Some large deposits are, however, entirely of kyanite rock. The pure kyanite-rock is massive, never cleaved; it is usually medium to coarse-grained, and even in those rocks which, in the hand-specimen, appear to be fine-grained, are found to consist under the microscope of quite coarse crystals full of fine inclusions. Kyanite is almost the sole constituent. It is often of the radiating columnar variety, and blades of crystals over 12 inches long may be seen sometimes in the large boulders. Such coarse kyanite indicates the action of at least a certain amount of metamorphic migration. Usually the only other constituent is rutile, which is often plentiful; fine corundum is present occasionally. Other places at which massive kyanite occurs in workable amounts in Singhbhum are Ghagidih, Rakha Mines, Badia-Bakra, and Kanyaluka. The minimum quantities of these present, calculated to a depth of one yard, are:—

	tons.
Lapsa Buru	214,000
Ghagidih	20,000
Badia-Bakra	10,000
Kanyaluka	8,000

Analyses of typical specimens of these rocks are:—

	Lapsa Buru. %	Ghagidih. %
SiO_2	30·2	36·0
Al_2O_3	65·35	60·7
Fe_2O_3	3·19	2·3
TiO_2	0·76	1·2
CaO	Tr.	0·8
MgO	1·37	0·4
H_2O	0·61	0·9
	100·78	102·3

Rec. Geol. Survey India LXV, part 2, *pp.* 285-305, 1931.

On certain rocks bearing kyanite and sillimanite in the Bhandara district by S. K. Chatterjee.

This paper gives an account of the schistose rocks of the district and method of formation of these schists by metamorphism. The kyanite here also occurs in a massive form. "The rocks carrying kyanite and sillimanite are distributed sporadically. The outcrops are small and discontinuous, give rise to slightly elevated features, and are disposed in parallel belts with a roughly north-south trend." "The thickness of the formations is variable and irregular. At Sonekhari it is about five feet; at Miregaon and Ganglewara about 15 feet; and at Sarathi about 30 feet. At the two hills at Pohra the maximum thicknesses are 50 feet and 125 feet, respectively. At Magra the thickness ranges up to 100 feet; whilst at Girola it is from 250 to 400 feet."

". . . . a consideration of all the outcrops reveals the following three salient features:—

1. Chlorite-muscovite-schist is invariably associated. In certain instances . . . . a gradation between chlorite-muscovite-schist and the kyanitic or the sillimanitic rocks . . . . could be recognised.

2. Although these rocks are restricted to the zone of chlorite-muscovite-schist, there is apparently no definite stratigraphic horizon at which they occur. At Girola there seem to be two bands at different horizons.

3. Each of the outcrops is intersected by myriads of quartz-veins, carrying among other accessory ingredients tourmaline, rutile, and occasionally roscoelitic mica. Granite is found to emerge out of the alluvial mantle at a distance, but pegmatites are occasionally seen quite close to these rocks" (not a commercial occurrence, as the kyanite is mixed with other minerals).

REPORT ON A BISMUTH CARBONATE DEPOSIT IN A PEGMATITE DYKE, M.C. 173H, YINNIETHARRA STATION (GASCOYNE RIVER).

(Lands Dept. Litho. 78/300, S.W. Quadrant.)

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

LOCALITY.

The deposit is situated on M.C. 173H in a very coarsely grained pegmatite dyke forming a low rise in which two quartz reefs ("blows") are prominent about 10 chains west from the western bank of Nardoo Creek and about seven miles on a bearing of 285 degrees from Morrissey Hill. M.C. 173H is situated in approximate latitude 24° 31′ S. and approximate longitude 116° 03′ E.

Nardoo Creek is a southerly trending dry watercourse, tributary to the Gascoyne River, and joins the river near the most northerly point of the big bend convex to the north some eight miles a little south of east from the Lockier Range. (See Plate I.)

ACCESS.

The locality can be reached from Carnarvon by a road which passes through Gascoyne Junction, Dairy Creek, Mooloo Downs and Yinnietharra, or from Perth by travelling in a northerly direction, via Mullewa, Byro Station and Dairy Creek. The latter is the most direct from places south of Mullewa. The distance to Carnarvon, the nearest port, would be about 250 miles by road.

HISTORY.

The deposit was discovered in October, 1938, by a prospector named Thompson, and the inspection on which this report is based was made on 20th and 21st April, 1939.

GENERAL GEOLOGY.

The area in which the deposit is situated is shown on the most recent geological map of the State (1933) as being composed of granite, but which actually consists of a gneiss and mica schist complex liberally invaded by very coarsely crystalline pegmatite dykes composed of quartz, microcline felspar and muscovite mica.

The regional strike of this area of gneiss and schist, at least as far south as latitude 25° 15′ S., is about 15 degrees west of north, and the same direction of regional strike prevails as far east as longitude 117° 50′ E. in these outcrops noted in a traverse from Dairy Creek to the Egerton gold mining centre, in the valley of the Gascoyne River.

PLATE I

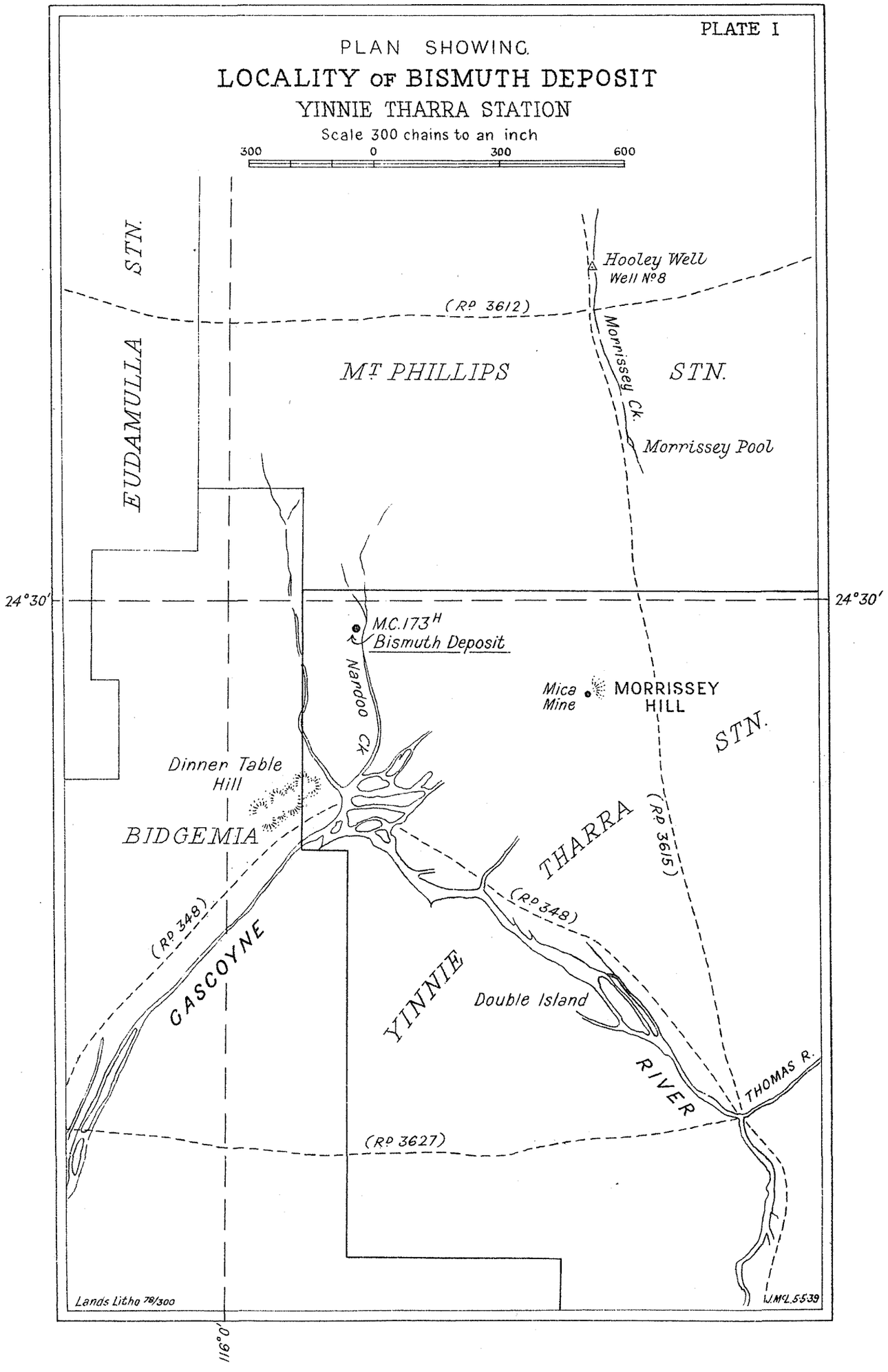
PLAN SHOWING

LOCALITY OF BISMUTH DEPOSIT

YINNIE THARRA STATION

Scale 300 chains to an inch

300 0 300 600



The belt of country in which the bismuth deposit occurs, is a continuation along the strike in a westerly direction of the gneiss and mica schist in which the mica mines were once worked at Morrissey Hill. A feature of the pegmatites of this area is a strong tendency for the various constituents (quartz, muscovite mica, and felspar) to segregate and form unimineral deposits. It was noted that in the case of the quartz constituent there was a tendency for the reefs, or "blows," as these quartz concentrations are known by prospectors, to occur more or less centrally in a pegmatite mass.

Very large crystals of beryl (Beryllium aluminium silicate) sometimes up to 6 inches across, and occasionally possessing a distinct basal termination with prismatic faces as the only other faces developed, occur in the pegmatite dykes. These beryl crystals were chiefly seen lying on the surface in the vicinity of quartz concentrations, but several were observed occurring in the solid quartz, and one was found in a matrix consisting of microcline felspar, muscovite mica, and quartz.

THE BISMUTH CARBONATE DEPOSIT.

Samples of a soft, heavy, greyish coloured mineral found in the eluvial material on the slopes of a low quartz hill on M.C. 173H (see Locality) were submitted by the prospector to Dr. Simpson, Government Mineralogist and Analyst, and proved on examination to be bismuth carbonate. This mineral is known under the name of Bismutite, and is a basic carbonate of bismuth, whose composition is given by Dana as perhaps $Bi_2O_3\ CO_2\ H_2O$.

An examination of a considerable number of specimens of the eluvial bismutite showed that besides a number of pieces consisting of pure bismuth carbonate, many of the lumps had quartz fragments adhering to and penetrating them, while others had microcline felspar, muscovite mica and hard limonite attached to them.

Up to the time of inspection, approximately 800 lbs. of eluvial bismutite had been obtained from the slopes of the hill, not all of which, however, could be regarded as pure ore. The size of the eluvial bismutite varied from pieces as big as a grain of wheat to pieces weighing three or four pounds, and one piece weighing about 17 lbs. was obtained. The only bismutite *in situ* was found in a very small vein in solid quartz, and yielded about 30 lbs. of ore impregnated with quartz.

MODE OF OCCURRENCE OF THE BISMUTITE.

The pegmatite dyke with which the bismutite is associated forms a gently rounded ridge about 10 chains long running in a general direction of N. 50° E. At each end of the ridge is a low quartz hill, that at the north-eastern end being about 60 feet high above the general level of the surrounding flat country, while the hill at the south-western end is about 80 feet high.

The country immediately to the north of the pegmatite dyke is a complex of pegmatite dykes, gneiss and heavily tourmalinised biotite schist, with varying strikes, and forms a flat to gently undulating area with numerous small rounded hillocks of quartz. It was on this ground that a considerable quantity of detrital columbite was found, though the columbite has not yet been found *in situ*. There are numerous small excavations made by mica prospectors on small mica concentrations distributed sporadically over this area, and although a careful search has been made for eluvial bismutite on it, none has yet been found.

The eluvial bismutite occurs on the quartz strewn south-eastern slopes of the pegmatite ridge, and is confined to the slopes immediately below the quartz concentrations. At the north-eastern end of the ridge, the quartz reef, situated roughly in the centre of the pegmatite dyke, is about 2 chains long and is very irregular in width, being as much as 20 feet wide in places. The walls of the pegmatite are not visible, but the dyke is at least 70 feet wide here, and may be considerably wider. The area over which eluvial bismutite has been found in this vicinity is about 1½ chains long by 1 chain wide to a depth of about 1 foot.

The only definite occurrence of the bismutite *in situ* was found as a small vein about 2 feet 6 inches long by 2 inches thick by 2 feet deep in the centre of the quartz reef at the north-eastern end of the ridge. This vein dipped steeply to the south-east, and had solid quartz on the hanging wall, and what appeared to be an iron-oxide-cemented, decomposed, medium grained pegmatite of small dimensions on the footwall.

The lateral limits of the formation could be plainly seen to be defined by quartz, and since the date of inspection, information has been received that the deposit terminated at a very shallow depth (perhaps 3 feet) in quartz, yielding only 30 lbs. of medium grade ore.

A considerable number of shallow holes had been made in pegmatite on the south-eastern slope of the hill, below spots on which large pieces of bismutite were found, but up to 21st April, no deposit *in situ* had been located in any spot other than in the solid quartz on top of the ridge.

At the south-western end of the pegmatite ridge, the quartz reef is of slightly larger dimensions, and is separated from the quartz reef at the north-eastern end by a low saddle of pegmatite about 5 chains long in which no quartz reefs occur. It is significant that no eluvial bismutite has been found in this intervening space, and points to the conclusion that the bismutite deposit is associated only with the quartz concentrations of the pegmatite dyke. The occurrence of the eluvial bismutite mainly on the south-eastern slopes of the hill also suggests that the main concentration of the mineral occurred near the south-eastern side of the quartz reefs.

The quartz reef at the south-western end of the ridge is about 3 chains long, and varies in width from a few feet up to 50 feet. It is surrounded by coarse grained pegmatite in which small concentrations of muscovite mica in "book" form occur. A costean some 50 feet long and 8 feet deep in the deepest part was cut across the eastern end of this hill, and passed through typical coarse pegmatite with concentrations of felspar and quartz. The boundaries of the quartz concentration are very irregular here, and although there is quartz on both sides of the costean at the surface, very little solid quartz was encountered in the cut.

A specimen of bismutite with fresh felspar adhering to it and which was reported to have been obtained from the pegmatite near the south-eastern end of the costean, close to the quartz outcrop, was examined, and from the nature of the material in the wall of the cut immediately below the spot indicated as being the original position of the bismutite, the latter was definitely associated with a concentration of microcline felspar and beryl in the pegmatite near the south-eastern side of the main quartz reef. No other occurrence of bismutite *in situ* had been found in this quartz reef or adjoining pegmatite at the time of inspection. A considerable area of quartz is exposed here, and examination of the outcrop is easy, but there is no indication at all in the quartz of the occurrence of bismutite in it.

The area over which eluvial bismutite has been found on the south-eastern slope of this hill is comparatively small, being about one square chain only.

The manner of occurrence of the two small patches of bismutite which had been located *in situ* up to the time of inspection, showed that the mineral occurred in isolated small concentrations, both in the solid quartz of the pegmatite dyke, and in association with felspar and mica in the pegmatite, adjoining the quartz reef on the south-eastern side. This is a typical manner of occurrence of the metallic mineral constituents of a pegmatite dyke, and on the evidence available from this bismutite deposit, the conclusion is justified that the eluvial bismutite is a concentration from the breaking up under natural agencies of a considerable volume of quartz reef and pegmatite, which has contained small concentrations of the bismuth ore. There is no evidence which suggests that the bismutite has been shed from a relatively large deposit of bismutite having the form of a reef or lode.

Much of the eluvial bismutite, and some of that obtained from the small deposit found *in situ* in the quartz is intimately intergrown with quartz. Some of the quartz has many of its crystal faces developed on it, and is embedded in bismutite, showing the bismutite to be of later age of crystallisation than the quartz.

Mineral deposits in pegmatite dykes are notoriously difficult to systematically prospect by mining methods, although in some cases the metallic constituents are confined to some particular portion of the dyke, being confined to one wall in some cases or to the quartz concentrations or felspar aggregates in others.

The evidence which could be used to guide a prospecting programme on this deposit of bismutite is not sufficiently convincing to enable one to have faith in the success of a programme laid out in accordance with it. The extremely irregular manner of mineral deposition in pegmatite dykes, coupled with the frequent total absence of indications as to where to search for a repetition of the deposit once it is lost in mining, makes systematic prospecting by, say, trenching, a very hazardous undertaking.

In the present case, a programme of trenching in the pegmatite adjacent to and following the wall of the quartz reef along the length of the eluvial shed of both outcrops, was suggested to the owners. It was also suggested that the pegmatite and quartz should be explored laterally from the trench by short trenches or drill holes at right angles to the main trench. A further excavation across the quartz reef at the site of the only small deposit found in the hill at the north-eastern end of the ridge, may reveal some useful evidence, or further small concentrations of ore.

SUMMARY AND CONCLUSIONS.

The deposit of bismuth carbonate (bismutite) found occurring in association with the major quartz concentrations of a pegmatite dyke on M. C. 173H had yielded about 800 lbs. of impure eluvial bismuth carbonate, the impurities being mainly adhering quartz and felspar, up to the time of inspection (21st April, 1939).

The only occurrence of the mineral *in situ* was seen in the quartz reef at the north-eastern end of the dyke, and yielded about 30 lbs. of impure bismutite before the deposit terminated in quartz.

No defined reef or lode formation, to which the mineral could be seen to be confined, was seen in the pegmatite dyke, and the evidence points to the occurrence of the bismutite as a series of small concentrations in the quartz and pegmatite possibly confined to the area in the vicinity of the south-eastern wall of the quartz reefs.

The area over which eluvial bismuth occurs is small, being about 3½ sq. chains, and at the time of inspection had not been completely worked out.

The price obtainable for clean bismuth carbonate is about 6s. per lb., but one parcel of 3 cwt. sold from this claim realised a much lower price than this on account of impurities (quartz, felspar, etc.).

The relatively large area of quartz exposed in which only one small vein of bismutite has been found is easily prospected, and despite this ease of prospecting, no other deposit can be found in it. This indicates the widely disseminated manner of occurrence of the bismutite as far as the quartz is concerned, and the adjoining pegmatite had not been shown to be definitely carrying bismutite concentrations, though it may well do so.

The failure to locate *in situ* any workable concentration of bismutite up to the time of inspection, coupled with the natural irregular manner of occurrence of this material in pegmatite dykes, makes it extremely unlikely that this deposit has any commercial prospects even on a small scale.

Some of the eluvial bismutite showed very small bright soft specks of metallic bismuth, and it is possible that metallic bismuth would be found in association with the bismuth carbonate should any deposit be found living to a moderate depth.

There are many quartz reefs associated with pegmatite dykes in this part of Yinnietharra Station, and bismutite may well occur in association with any of them.

ASSOCIATED MINERALS.

Besides the obvious minerals, quartz, microcline felspar, muscovite mica, beryl and bismutite which constituted the pegmatite, some other minerals were collected and submitted to Dr. Simpson, Government Mineralogist and Analyst.

Dr. Simpson reports as follows on these specimens:—

Lab. No. 1820. *"No. 1 Brown Microcline."*—This is a mixture of microcline, quartz, limonite and a hydrous ferric phosphate. The microcline is brown throughout, due to the presence of this film of limonite and the hydrous ferric phosphate in the cleavages.

Acid soluble Phosphoric oxide P_2O_5, 0.74 per cent.

Lab. No. 1821. *"No. 2 Brown Microcline."*—Microcline with a little muscovite and veins of kaolinised felspar. The brown colour of the felspar is due to films of limonite and a hydrous ferric phosphate.

Lab. No. 1822. *"No. 3 Brown Microcline with Mammillated Crusts."*—Brown microcline with white patches of chalcedony and kaolin. The brown staining throughout the microcline and the black mammillated crusts consist of limonite and a hydrous ferric phosphate.

Lab. No. 1823. *"No. 4 Beryl."*—Beryl with a surface staining of limonite and a hydrous ferric phosphate.

Lab. No. 1824. *"No. 5 Columbite."*—Manganocolumbite.

Specific Gravity	6.54	
Tantalic oxide, Ta_2O_5	51	per cent.
Niobic oxide, Nb_2O_5	32	„ „

The presence of small quantities of iron phosphate in all the ironstained specimens is interesting as pointing to the presence in the vein of masses of zwieselite (Fe_2FPO_4) or triphylite ($LiFePO_4$).

PROGRESS REPORT ON THE GEOLOGY OF PORTION OF THE MT. MARGARET GOLDFIELD.

(R. A. Hobson, B.Sc., (Hons.).)

INTRODUCTION.

The work done during the 1939 field season is a continuation of that already carried out during the field seasons of 1937 and 1938, and reported upon in the Annual Report for 1938.[1] Mapping has now been extended northward to include the whole of the Erlistoun-Duketon-Mulga Queen auriferous belt, southward to include Yundamindera and Wilga (E 40), and eastward to include Burtville. In all, approximately 5,000 square miles have been mapped. Field work this year was commenced by Mr. K. R. Miles on 22nd March. At that time the writer had been withdrawn from the Mt. Margaret Survey to carry out the proposed survey of Western Australian iron deposits. It was later decided not to go ahead with this work, and the writer returned to the Mt. Margaret Goldfield early in June. By the end of November the field party had returned to Perth.

Mr. Miles is responsible for the regional mapping in the vicinity of Wilga, Burtville and Yundamindera and the southern end of the Erlistoun-Duketon auriferous belt. He has also examined the following mining groups:—Victory Group, New Erlistoun Group, Midas Group, Baneygo Group, The Patch, Connemara Group, Famous Blue Group, Mulga Queen Group, Hutanui Group, Escreet's new find between Erlistoun and Duketon, Kelly's new find north of Duketon, and briefly inspected many abandoned workings. Reports on the mining groups are to be found elsewhere in this report (p. 43).

Within the area examined this year there is very little prospecting activity, and no prospecting workings of any extent. Except for the New Erlistoun Gold Mine[2] at Cox's Find there are no larger mines now working. Consequently information as to the nature of the gold deposits is somewhat meagre. Most of the ore bodies are small, but frequently quite rich. The abandoned workings however, show that in the past larger ore bodies have been worked. Throughout the area ground water is shallow—rarely exceeding 100 feet in depth and more usually of the order of 50 feet. This has, in all probability, accounted for the closing down of many of the smaller mines operated by prospectors.

GENERAL GEOLOGY.

In last year's progress report[3] it was stated that country with a yellow to reddish brown sandy soil and a spinifex and mallee vegetation was being mapped as soil covered, because it was considered that this sandy soil had been transported by wind action to its present position. This type of country has now been seen in many places to overlie granite or gneiss, which is frequently exposed in breakaways forming the edge of the spinifex and mallee country. That some of the sandy soil is transported is shown by the occurrence of sand dunes and the piling of sand against ridges. Some of the soil so transported overlies greenstone. It is now believed however that, except in a few relatively small areas, the spinifex and mallee country overlies granite or gneiss.

In addition to extensive areas of alluvium associated with well defined drainage channels, smaller areas of alluvium have been found fringing the generally hilly greenstone complex country. This alluvium is deposited by a series of small and not very well defined drainage channels.

Glacial erratics have been recorded at many places between Erlistoun and Duketon, where they are generally found as scattered patches of boulders. In the south bank of Mallee Creek (23 miles north of Beria, on the Beria-Erlistoun Road) they occur in a white matrix, overlying unconformably rocks of the Greenstone Complex. The exposures are not very complete, and no examination has yet been made of the matrix for fossils. So far the glacial erratics have been found only on the " New Plateau." Further evidence of the age of the glacial erratics may be expected from the examination of conglomerate and greywacke pebbles

[1]Hobson, R. A., Progress Report on the geology of an area in the vicinity of Laverton and Morgans—Mt. Margaret Goldfield, Annual Progress Report of the Geological Survey for the year 1938, p. 15.

[1]Miles, K. R., Gladiator Gold Mine, The Mary Mac Gold Mine, Notes on the geological structure of portion of the Mt. Margaret Goldfield, Notes on the banded jaspilites of the Mt. Morgans-Mt. Margaret District, Annual Progress Report of the Geological Survey for the year 1938, pp. 27, 28, 29, 31.

[2]Matheson, R. S., Erlistoun Gold Mine, Cox's Find, Annual Progress Report of the Geological Survey for the year 1938, p. 24.

[3]Hobson, R. A., op. cit., p. 16.