable extension of this sunkland into Western Australia,[9] that is, that the Larapinta (Ordovician) Series extends westwards across the border. That this is a reasonable deduction will be seen from the paragraphs which follow.

On following the Docker River north-west from Livingstone Pass, a number of bold hills and short ranges composed of highly folded quartzite and gneiss are to be seen on either side for a distance of about 7 miles northerly from the pass. At the Docker Gap itself, situated some 13 miles north-west of Livingstone Pass, the gneiss has disappeared, and the low ranges in this vicinity through which the Docker River has cut its way, are composed entirely of a dense, highly jointed quartzite, dipping mostly to the north but showing signs of folding in the varying strikes of the outcrops. East-west strikes predominate here. For 3 or 4 miles north-west of the Docker Gap, short, strong quartzite ridges with a general east-west trend may be observed, and at a distance of about 6 to 7 miles north-east of the same point the western end of Blood's Range comes into view.

This range runs nearly east and west for a total length of about 55 miles, and when viewed from the south and south-west presents the topographic expression characteristic of the quartzite formations in the known Larapinta Series elsewhere in Central Australia.

George,[10] Tietkens,[11] and Basedow[12] describe the rocks of Blood's Range as northerly dipping quartzites, and George states that the highest point of the range is about 800 feet above the general level of the surrounding country. At a distance of about 12 miles south of Mt. Harris, which is situated in Blood's Range, George[13] reports a quartz blow in quartzite, and it therefore seems probable that this locality is somewhere near the northern limit of the southern or Pitjentara Shield in this vicinity.

At an average distance of about 12 miles north of Blood's Range, and running nearly parallel with it for its length of about 24 miles, is South's Range, and this is described by George as being composed of northerly dipping red, white and yellow sandstone. It would appear then that we have here in South's and Blood's Ranges some sedimentary beds whose lithological characteristics, stratigraphical succession and structural position would suggest that they were the upturned edges of the Larapinta Series corresponding to similar beds much further to the north and which dip in the opposite direction. Dr. Chewings[14] summarises the position as follows:—

"Blood's Range, according to George, Tietkens and Basedow, appears to be the southern limit of the great sandstone and quartzite area of Larapinta rocks that extends westwards from Gardiner's Range, Glen Edith, and Laurie's Creek, apparently without a break to the Western Australian border. Along its southern edge the Blood's Range and South's Range beds are upturned in the same way that the Larapinta Series are seen to overlook the Glen Helen Valley, on the opposite (north) side of the sunkland, only in the opposite direction, for Blood's Range and South's Range dip north."

At the Western Australian border this sunkland must be at least 50 miles broad in a north and south direction, and its probable extent into Western Australia will now be considered.

Proceeding in a general north-west by west direction from the Docker Gap, with the exception of the few quartzite hills and short ridges previously mentioned, no outcrops are encountered until an air-line distance of about 52 miles has been travelled. The Walter James Range, situated in approximately the same latitude as Blood's Range, is passed on the northern side and it appears to be composed of quartzite. It has a flat sky-line for the most part, but presents a broken appearance at its southern end. A prospector reported to the writer that there was no quartz, mica, sandstone or shale in it, that it was composed of quartzite, and that the main bulk of the range was oriented north and south. Circumstances did not permit of a visit to this range, but observations through field glasses conveyed the impression that there were some steeply dipping quartzite beds on its eastern side.

The first outcrop encountered in the desert country on a north-west by west course from the Docker Gap is about 50 miles out, where a low mass of broken sandstone hills with a general north-south trend rises to a height of about 100 feet above the general level of the surrounding sandhills and flat sandy spinifex country. The southern end of these hills lies some 8 miles north of the Robert Range, and their eastern flank extends for about 8 or 9 miles northwards and is marked by conspicuous bluffs and gaps. The sandstone weathers brick red, is current-bedded, cavernous, and contains occasional small water-worn pebbles of quartzite distributed through it, the pebbles not being confined to any particular horizon. The strike and dip varies, two prominent directions being N. 40° W. and east and west with dips of from 20° to 45° southwards. It is folded into gentle anticlines and synclines with horizontal east-west axes where seen in the southern exposures.

This nest of hills is separated from the Robert Range to the south by flat sand-ridge country, and although this range was not visited it can be stated with a fair degree of certainty, as the result of field-glass inspection in a remarkably clear atmosphere from a distance of about 9 miles, that it is composed largely of the same red sandstone. The Robert Range has a general east-west extension of about 10 miles, and the sandstone beds appear to strike east and west and to dip flatly to the south.

George[15] reports occasional sandstone outcrops in the desert country north of South's Range; Warman Rocks, situated about 64 miles north-north-east from the Docker Gap, being composed of this rock.

On lithological and structural grounds it seems to be a reasonable suggestion that the lower quartzite beds of the Larapinta (Ordovician) Series are repre-

[9] Op. cit., p. 151.
[10] Op. cit., p. 8.
[11] Tietkens, W. H., 1889 Journal of The Central Australian Exploring Expedition, with map and section: C. E. Bristow, Govt. Printer, Adelaide, 1891.
[12] Basedow, H., 1926, Geological Report on The Petermann Ranges, Central Australia: Geographical Journal, 1929, pp. 259-265.
[13] Op. cit., p. 8.
[14] Op. cit., p. 151 (top of page).
[15] Op. cit., p. 12.

sented in Blood's Range and the Walter James Range, and that South's Range and the Robert Range with the sandstone hills situated about 9 miles north of it, belong to the sandstone facies of the same series.

The northern edge of the Pitjentara (Southern) Shield would appear to lie along a line drawn approximately in an east-west direction a little south of the Docker Gap, extending westwards to at least as far as the Robert Range in Western Australia, and passing eastwards to the north of Mount Currie in the Northern Territory as postulated by Dr. Chewings.[16] The extent of these probable Larapinta (Ordovician) rocks in Western Australia westerly and to the north of the Robert Range is not known, and cannot be surmised in the present state of our geological knowledge of this part of the State. Dr. Chewings[17] suggests that the western limit of the sunkland in which the Larapinta (Ordovician) beds are the special feature, may be somewhere in the vicinity of the western side of Lake Hopkins in Western Australia, on account of the presence there of a ring of ranges and the exposure of limestone beds.

Reverting now to the geology of that portion of the Musgrave Ranges passed through on the journey, it is regretted that circumstances permitted of observations of such a nature only as make possible the remarks contained in the paragraphs below.

The Musgraves were reached from the north in the vicinity of Erandirrinna Bluff, just inside the Northern Territory border, in approximate longitude 132° 15′ E. after passing over a wide stretch of red sandy loam flats with some sand-hills. About 15 miles north of this bluff there is an exposure of a very coarse grained porphyritic granite of a very fresh appearance, in which the ferromagnesian minerals are present to a very minor extent only. There are a few thin quartz veins in this granite, and in one of the major joints a "gnamma-hole" has been developed. The granite is level with the sandy ground surface and is exposed for only about two square chains. It does not show any trace of a gneissic structure and no other exposures of a similar type were seen anywhere on the journey.

By far the greater portion of the outcrops passed over in a westerly course along the northern flank of the Musgrave Ranges consisted of granite and gneiss. The granite weathers to low rounded hills which are sometimes bouldery and sometimes smooth, and does not possess any gneissic structure. The gneiss seen appears to be mainly orthogneiss derived from a granitic magma, and many degrees of gneissosity, ranging from a wide and barely perceptible banding right down to a nearly schistose structure, are to be seen. In these gneisses there is a lack of sharpness in contact between the acidic and more basic portions and sometimes, as at Mitchell's Knob, the banding has a fine flow-like structure and even closes in almost circular forms. Some gneisses were seen north of Mitchell's Knob, which, on account of the sharp contact between the acidic and more basic portions, the relatively narrow width of the type (mostly basic), its continuity of outcrop, the presence of pitching drag-folds, and in one instance the distinct recognition of diminishing grain-size towards the top of the bed, can be surely classified as paragneisses.

[16] Op. cit., Map p. 155.
[17] Op. cit., p. 150.

A hint of the existence of extensive beds of para-gneisses is obtained when the mass of the Musgrave Ranges lying to the south of a long and wide re-entrant between Erandirrinna Bluff and Mitchell's Knob is viewed from Mitchell's Knob in the late afternoon of a bright day. Long, continuous, curving and wavy narrow bands of rocks of contrasting colours can then be seen to stretch for miles in a general east and west direction, conveying the impression of a vast sedimentary series highly folded and steeply dipping.

Near Indultna (Indulka on South Australian maps) Soak, about 4 miles north of Mitchell's Knob, the gneisses are invaded by pegmatite, and short narrow quartz lenses with tourmaline are of frequent occurrence. Tourmaline and quartz were not seen in association in any other locality.

In many of the dry creek beds which run north from the Musgraves near their western extremity, numerous slabs and sub-rectangular pieces of quartzite occur, and in the ranges to the south there is a distinct suggestion of narrow steeply dipping beds which are probably composed of quartzite.

Generally speaking, the axes of the folds in this obviously highly folded complex strike east and west, but there are many deviations from this direction, particularly in that portion of the Musgrave Ranges which runs northwards from Mounts Morris and Woodward, where strikes approximating to west-north-west are persistent for many miles.

Some fragments of a fresh, medium grained basic rock with the macroscopic characteristics of a dolerite were seen near Indultna Soak. This rock is probably present in the complex here as intrusive dykes, since numerous occurrences of fresh basic dykes are known in the Musgrave Ranges further to the south, and are also reported to exist in parts of the Petermann and Rawlinson Ranges.

On the northern flank of the Musgrave Ranges there are no rocks of a younger age than the Pre-Pertatataka Series (Pre-Nullagine)—on the southern flank there are some sedimentary beds which, according to Jack[18], are of Cretaceous, Ordovician and Cambrian ages. It would seem that Chewings[19] regards Jacks' Cambrian as Pertatataka (Nullagine). Ayer's Rock and Mt. Connor, though almost certainly belonging to the Pertatataka Series, cannot be regarded as flanking the Musgrave Ranges to the north, separated as they are from the latter by a very wide stretch of sandy desert country.

The predominant rock types noted in the Musgrave Ranges were acid and basic para-gneisses, orthogneisses of a granitic origin, quartzites, gneissic granite and massive granite. Similar rocks were noted in the Petermann and eastern portion of the Rawlinson Ranges, with the notable difference that in the latter areas quartzite predominates and the proportion of gneisses of a slightly more basic nature increases.

Nowhere in this semi-mountainous area of Pre-Nullagine rocks is there any development of a volcanic or intrusive igneous phase comparable with the greenstone areas associated with rocks of a similar age in the goldfields of Western Australia, nor is there any marked parallel between these Musgrave, Petermann and Rawlinson Ranges rocks, and the

[18] Jack, R. L., 1915, The Geology and Prospects of the Region to the South of the Musgrave Ranges, . . . . Geol. Surv. S.A. Bull. No. 5, p. 19 et seq.
[19] Op. cit., p. 162.

other lithological divisions of the Western Australian Pre-Nullagine Series. They do not contain nearly as many distinct rock-types as occur in say the Arltunga or Winnecke areas in Central Australia, and they clearly lack the noticeable variety of metamorphic, sedimentary, volcanic and intrusive igneous rocks of the mineral fields of North Australia and the other Central Australian gold localities such as Tanami and The Granites.

Throughout the Petermann, Rawlinson and Musgrave Ranges there is a moderate development of quartz as short lenses and stringers in the planes of gneissosity of the various gneisses, and occasionally in bedding planes and tension cracks in quartzite. In the vicinity of Indultna Soak in the Musgrave Ranges these quartz veins are associated with tourmaline, but in most of the other occurrences noted, the quartz was either entirely glassy or was sparsely impregnated with titaniferous haematite. Occasional pegmatite dykes of small extent occur in the gneiss, and these, like the quartz veins, follow the planes of foliation or gneissosity.

It is probable that the rounded outcrops of non-gneissic granite, the only unmetamorphosed rock (with the exception of basic dykes) occurring in the area under discussion, represents an intrusive granite from which the pegmatite dykes and quartz veins have been derived.

An outstanding feature of the outcropping rocks in the Musgrave, Petermann and Rawlinson Ranges is the remarkable freshness and hardness of all of the rocks. The bands of softer, more "kindly" looking, ironstained and fissile rocks frequently associated with Central Australian mineral fields are conspicuous by their absence here. There is not nearly as much detrital and reef quartz in this area either, when compared with other mineral-bearing localities in rocks of similar age in Central Australia. A fairly steady east and west strike varied by occasional stretches of country where a west-north-west strike prevails extends for a distance of nearly 270 miles, and the impression is gained from a study of structural features throughout this length that although crustal deformation has been severe, it has not been of the same magnitude as that associated with other mineral-bearing localities in rocks of the same age in other parts of Central, North and Western Australia.

For those who favour the necessity for the existence of north-south strikes, or strikes approaching thereto, before any hope can be held out for the existence of mineralised belts of country, there is little encouragement in this long length of possible mineral-bearing country. Strangely enough, belts of Pre-Nullagine rocks both in Western Australia and in North Australia which have a general east-west trend have been found to be barren of mineral contents, while on the other hand just such belts of country at Arltunga, Winnecke and Tennants Creek in Central Australia carry gold reefs.

It is not unreasonable to come to the conclusion, based solely on comparison with other gold-bearing areas in rocks of similar age in other parts of Central, North, and Western Australia, that the Musgrave, Petermann and Rawlinson Range areas are not promising metalliferous provinces. It may be urged against this statement that it is not backed by detailed investigation and that it is too sweeping. It is backed, however, by the statements of some widely experienced geologists who have visited the area before the writer, and what is perhaps more important, by the experience of a great many very good prospectors—only good prospectors can operate in this part of Australia—who have spent a great deal of time with the pick, shovel, dish and dolly pot, and who have mostly failed to raise a colour of gold in this part of Australia which has come to be commonly known as "Lasseter's country."

## PROSPECTING OPERATIONS IN THE MUSGRAVE, PETERMANN AND RAWLINSON RANGES.

On account of the relative inaccessibility of the country embracing these ranges, situated as they are in perhaps the most arid part of the Australian continent, it may be pardonable for the general public to have the impression that this area is but little known to prospectors. This is not correct, as will be shown by subsequent paragraphs.

The Musgrave Ranges, being situated closest to the main overland telegraph route, have perhaps received most attention from prospectors. In the years 1900 and 1901 the South Australian Government sent two expeditions under the leadership of Messrs. R. T. Maurice and W. R. Murray on journeys of exploration from Fowler's Bay to the Rawlinson Ranges, and from Fowler's Bay to Cambridge Gulf. Although these journeys were mainly in the nature of exploratory work, a considerable amount of prospecting was done on both trips where the route passed through the Musgrave, Mann and Rawlinson Ranges, and the leaders of these expeditions report[20] very disappointingly on the mineral possibilities of the range country.

In 1903 Messrs. L. A. Wells and F. R. George led a South Australian Government prospecting party into the Musgrave, Mann and Tomkinson Ranges, and in the subsequent report[21] Mr. L. A. Wells could not hold out any bright prospects, from a mineral point of view, for the country traversed.

The Petermann Ranges were exhaustively prospected during another South Australian Government Prospecting Expedition sent out under the leadership of F. R. George in 1905. In the subsequent report[22] on these operations compiled by W. R. Murray, it is observed that the only place in the Petermann Ranges where traces of gold could be found was at Foster's Cliff, and these traces were found in a "floater" of quartz and were certainly not indicative of payable gold.

The first recorded details of the topography and geography of the Petermann and Rawlinson Ranges resulted from the exploration by E. Giles in this part of Australia in 1874, and appears in a volume written by E. Giles.[23] Giles does not appear to have done any systematic or even intermittent prospecting, or if he did, no mention is made of the mineral possibilities of the country in his writings. It is probable that Giles was the first white man to visit the Petermann Ranges, and he certainly did not discover any free

[20] Maurice, R. T., Extracts from Journals of Explorations, Fowler's Bay to Rawlinson Ranges and Fowler's Bay to Cambridge Gulf (with plans): S.A. Parliamentary Paper No. 43, 1904.

[21] Wells, L. A., and George, F. R., Reports on Prospecting Operations in the Musgrave, Mann and Tomkinson Ranges (with plans): S.A. Parliamentary Paper No. 54, 1904.

[22] George, F. R., Journal (with plans) of the Government Prospecting Expedition to the South-Western Portions of The Northern Territory. S.A. Parliamentary Paper No. 50, 1907, vol. iii.

[23] Giles, E., Australia Twice Traversed: The Romance of Exploration, being a Narrative compiled from the Journals of Five Exploring Expeditions into and through Central South Australia, and Western Australia from 1872 to 1876. Vols. I. and II. Published by Sampson Low, Marston, Searle & Rivington, London, 1889.

gold there, otherwise he would have mentioned the fact in his writings.

The Horn Scientific Expedition to Central Australia in 1896 and a Central Australian Exploring Expedition in 1889 traversed portions of the area under discussion, and although the reports on these expeditions are not available to the writer, neither expedition could have found free gold in payable quantity since there are no records of any payable gold having been found in this part of Australia.

One of the last of the official expeditions, or at least those having persons among their number who possessed some geological training, is the journey made by the late Dr. H. Basedow in 1926.[24] This publication has not been seen by the writer, but no discovery of payable gold was made, otherwise the fact would be well known.

In the year 1931 Messrs. Blatchford and Talbot, two Western Australian geologists who spent many years in the service of the Geological Survey of Western Australia, and who possess a wide knowledge of the goldfields of this State, accompanied the second expedition equipped by the Central Australian Exploration Company, Ltd. (Sydney), which was despatched to the alleged locality of "Lasseter's Reef" in the Petermann Ranges. During this journey Messrs. Blatchford and Talbot traversed the Petermann and Rawlinson Ranges from Piltardie Rock-hole in the east to Sladen Waters, near the western extremity of the Rawlinsons in Western Australia. Prospecting operations were carried out, but without success, by this party, and the conclusion reached by Messrs. Blatchford and Talbot was that the Rawlinson and Petermann areas were not a mineral nor a gold province, and to further prospect them would be a waste of time and money.

In the year 1930, the well known overlander, Mr. M. Terry, took a party of prospectors into the Petermann and Rawlinson Ranges starting from the overland telegraph line. Included in this party were some very efficient Central Australian prospectors, but in a personal communication to the writer Mr. Terry stated that no payable gold was found, and that the entire area was most unpromising from the point of view of the possible occurrence of gold.

In the same year Mr. D. McKay conducted an Aerial Survey Expedition into Central Australia and used the Petermann Ranges extensively for his ground organisation, clearing landing grounds between Foster's Cliff and Butler's Dome, at Mt. Bowley, and at the Ruined Ramparts. Associated with the ground parties were some leading Central Australian bushmen, and although the objects of this expedition were mainly that of the aerial mapping of the country, it is reasonable to assume that the ground parties did some prospecting. Evidence to this effect was noted by the writer when in 1936 he visited the landing grounds at Mt. Bowley and the Ruined Ramparts, and saw there at the old camp sites of this party, numerous miscellaneous collections of quartz and rocks. No likely auriferous country or payable gold has been reported by Mr. McKay.

Another expedition on which prospecting was carried out by experienced prospectors was that financed by Mr. V. Foy, of Sydney, and led by Mr. R. Buck, which traversed the Petermann Ranges as far west as the Western Australian border in 1936. This party sampled numerous quartz reefs and in no case was anything approaching payable gold found, although one of the prospectors on this trip reported to the writer that traces of gold were found in thin quartz veins in the vicinity of Livingstone Pass in the Petermann Ranges.

The paragraphs above deal with the operations of organised Government, scientific, or private expeditions known to the writer through the medium of published reports or personal knowledge. There may possibly have been other expeditions, and in this resumé the observations of the surveyors who carried out the major triangulation surveys of the northern part of South Australia in the latter half of the nineteenth century have not been taken into account. Messrs. E. C. Playford and T. J. Worgan, who were for many years prominently associated with the Mines Department and mining industry of the Northern Territory, and who were also surveyors who had been engaged on the major triangulation of the Musgrave Ranges, informed the writer some years ago that the Musgrave Ranges were unpromising from a mineral aspect.

Of the individual prospectors either in pairs or in small parties who have entered the Musgrave, Petermann and Rawlinson Ranges from the north, south, east, and west, there is no record. The name J. Tregurtha and the year 1896 appears cut in the quartzite at Piltardie Rock-hole in the Petermann Ranges, and no doubt there were prospectors there before that year. Tregurtha was a West Australian prospector and came in from the west.

In 1904, another well-known West Australian explorer, F. Hann, got as far east as the Rawlinson Ranges and prospected round their western extremity. Some of the Central Australian prospectors who have prospected in the Petermann and Rawlinson Ranges are R. Wilkinson, A. Cameron, R. Westgarth, P. Johns, N. Crowther and L. Bloomfield and several of these prospectors, now well advanced in years, personally assured the writer recently in Alice Springs that they had not seen more unlikely looking gold country anywhere in Central Australia than that embracing the Petermann and Rawlinson Ranges.

## THE LASSETER MYTH.

Strangely enough, the only person who seems to have ever found gold in this part of Australia was one named Lasseter, and he, according to his own story, found what prospectors dream about—gold in large lumps sticking out of a quartz reef.

In brief, Lasseter's story of the discovery is as follows:—

Early in the twentieth century he lost his bearings in the Macdonnell Ranges to the west of Alice Springs whilst travelling in that country with horses. In his wanderings alone he found this fabulously rich gold reef, and was only saved from perishing by an Afghan who found him, to be ultimately restored to health by a surveyor named Harding. Several years later he set out with Harding and again found this reef, the surveyor taking its position with his instruments. It is stated that on returning to civilisation they found their watches to be an hour and a quarter slow, hence the calculated position of the reef was 100 miles out as a consequence. (See page 29.)

[24] Basedow, H., 1926, Geological Report on the Petermann Ranges, Central Australia: Geographical Journal, 1929, pp. 259-265.

In 1929 or 1930, as a result of personal representations made by Lasseter to residents of Sydney, the Central Australian Exploration Company, Ltd., despatched a well equipped party with Lasseter as guide to again locate this reef. The result of this expedition was that Lasseter again found the reef when by himself, but perished in the Petermann Ranges.

The story of Lasseter's lost gold reef has been given to the world in book form as an historical novel,[25] and only those uninitiated in the psychology of gold prospecting will fail to see in it the utter lack of any evidence establishing the fact that Lasseter ever found any gold of any description.

Dealing with a few of the more important aspects of the case against the supposition that Lasseter ever found a gold reef, we must first of all enquire into the truth or otherwise of his statement that he was in that part of the country when he claims to have first discovered the reef. Prior to his departure from Alice Springs on the journey from which he did not return, and on which he claimed to have again found his reef, he was closely questioned by a number of old residents of Central Australia who knew the country to the west of Alice Springs. He was unable to answer questions relating to various names and places and could not fix positions familiar to his interrogators. He could not, in fact, give any correct information about any building, store or Government office in Alice Springs at that time, and the consensus of opinion was that he had never been in Central Australia before the time of his being questioned. The Government administrative officers who also questioned him firmly believed that Lasseter was suffering from delusions, and he certainly failed to convince anybody in Central Australia that he had ever been there before.

Dr. L. K. Ward, Government Geologist of South Australia, interviewed Lasseter in 1929 and comments as follows on the result of that interview*:—

''Lasseter was unable to give any satisfactory account of his alleged movements after leaving Arltunga, and it was impossible to arrive at any conclusions as to where he had been at the time of his claimed discovery. With tragic irony he stated that he was anxious that no one should perish from thirst on the track to the find, and wanted the Government to lay a pipe line from the Gascoyne River in Western Australia prior to the resumption of the search for the reef. Lasseter stated that he made his way back to settlement on foot, after losing his last horse at the western end of Lake Amadeus.''

In a letter published in the Sydney "Bulletin" on July 15, 1936, a correspondent who knew Lasseter personally submits evidence distinctly in favour of the conception that Lasseter could easily be suffering from hallucinations when he claimed to have found this fabulously rich gold reef.

It is not unlikely that the germ of the hallucination responsible for Lasseter's claim to the discovery of a rich gold reef had its origin in a novel entitled ''Blood Tracks of the Bush," by Simpson Newland, published by Gay and Hancock, Ltd., London, 1919, where, in Chapter XV., pages 120-134, an account of the imaginary existence of rich gold deposits in this part of Australia is given. The circumstances associated with this fictitious gold occurrence bear a remarkable resemblance to Lasseter's story, and from information contained in the Sydney "Bulletin," previously mentioned, it is very probable that Lasseter had read this book.

The obvious trimming to Lasseter's story whereby the position of his reef located by Harding by astronomical methods was considered to be in error by 100 miles (no direction is stated) on account of a watch error of 1¼ hours will not stand investigation. Time is not required in the determination of latitude, but is essential for the working out of longitude. An error of 1¼ hours in time would mean not an error of 100 miles in longitude, but of about 1,100 miles, hence this story cannot be given any weight as a reason for the elusive nature of the locality of this lost gold-reef.

Another very strange aspect of the case is the fact that a period of some 30 years was allowed to lapse by Lasseter before he made any attempt to exploit his alleged find. This, of course, when viewed in the light of what genuine gold-seekers will do and suffer in pursuit of gold is sufficient evidence in itself to stamp the find as mythical. The whole of the area where this alleged reef exists is accessible to camel transport, given the right time of the year and a normal season, and it can be confidently asserted that there is hardly a square mile of this part of Australia that has not been seen by white men since the year 1900.

A feature of the story is the difficulty experienced by Lasseter in again locating this reef when with the last expedition which he accompanied as a guide. If he were able in the first place to get through this country with horses he must have been a really first-class bushman, and as this part of Australia is particularly prolific in distant landmarks and he had the sight of an El Dorado to spur a bushman's instincts in the matter of fixing the landmarks in his mind, then surely he should know within a few miles of where this reef was situated. There is no doubt that his lack of knowledge and experience of the country was the cause of his failure to survive its pitfalls, and ultimately led to his death.

In recent years several claims to the discovery of Lasseter's lost reef have been made; in each instance as in Lasseter's own case, the reef has been seen by only the alleged discoverer. Strangely enough too, when nearing the supposed locality of the reef, the finder generally either quarrels with his mate or for some other reason goes away by himself and returns with the statement that he has found the reef, but never yet has anyone produced any specimens which unquestionably came from the reef. Specimens have at times been produced which are alleged to be from this reef, but investigation has established the fact that they have actually been obtained from other sources.

To the writer's mind, one of the strongest arguments against the probable existence of a quartz reef studded with gold and outcropping for a considerable length in this part of Australia is the fact that not at any time have any of the natives who inhabit this country ever produced to the white men who go into it or those with whom some of them come in con-

[25] Idriess, Ion L., Lasseter's Last Ride: Published by Messrs. Angus & Robertson, Sydney, 1931. (Many subsequent editions.)

* Personal communication.

tact at the Hermannsburg Mission, any specimens of either tin ore or gold. Most of the inland natives of Australia know what brings the white man into their country, as is evidenced by the manner in which even the most uncivilised of them approach a camp with quartz-crystals, haematite in quartz, any unusual development of mica, or, in fact, any what to them is an unusual rock occurrence. Prospectors with an intimate knowledge of the native tongue and native customs have combed this so-called "Lasseter's country" with the aid of natives who have been born in it and lived in it for years, and they have come out of it firmly convinced that Lasseter's Reef is a myth. It is wrong to think that because a large portion of "Lasseter's country" is desert nothing is known of it. The natives have been for centuries and still are, hunting over it, and over thousands of square miles of it the natives will tell you there is not even a pebble of white quartz.

A detailed analysis of all of the statements associated with the alleged finding of a fabulously rich gold-reef in Central Australia by one named Lasseter is not intended in this report, and only the most obvious flaws in the story have been dealt with above. In conjunction with the paragraphs under this heading of "The Lasseter Myth," it would be as well to include a summary of the geological information set out in previous chapters having a bearing on the subject under immediate review.

There is, to begin with, the outstanding consistency in the results and reports of the prospecting parties and individual prospectors who have operated in the only possible area where gold could occur in this part of Australia, namely, the Musgrave, Petermann and Rawlinson Ranges. These results have shown that the country, though possibly goldbearing, is of a most unpromising nature, and that the most that has ever been obtained in it is traces of gold.

The conclusion arrived at by Messrs. Blatchford and Talbot, Western Australian geologists with a very extensive knowledge of gold and its manner of occurrence, after an extensive journey through the Petermann and Rawlinson Ranges, was that these areas did not constitute a probable metalliferous province. The writer wishes to associate himself with this view, and would add that a detailed knowledge of practically all of the known gold-bearing areas in Central and North Australia (gained in his capacity as Commonwealth Government Geologist for the Northern Territory over a period of three years) as well as many in Western Australia, helps him to arrive at his conclusion.

There is a very great area of what has become to be known as "Lasseter's Country" in which there is no geological possibility of the occurrence of gold-reefs or any other minerals usually associated with the gold-bearing rocks of Central Australia. At the risk of aiding any future finders of Lasseter's Reef, and in the hope of providing some means whereby the *bona fides* of such finders may be gauged, this area of totally impossible gold country will be described. (See Plate IV.) It embodies all that portion of Central Australia situated westwards of the overland telegraph line and lying between two approximately east and west lines located as follows:—

The northern boundary line can be said to start immediately south of Heavitree Gap 2 miles south of the town of Alice Springs, and extends westwards along the southern flank of the Macdonnell Ranges to just south of Mt. Tate, then westwards to just north of Mt. Winter, then slightly south of west to the south of Mt. Rennie, and then in a general westerly direction for at least 50 miles into Western Australia.

The southern limit of this zone is marked by a line drawn through Mt. Daniel near the railway line, about halfway between Crown Point and Charlotte Waters, west-by-north to Goyder's Springs, then west-north-west to the south-eastern end of Lake Amadeus, then in a general westerly direction north of Mt. Currie, passing across the Western Australian border between the Docker Gap and Livingstone Pass immediately north of the Petermann Ranges, and continuing for at least 50 miles into Western Australia along the northern flank of the Rawlinson Ranges.

This area is what is termed by Dr. Chewings the Amadeus Sunkland, and is occupied mainly by beds of Ordovician age and their recent weathering products. This very large area of sandstone and quartzite belongs to a series of rocks of sedimentary origin laid down millions of years after the period of gold introduction into the older rocks on which they rest. The basement rocks, the only possible gold bearers, are buried thousands of feet deep over the major portion of this sunkland.

Outside of this area, particularly to the north and west, the older possible gold-bearing rocks are covered with thick deposits of almost horizontal sediments of yet another age, and only very infrequently are the older rocks exposed to view as the result of the removal of the cover rocks by weathering processes.

The object of compiling the section of this report dealing with the alleged discovery of a rich gold-bearing reef in Central Australia by a person named Lasseter is to present to those people interested in gold-mining a few of the more salient features of what may be termed "The Case against Lasseter's Reef." In the past, many glamorous newspaper and prospectus accounts have been given as a "Case for Lasseter's Reef," but it is hoped that the subject matter of this report will be found to be a more reliable guide to hopeful investors than some of the statements which have appeared in the past.

It cannot be too strongly urged that "Lasseter's Reef" is likely to be held out as a bait to mining investors for many years to come, and it is necessary to urge just as strongly the necessity for extreme caution when contemplating any investment in a mining venture, the basis of which is a fabulously rich gold reef in Central Australia, which more than likely, the prospective investor will be informed is probably "Lasseter's Reef."

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## PROGRESS REPORT ON THE GEOLOGY AND MINES OF THE YILGARN GOLDFIELD

(South of the Great Eastern Railway).

(H. A. Ellis, B.Sc., A.O.S.M.)

### GENERAL GEOLOGY.

In a resumé of the general geology of this area made by the writer at the conclusion of the 1935 field-season and published in the Annual Progress Report of the Geological Survey for 1935, several tentative conceptions of the geological structure were set out, it being pointed out at the time that these ideas were subject to revision as progress in field-work was made.

Up to the close of field-work in 1935, no evidence sufficient to establish the intrusive nature of any of the greenstone had been discovered, but towards the end of the 1936 field season, examination of the hilly country immediately south of Southern Cross, where exposures are reasonably good, revealed the presence there of unsheared basic igneous rock transgressive into a highly sheared basic rock composed mainly of a variety of hornblende classified by Dr. Simpson, Government Mineralogist and Analyst, as anthophyllite.

Associated with this basic igneous intrusive rock is a liberal development of small patches of a basic pegmatite, occurring in the intrusive rock in much the same manner as does a normal pegmatite in granitic masses.

Examination of black mineral concentrates from very decomposed basic rocks from the vicinity of Marvel Loch reveals the presence of chromite, hence it is reasonable to assume a probable ultrabasic composition for these rocks, and also attribute to them a probable intrusive habit.

It can now be stated that some of the greenstones are intrusive, but this feature has in no way been found to affect or influence the occurrence of gold.

One result of the regional mapping has been to establish an order of succession for the various rock-types occurring in this portion of the Yilgarn Goldfield. This system of metamorphic rocks starts off with the greenstone series at the base and passes upwards, with the increasing development of the sedimentary phase, to the metamorphosed sediments of what has been known as the Yilgarn series.

It has been decided to refer to the whole of the metamorphic rocks of the Yilgarn Goldfield as the Yilgarn system, and to subdivide this system into two series, namely, the greenstone series and the whitestone series, of which the former is the lower in the stratigraphical succession and hence the older.

The greenstone series embraces the rocks of a basic or intermediate composition derived from a volcanic or intrusive igneous origin. The term includes the dark coloured sediments, tuffs, and all fragmental volcanic material associated with the flow and intrusive volcanic rocks.

The whitestone series embraces the recognised metamorphosed sediments of an acid composition, previously referred to as the Yilgarn system by Mr. Blatchford (G.S.W.A. Bulletin No. 63).

### THE BROAD GEOLOGICAL STRUCTURE.

The ultimate key to the major geological structure of the gold-bearing belt of the Yilgarn Goldfield, south of the Great Eastern Railway, was found in the distribution of the ferruginous quartzites or jaspilites ("Jaspers" of the prospector), and when these failed, in the distribution of a recognisable band in the greenstone series characterised by being composed of anthophyllite with associated ironstone, and cellular and banded secondary silica formations.

The structure can be fairly completely indicated as far south as the Cheriton group at the southern end of Parker's Range, but the paucity of outcrops and the dense scrub from this point south to the southern boundary of the goldfield, has prevented the elucidation of the major structure in this portion of the area investigated. The only known auriferous locality south of Parker's Range in the Yilgarn Goldfield is Forrestonia, and from structural data obtainable from the South and Middle Ironcap, this occurrence would appear to be situated on or near the axis of an anticlinal crossfold trending north-east and south-west.

The structure of the Yilgarn system, and hence the distribution of the rock types, is controlled primarily by two sets of folding, the axes of which lie practically at right angles to each other. The first system took place along axes having a general north-north-west and south-south-east trend, and resulted in a series of generally parallel, tightly folded anticlines and synclines. These folds were not always symmetrical, and overturned asymmetrical anticlines and synclines form part of this folded system, the major folds of which are anticlinoria and synclinoria.

Superimposed upon this series of folds, either subsequent to or coincident with the folding period during which the first series was formed, is a series of crossfolds which has produced a buckling of the main N.N.E.-S.S.W. series, and has been re-