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WESTERN AUSTRALIA.

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ANNUAL PROGRESS REPORT

OF THE

GEOLOGICAL SURVEY

FOR THE

YEAR 1933.

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*Annual Progress Report of the Geological Survey of Western Australia  
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## Annual Progress Report of the Geological Survey of Western Australia for the Year ended 31st December, 1933.

I have the honour to submit for the information of the Hon. the Minister for Mines my report on the work of the officers of the Geological Survey for the year 1933.

### STAFF.

The personnel of the Staff has remained unchanged from that of the previous year, and still remains at two field officers, one technical assistant and a messenger.

### FIELD WORK.

*Government Geologist.*—I was unable to be in the field as much as usual this year owing mainly to the absence of one of my assistants—Mr. Forman—for a period of six months, and my own absence for three months when doing special work for the Anglo-Australian Gold Development Company. Three short trips were made and reports furnished on the gold discovery at Wannaway and Yining Creek, and the Water Supply for the Margaret River Butter Factory.

The increasing number of inquiries also calls for more time in the office.

*F. R. Feldtmann, Field Geologist.*—With the exception of a short time in the field investigating the occurrence of glauconite sands at Gingin, a copy of which with maps is appended, practically the whole of the rest of the year was occupied on his report on Kalgoorlie.

*F. G. Forman, B.Sc., Assistant Geologist.*—In January, Mr. Forman completed his work on the correlation of the Artesian bores of the Metropolitan area. This was published in last year's Annual Progress Report.

During February, he assisted Miss Armstrong in the revision of the Catalogue of Scientific Periodicals, as it affected the Departmental Library. From March to September Mr. Forman acted as Lecturer in Geology at the University of W.A. during the absence of Professor Clarke. From September to the end of November he was engaged in an examination of the Ingliston Consols Extended, the Ingliston Alberts, and the Lady Central Gold Mines at Meekatharra. During December he investigated and reported on the prospects of boring for deep leads on the Greenbushes Tinfield.

### HEAD OFFICE.

*F. Armstrong, B.Sc., Technical Assistant.*—Throughout the year there has been an increased demand by the public for published information on potential gold-bearing areas of the State. To cope with these inquiries, Miss Armstrong has completed an Index map for the Annual Reports, which shows at a glance each area dealt with by articles published in the Annual Progress Reports of the Geological Survey of W.A. from 1897 to date.

This map in conjunction with a similar one for the bulletins gives the public ready access to published reports.

In addition, she has compiled a new geological map of the State. The 1920 map was used as a basis for the geology, and all work done subsequent to that date was added. In some places it was found necessary to alter the pre-existing boundaries as recent work had proved them at fault. The map is now in the hands of the Printer for publication.

Miss Armstrong was responsible for the selection of an exhibit of gold and minerals of economic importance displayed at the "Industries Exhibition" held in Government House Ballroom; and assisted me in the preparation and setting out of a gold exhibit at the Royal Show.

During the re-arrangement of the Library it was found that many publications contained therein had not been listed in the C.S.I.R. Catalogue of Scientific Periodicals. As entries for the Supplement to the Catalogue were being called for, Miss Armstrong compiled the cards for amended and new entries.

Owing to the demand for Bulletin 61: "An Outline of the Physiographical Geology (Physiography) of Western Australia," by J. T. Jutson (1913)—now out of print—the author was approached to re-write this work for a new edition. Due to the lapse of time since Mr. Jutson handed in his revised manuscript, many changes have been made in the geological boundaries of the State, which necessarily added largely to the amount of work attached to re-editing. Miss Armstrong has been in charge of this work, and was able personally to finalise with Mr. Jutson any alterations and additions when she was passing through Melbourne on her return from her annual leave.

In addition to the general routine work of the office, Miss Armstrong has dealt with the correspondence, made petrological determinations for the general public, and kept up to date the cross referencing of all articles on Australian geology published in scientific journals.

### PETROLOGICAL WORK.

The petrological work in determining rocks for both office and the public was carried out by Mr. Forman and Miss Armstrong, depending on the class of work.

The reports or summaries of the reports arising from the field work are attached, except in such instances when they were made for purely departmental use.

In conclusion, I take this opportunity for expressing my appreciation of the work and loyal support of the members of the Staff during the year.

T. BLATCHFORD,  
Government Geologist.

# 1.—THE GLAUCONITE DEPOSITS AT GINGIN, SOUTH-WEST DIVISION.

(F. R. Feldtmann.)

*Introduction.*—The chalky limestones at Gingin, in particular those capping One Tree and Molecap hills, were worked many years ago as a source of industrial lime. At a later date some attempt was made to utilise for agricultural purposes the phosphatic nodules which occur at several horizons in the Cretaceous rocks, but are particularly numerous in a zone occurring partly in the lower portion of the chalk, partly in the underlying greensand. A fair amount of the phosphatic material was quarried on the north-eastern slope of Molecap, but the deposit proved to be too narrow to be worked profitably. Recently, attention was drawn to the greensand beds as a source of the mineral glauconite ( $\text{KMgFe}_2(\text{SiO}_3)_2 \cdot 3\text{H}_2\text{O}$ ), which is an important constituent of the greensand and which has been found to be an effective water softener.

The Gingin area was visited by earlier observers such as Gregory, Brown, and Göczel, but although it has been of considerable interest to geologists, not only on account of the economic possibilities of the rocks, but also because of the abundant fossil remains found in the chalk, but little detailed geological mapping has been attempted. In 1909 and 1910 the area was examined by Mr. L. Glauert in connection with the limestone deposits, and a brief description of the geological features was given by him in the Annual Report of the Survey for 1910 (pages 29 and 30), and also in Bulletin 36, the latter report being accompanied by a small map and section on a scale of a mile to the inch. At the time of Mr. Glauert's examination, the lower bed of glauconitic sandstone, usually known as the Lower Greensand, was not exposed in a sufficiently unweathered state, in the area examined by him, to be identified and separated from the underlying shales.

A brief description of the geology of the Gingin area, accompanied by a geological section, was given by Dr. E. S. Simpson in his description of the occurrence of the rare mineral gerkasutite on Loc. 457, about  $1\frac{3}{4}$  miles east of Gingin. (Mineralogical Magazine, May 1920, Vol. XIX, No. 89, pages 23-39.) The existence of the lower greensand was recognised by Simpson, who assigned to it a thickness of 100 feet.

The district was visited in 1930 by my colleague, Mr. F. G. Forman, in connection with an investigation by officers of the Department of Agriculture of the affection of stock by a disease known as "Gingin Rickets." Mr. Forman's description of the geology of the district on pages 8 and 9 of the Annual Progress Report of the Survey for 1930 covers a somewhat wider area than that described by Mr. Glauert.

*Location and Topography.*—The small farming town of Gingin is situated on the Midland Railway Company's line to Geraldton, about 50 miles by rail north of Perth. It lies on both sides of Gingin Brook which, north-east of the town, flows in a south-south-westerly direction but makes an abrupt U-shaped bend to the east where it is joined by Moonda Brook before flowing in a west-south-westerly direction through and west of the town.

The country around Gingin is strongly undulating, particularly north and south-east of the town. Several hills rise to a fair height above the level of Gingin Brook which, immediately west of the town, is about 270 feet above sea-level. The most prominent hills near the town are Moorgup, about  $1\frac{1}{2}$  miles south-east of the railway station, and about 667 feet above sea-level; Molecap, rather more than half a mile south-east of the station and about 510 feet above sea-level; One Tree Hill,  $1\frac{1}{4}$  miles north-north-west of the station and about 515 feet above sea-level; and Ginginup,  $2\frac{1}{4}$  miles north of the station, and about 666 feet above sea-level. The positions of the first three hills are shown on the accompanying map. The highest hill in the neighbourhood of Gingin is Poison Hill or Udoinup, about four miles north-north-west of the railway station, and 724 feet above sea-level. This hill has a steep escarpment facing north and north-west.

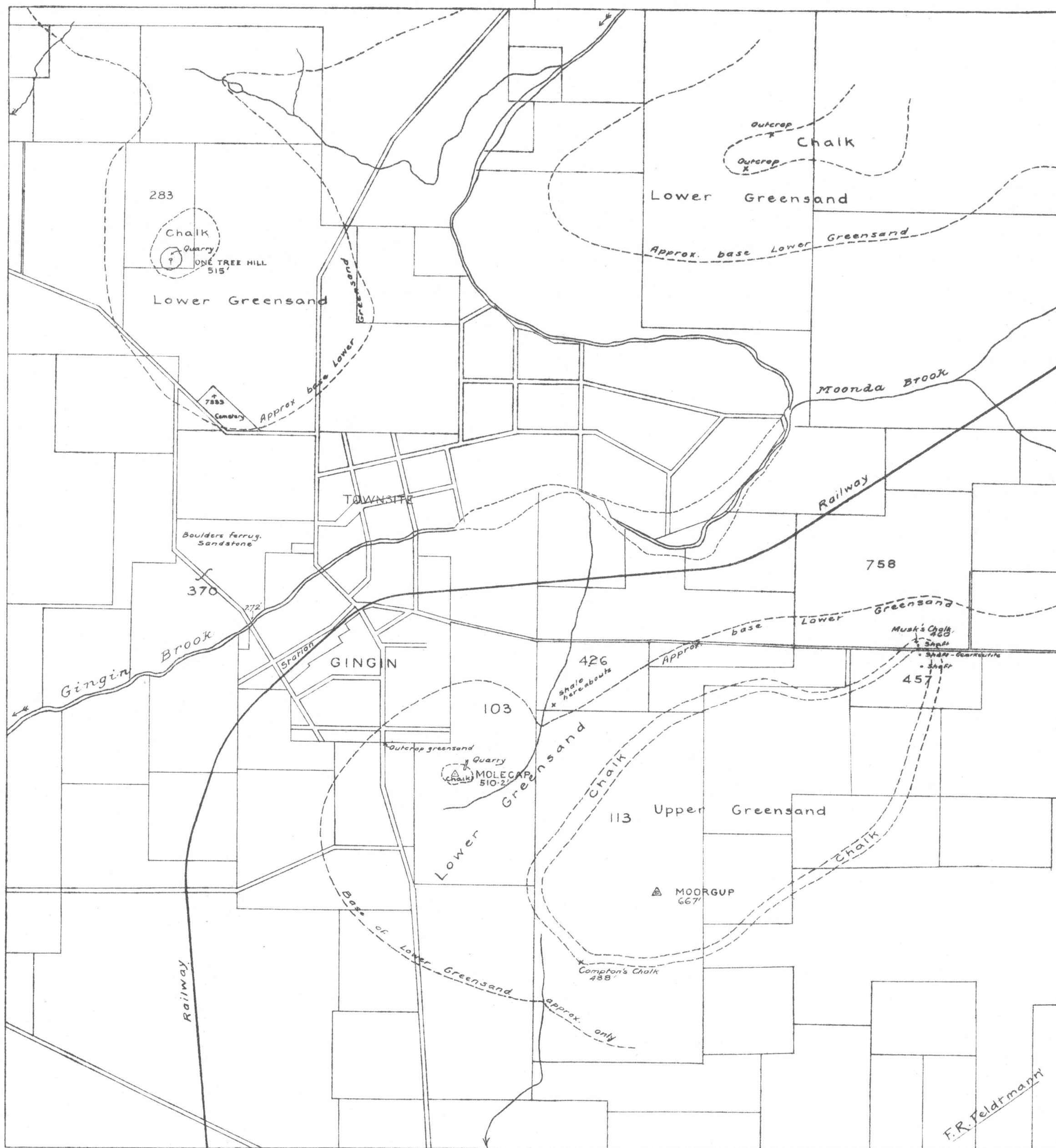
*Geology.*—Gingin lies in an area of Cretaceous rocks, the boundaries of which have not been determined. Cretaceous rocks including both chalk and ferruginous sandstone (weathered greensand) and containing bands with phosphatic nodules are known to occur at Dandaraga and Yatheroo, about 54 and 42 miles, respectively, north-north-west of Gingin. They have been traced from about eleven miles north of Dandaraga to about two miles south of Yatheroo, but whether the Dandaraga and Gingin rocks form parts of a continuous area is uncertain. In view of the economic possibilities of the Cretaceous rocks, a geological survey to determine their boundaries is desirable. On the west they appear to be bounded, in part at any rate, by the Darling Range scarp, which strikes about north-north-west and is considered, on topographical and other evidence, to be a fault scarp. In the Gingin area, the western boundary probably lies a short distance west of Poison Hill and One Tree Hill. East of Gingin the Cretaceous rocks probably extend to within a short distance of Mooliabeenie, where, I was informed orally by Dr. Simpson, small outliers of probably Cretaceous rocks overlie the granite. The positions of the northern and southern boundaries are quite unknown.

The general sequence of the Cretaceous rocks at Gingin, in descending order, appears to be:—

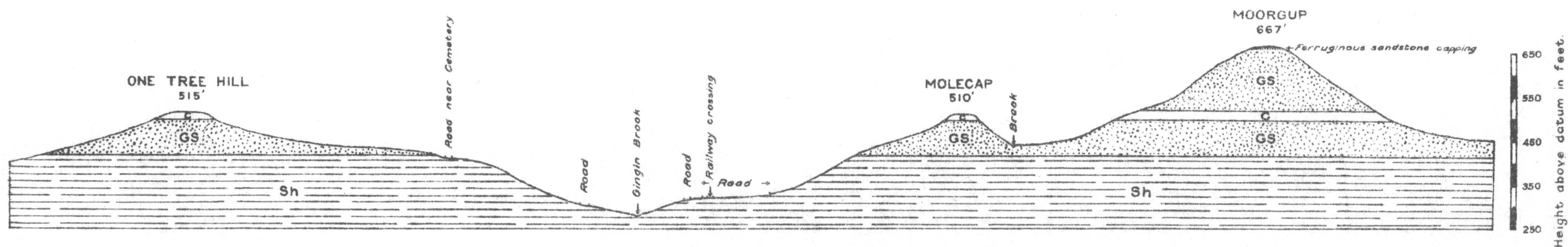
1. The Upper Greensand or glauconitic sandstone.
2. The chalk.
3. The Lower Greensand or glauconitic sandstone.
4. Shale and micaceous sandstone with little or no glauconite.

Accurate determination of the boundaries of the beds, their thickness, and the direction and degree of their dip is somewhat difficult, as over the greater part of the area they are obscured by soil, sand or ironstone gravel. In places their approximate position may be recognised by the character of the soil, the chalk, in particular, giving rise to a fine black soil easily distinguished from the red somewhat coarse and sandy soil derived from the greensand, but the shales are largely obscured by the accumulation of material derived in part from the overlying rocks.

# GEOLOGICAL SKETCH MAP OF GINGIN.



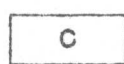
## SECTION THROUGH ONE TREE HILL, MOLECAP, AND MOORGUP, GINGIN.



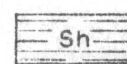
### LEGEND



Greensand



Chalk



Shale and micaceous sandstone

F.R. Feldtman

The most satisfactory method of determining the boundaries, thickness and dip of the beds would be a contour survey, with the location of outcrops and quarry exposures, by means of the tachometer. A series of tachometer traverses in the vicinity of Gingin has been made by students of Geology of the University of Western Australia, and a copy of a contour map embodying the results of their work was obtained through the courtesy of the Department of Geology of the University. I am indebted to Professor E. de C. Clarke for permission to make use of the data afforded by this map, which has been of great assistance in fixing the approximate boundaries of the beds where no exposures were observed.

The profile shown on the geological section through One Tree Hill, Molecap, and Moorgup, is also based on the contours shown on this map. Additional work of this character is desirable.

The most convenient horizon for estimating the dip of the beds is the base of the chalk at its junction with the lower greensand. Good exposures of this junction are shown in the quarry on the north-eastern slope of Molecap and below the limekilns on the southern side of One Tree Hill. The mean of my observations at Molecap shows the base of the chalk to be 15.6 feet below the top of the hill, the height of which is shown on the University map to be 510.2 feet above sea-level. The base of the chalk at Molecap is, therefore, approximately 495.6 feet above sea-level. At One Tree Hill, the base of the chalk below the limekilns was roughly estimated at about 18 feet below the top of the hill which is shown as 515 feet above sea-level on the University map. Allowing for slight errors owing to the inadequate means for accurate survey at my disposal, these observations show the chalk to be practically horizontal between these two points, nearly  $1\frac{3}{4}$  miles apart. Of the other exposures of the chalk examined, one, a small outcrop, a few feet in length, on the south-western slope of Moorgup and usually known as "Compton's Chalk," is shown on the University map as 488 feet above sea-level; another, known as "Musk's Chalk," in a small open cut on Loc. 758 at a point  $1\frac{3}{4}$  miles east of the railway station, and 90 feet north of the road to Mooliabeenie, is shown at about 460 feet above sea-level. Compton's Chalk occupies its present position owing to a landslide that is known to have taken place in recent years, and the configuration of the ground near Musk's Chalk suggests that its present position may also be due to a somewhat older landslide. Practically all the other exposures known occur at or about the 500 feet horizon. On the accompanying map and section the base of the chalk is, except at the two last places mentioned, assumed to be approximately horizontal and 496 feet above sea-level.

The original thickness of the upper greensand is unknown. At Moorgup, where it is exposed on the top and on the south-western slope of the hill, the thickness is approximately 150 feet (*vide* the geological section). At Ginginup it is probably about the same. The rock composing this bed may not be of similar composition throughout. Simpson (*op cit.* p. 30) mentions that some bands are distinctly shaly, one such being seen about 20 feet above the gearsutite horizon on Loc. 457, but from the exposures observed it appears probable

that by far the greater proportion of the bed consists of glauconitic sandstone similar to that quarried in the lower greensand. Bands containing phosphatic nodules occur near the base of the upper greensand.

The thickness of the chalk can be estimated approximately although the exact figure is uncertain and the thickness may vary slightly from place to place. Simpson's estimate is 15 to 20 feet. At Molecap nearly 12 feet of chalk is exposed at the southern end of the quarry, the top of the chalk at this point being nearly three feet below the top of the hill. At One Tree Hill approximately 17 feet is exposed in the quarry and below the limekilns. On both hills the chalk is covered by black soil averaging about one foot in thickness, and resulting from the weathering of the chalk, so the original thickness was probably slightly greater. Near Compton's Chalk, exposures of both the upper and the lower greensand and above and below the chalk, respectively, indicate that its thickness at this point cannot be much more than 20 feet, which is assumed to be its thickness on the section.

The main portion of the lower greensand is separated from the chalk in the Molecap quarry by a band, between  $2\frac{1}{2}$  and 3 feet thick, of glauconitic sandstone containing numerous phosphatic nodules and a small proportion of chalk. The main bed of glauconitic sandstone is exposed in the quarry to a depth of 12 feet below the phosphatic band. Only about 3 feet of the rock underlying the chalk is exposed below the limekilns at One Tree Hill, and this is very similar in appearance to the phosphatic band at Molecap, consisting of somewhat weathered glauconitic sandstone with small fragments of chalk. It is, without doubt, underlain by glauconitic sandstone similar to that in the Molecap quarry.

Owing to the lack of exposures in the area examined the exact thickness of the lower greensand could not be determined. Simpson (*op. cit.* p. 26) estimates it at 100 feet, but it is probably not so great as this. On the main road running south from the town, a definite outcrop of the greensand is exposed above, and in a gutter on the east side of the road at a point about 170 feet south of the short cross road running east towards Molecap. This outcrop was estimated to be about 430 feet above sea-level or 66 feet below the base of the chalk. A somewhat doubtful exposure, that might be either massive or detrital, was observed a few feet lower down in the gutter. North-east of Molecap, an outcrop of the underlying shale occurs on Loc. 426 at a point a few feet below the 400 feet contour as shown on the University map. The lower greensand, therefore, is at least 66 feet and not more than 100 feet in thickness. On the section it is assumed to be about 80 feet. The determination of the true thickness of the lower greensand is of importance, as it will be understood from examination of the geological section, that each additional foot in thickness means a proportionally greater increase in the quantity of glauconitic material.

Relatively, little is known of the beds underlying the lower greensand or the depth to which they extend. The few exposures known indicate them to be mainly shales and micaceous sandstones with little or no glauconite, but it is possible that there is some lateral variation in the beds and that bands



of glauconitic sandstone may occur interbedded with the shales. Small boulders of somewhat laterised ferruginous sandstone derived by weathering from glauconitic sandstone were observed in the northern portion of Loc. 370, east of the road which runs north towards One Tree Hill, and about the 300 feet horizon, and compacted material also derived by weathering from glauconitic sandstone was observed in a gutter on the same road at a much lower point some 500 or 600 feet north-west of Gingin Brook. Whether these exposures are *in situ* or have travelled a considerable distance from their source could not be determined.

*Workings in the Glauconitic Sandstones.*—The only place where the glauconitic sandstone has been quarried is on Loc. 103 in the lower greensand on the north-eastern slope of Molecap, on the site originally quarried for limestone and phosphatic nodules. The extent of the quarry and its position relative to the former trigonometrical station (now dismantled) on Molecap is shown on the accompanying plan and section. The southern end of the original quarry in the chalk is approximately 125 feet east-north-east of the old trig. site, that of the deeper cut in the greensand about 20 feet farther north. At this last point the greensand has been quarried to a depth of nearly 15 feet below the base of the chalk. The deepest end of a small cut from 10 to 19 feet in width, near the northern end and in the western half of the quarry, extends to a depth of about 16 feet below the base of the chalk. The main cut in the greensand is about 86 feet in length, the width ranging from about 14 feet at the northern and shallower end to a maximum of 35 feet close to the southern end.

*Conclusions and Recommendations.*—The geological sketch map accompanying this report covers barely half the area of the Cretaceous rocks definitely known to occur near Gingin. The average height of the area to the north of that shown on the map is considerably greater than the average of the area shown and the proportion occupied by the upper greensand must therefore be much greater, as is indicated by Mr. Glaucert's map (Bull. 36, fig. 4). Any estimate of the quantity of glauconitic material available is at present impossible, but the sketch map and section indicate that it must be very great indeed running into millions of tons in the area shown. The actual quantity existing in the known areas of Cretaceous rocks is, without doubt, enormous.

The site chosen for working the deposit is favourably situated, being near a good road and less than a mile by road from the railway station.

The best method of testing the thickness and glauconitic content of the greensand beds would be to put down a vertical bore with a drill, such as the Calyx, that would give a suitable core, the core to be sent to the Geological Survey for determination of the rocks and the choice of representative samples for analysis. A bore put down from the top of Moorgun to a vertical depth of 400 feet would not only test the glauconitic content at different horizons of both the upper and lower greensands and the vertical extent of the latter, but would also show whether other bands of glauconitic material are interbedded with the underlying shales.

The desirability of a survey to determine, so far as possible, the boundaries of the Cretaceous rocks,

together with a more detailed examination of the Gingin area, has already been mentioned.

## 2.—INGLISTON CONSOLS EXTENDED AND FENIAN GOLD MINES, MEEKATHARRA.

(F. G. Forman, B.Sc.)

These two properties at present held and worked by the Ingliston Extended Gold Mining Syndicate are situated about one and a half miles south-east of Meekatharra township on the southern part of the main portion of Paddy's Flat.

A detailed description of the geology and ore deposits of Meekatharra is given by E. de C. Clarke in G.S.W.A., Bulletin 68. This includes a description of the Ingliston Consols Extended and Fenian workings (included with the Marmont as the "Consols Group") as far as they had been developed at the time of his survey in 1915. The present examination of the two mines was confined to the workings developed since that date, together with such re-examination of the old workings of these and other mines as was necessary to a clear understanding of the geological features at present exposed.

At the time of the survey in 1915, the deepest development in the Fenian workings was at the No. 9 level (850 feet) and in the Ingliston Consols Extended workings at the No. 6 level (746 feet). Since that date development on the Fenian has extended to the No. 11 level (1150 feet) and on the Ingliston Consols Extended to the No. 12 level (1365 feet). Of these later workings the Nos. 7 and 8 levels of the Ingliston Consols Extended were of necessity excluded from examination owing to inaccessibility of the drives and stopes.

Bulletin 68 contains a detailed description of the petrology of the rock types encountered in the district, and also of the distribution of the rocks as exposed in the mine workings.

During the present examination no fresh evidence was obtained which would serve to change the general ideas expressed in Bulletin 68. A detailed description of the rocks and of their mode of origin is therefore considered unnecessary in this report.

The writer wishes to acknowledge his indebtedness for information set out in Bulletin 68 and to the staff and employees of the Ingliston Consols Extended Gold Mining Syndicate, all with whom he came in contact supplying much valuable information which would otherwise have been extremely difficult to obtain.

### General Geology.

The oldest rocks in the vicinity of the workings are a complex of greenstones of Pre Cambrian age, which may be subdivided into a number of distinct types, some of which have a doleritic and others a peridotitic origin.

#### Rocks of Doleritic Origin.

These are represented chiefly by the "flecked schists" which are green or grey-green highly sheared rocks containing duller chloritic patches which give the rocks a flecked appearance. The flecked schists are the chief wall rocks of the lode above the Fenian No. 4 level (326 feet) and the Ingliston Consols No. 5 level (621 feet).

Chloritic slates, which enter the Ingliston Consols Extended shaft below the No. 8 level plat, and are found as a narrow band in the flecked schists at the lower levels, are probably also of doleritic origin, being presumably highly altered derivatives of the original dolerite in a zone of more intense shearing. They are grey-green imperfectly fissile rocks with a blocky fracture.

Fuchsite-quartz carbonate rocks, little sheared, and usually having a bright green colour due to the presence of the green chromium bearing mica, fuchsite, are also thought to have a doleritic origin. These rocks are usually found in close association with the porphyry dyke of the lode channel and are important because of their possible influence on the ore body in certain sections of the mines. See below.

#### *Rocks of Peridotitic Origin.*

These rocks are represented by a little sheared black carbonate rock which encloses the ore body below the Fenian No. 4 level (326 feet) and the Ingliston Consols Extended No. 5 level (625 feet). The rocks vary in appearance from place to place, the more highly sheared varieties being in some cases difficult to distinguish from the flecked schists.

#### *Porphyry.*

This is an albite quartz porphyry which varies in appearance from an extremely fine grained translucent white rock difficult in the hand specimen to distinguish from a bucky quartz or quartzite to a greenish or brownish green rock with distinct porphyritic texture. It is economically the most important rock in the mines because of its intimate association with the ore deposits.

#### *The Main Lode Channel.*

The main lode channel is a shear zone in the old greenstone complex, striking N.N.E., and dipping east. In the upper part of the workings the average dip of the lode is about 68°, but in the lower workings the lode steepens considerably; between the No. 10 and No. 12 levels of the Ingliston Consols the average dip being 80°.

This shear zone has been the path followed by a porphyry dyke (Paddy's Flat Dyke of Bulletin 68) and subsequently also by the ore bearing solutions.

#### *The Porphyry Dyke.*

The dyke does not everywhere reach the surface. In the northern part of the Ingliston Consols Extended Lease and in the southern part of the Marmont Lease, which adjoins the Fenian Lease on the south, the porphyry is present as a continuous dyke from 15 to 60 feet wide. In the upper levels of the main workings of the Ingliston Consols Extended and Fenian mines, the porphyry is present only in disconnected peaks which, however, join together below the No. 6 level of the Ingliston Consols Extended to form a continuous body lying in and more or less filling the shear zone. The dyke has an average width of 40-50 feet at the Ingliston Consols Extended No. 12 level (1,365 feet).

#### *Brecciation of Porphyry and Formation of Cross Fissures.*

Subsequent to the injection and cooling of the porphyry renewed earth movement caused the development of cross fissures in the porphyry with,

in places, a complete brecciation of the rock. Movement on several of the larger cross fissures caused actual sideways displacement of the dyke. Viewed in the mine workings this displacement has been almost invariably towards the west when looking north, the strike of the fissures being towards the south-east and the dip north. However, large displacements of the dyke seen in the northern ends of the drives at the Nos. 10 and 11 levels of the Ingliston Consols Extended are exceptions, the movement in these cases being towards the east looking north, the dip of the planes along which the movement took place being towards the south.

#### *The Ore Deposits.*

*Main Lode.*—The gold bearing solutions which were responsible for the formation of the ore deposits presumably travelled up along the same path as the porphyry dyke, and after its brecciation and displacement by the cross fissures or faults. The main lode in the upper levels consists of a network of gold bearing quartz veins and veinlets in a matrix of sheared rock, impregnated with arsenopyrite. In the lower levels where the porphyry is present as a continuous dyke more or less filling the shear zone, the lode is found either on the hanging wall or on the footwall of the dyke, while the fissures formed by the brecciation and cross faulting of the dyke are filled with veins of auriferous quartz. The lode must, therefore, be considered as including not only the sheared rock of the main shear zone, but the brecciated and fissured porphyry of the dyke. This is recognised by the mine management; the porphyry and the wall rock where it is found to carry values all being crushed in the mill.

*Spur Veins.*—Spur veins, which are auriferous quartz veins occupying cross fissures in the porphyry, are of frequent occurrence throughout the mines, but do not usually extend far into the country rock. Where they do extend into the country it is usually in the hanging wall or east side of the porphyry. These spur veins are usually richer than the main lode, indeed, it is said that were it not for the presence of these cross veins or spurs in the lower levels, the lode could not be worked at a profit. The strongest and most important of these spurs is the Fenian South-east spur, which has in the past contributed considerably to the total tonnage obtained from that mine. The cross fault on which this spur lies has displaced the porphyry from 40 to 45 feet in the Fenian workings, and the quartz vein carrying the gold averages 60 to 70 feet in length. The downward continuation of this spur, which dips to the north, is now being worked in the Ingliston Consols Extended mine at the Nos. 11 and 12 levels, but here the spur appears to be neither so strong nor so extensive as in the upper levels of the Fenian. Clarke, in Bulletin 68 (page 159), notes the poorness of the main ore channel south of the Fenian South-east spur for which he suggests that diversion of the ascending solutions by this and the Marmont No. 2 spur is responsible. This, combined with the influence of the country rock in the southern part of the channel (see next section), is in the opinion of the present writer responsible for the poorness of that part of the ore body south of the main south-east spur in the Ingliston Consols Extended. (Fenian S.E. Spur of Bulletin 68.)



*Influence of Country Rock on Productiveness of the Ore Body.*

In Bulletin 68 (page 90) the statement is made: "The ore bodies of the Paddy's Flat Belt are most productive where they lie in the 'flecked schists' (sheared dolerites), are less productive when in the 'black schists' (sheared peridotitic rocks), and are patchy in the fuchsite rock."

The present writer agrees with this statement and suggests that the varying tenor of the ore in the three rock types is due to the relative ease with which the solutions, which introduced the gold, were able to circulate. The flecked schists are more highly sheared than the others, and would be, therefore, presumably more porous. On the other hand the fuchsite rocks are very little sheared and are frozen or dovetailed on to the porphyry with which they are usually in contact, so that there was relatively little opportunity for the circulation of solutions. The rich patches which do occur in the fuchsite rocks are associated with local areas of more intense shearing or with strong cross faults of which the Marmont No. 2 spur is an example.

*Mine Development since Previous Survey.*

In the main section of the workings the chief development has been at the Nos. 10 and 11 levels from the Fenian Shaft, and at the Nos. 7 to 12 levels from the Ingliston Consols Extended shaft. In addition to this there are shallow workings in the northern part of the Ingliston Consols Extended lease from two shafts, the "Whip Shaft" (vertical depth 170 feet) with levels at 120 feet and 170 feet below the surface; and the "New Shaft." The latter shaft was not examined as all the necessary information was available from an examination of the "Whip Shaft" workings. A shaft near the south boundary of the Ingliston United lease, now known as Candy's Shaft, and identical with shaft D on sheet 7, plate XIII. of Bulletin 68, has been sunk to a vertical depth of 214 feet, the last 30 feet with an easterly underlay, with levels at 52 feet, 116 feet, 154 feet, 183 feet, and 214 feet, below the brace.

*Shallow Workings.*

In the shallow northern workings stoping has been confined to the richer cross leaders in the porphyry which here averages 50 feet in width. No stoping has been done in the main north-south drive at the 120 feet and 170 feet levels of the Whip Shaft which follow the hanging wall or east side of the porphyry. Because of the entire absence of assay plans of these and other parts of the mine it is impossible to gauge accurately the value of the lode material.

*Main Workings.*

The relationship of the mine openings to the geological features of the lode is shown clearly on the accompanying plans\* and will therefore not be described in detail.

It was originally planned to show by a distinctive marking the position of the lode in relation to the drives at the various levels, but when it was found that the profitable ore included not only the hanging wall and footwall shoots, but the porphyry itself, it was considered that the distribution of the porphyry as shown on the plans was a sufficient

\* Plans not published.

ent indication of the lode. In the Fenian workings where it has been the practice to mine only the lode material on the walls of the porphyry and in the spur veins, the stopes do indicate the position of the richer shoots of ore. These ore shoots are indicated on the plans.

The main south-east spur vein last seen in the Fenian Mine at the No. 10 level (1,000 feet) has not cut out below that depth, but passes into the Ingliston Consols Extended Mine, between the No. 9 level (1,030 feet) and the No. 10 level (1,150 feet), and is now being worked at the Nos. 11 and 12 levels as a spur off the main south drives. Failure to cut the spur vein at the Ingliston Consols Extended No. 10 level is accounted for by the presence of a complicated system of faults which have displaced the lode channel and the porphyry. The probable positions of the displaced porphyry dyke and the spur vein are indicated approximately on the accompanying plan\* of the Fenian No. 11, and the Ingliston Consols Extended No. 10 levels.

The spur vein 80 feet north of the crosscut at the Ingliston Consols Extended No. 11 level, and a similar vein opposite the crosscut at the No. 12 level, are considered to be one and the same ore body. Stopping on this spur was started at both levels, but was discontinued when the values cut out. The patchy distribution of the values is characteristic of both the main lode and the spurs, and further exploratory work at least on this spur is advisable, either by continuing the stope above the No. 12 level and using the broken rock as filling elsewhere, if of unprofitable grade, or by winzing on the spur from the No. 11 level.

The entire absence of assay plans and sections makes the question of development both laterally and at depth a difficult one to decide.

An examination of the Fenian workings shows that in the lower levels at least a considerable amount of prospecting driving has been done on the main lode channel south of the Fenian south-east spur, but that no stoping of any importance has been carried out from these drives. This suggests that the ore body was here found to be unpayable owing probably to the diversion of the gold bearing solutions by the spur, and to the unfavourable nature of the fuchsite carbonate rock enclosing the southern part of the ore channel at the lower levels. Although it cannot be definitely stated that a payable ore body does not exist in the southern continuation of the ore channel, past experience in the Fenian mine, as set out above, suggests the advisability of looking elsewhere for development.

The workings at the 120 feet and 170 feet levels from the Whip Shaft show that the main lode channel continues north of the present workings from the Main Shaft, but the absence of stoping except on the richer cross veins in the porphyry suggests that the main lode is here of low grade. Bulking the low grade ore with the richer cross veins, as is done elsewhere in the mine, may make the lode payable below the present development in this northern section.

The irregularity in longitudinal section of the northern limits of the stoping at the various levels from the Ingliston Consols Extended shaft suggest

that other causes than the falling off in gold values were responsible. This idea is confirmed by the present management who state that stoping limits were determined by the increase in size of the porphyry dyke which increased the cost of mining by the hand drilling methods earlier in use to such an extent as to make further development unprofitable. With the modern machine drills now in use development to the north would seem to have a reasonable chance of success.

The increasing width of the porphyry dyke with depth in the lower levels is accompanied by a falling off in the gold values. This may be due to the same amount of gold which filled the ore channel where the dyke was narrow being distributed over a much greater area where the dyke is wide; or to a less extensive fracturing of the porphyry owing to its greater width, and therefore greater resistance to pressure, reducing the available space for the deposition of gold from the solutions.

There is no available evidence to indicate the behaviour of the porphyry dyke at depth below the present bottom level, No. 12 (1,365 feet). Exploratory boring with a diamond drill below the No. 12 level would indicate the width of the dyke and the existence of the ore channel at lower levels. Such boring, however, should not be relied on to indicate the presence or absence of payable ore, because of the characteristically patchy nature of the lode and the chance of the bore holes penetrating poor zones.

#### *Possible Extension of Ingliston Extended East Lode. (Mud Lode.)*

Exploratory diamond drill boring eastward from the end of the long east crosscut at the No. 9 level from the Fenian shaft, has explored the country to the east of the Main Lode channel for a distance of approximately 1,000 feet. Records of this boring have been lost so that no definite information is available. However, it seems likely that had any lode material been cut in the bores, some knowledge of it would be in existence to-day, even if only in the form of rumours which are common with most matters geological at Meekatharra. The complete absence of legends about this boring seems to indicate that no lode channel was cut in the bores. The east lode, therefore, if it extends southwards at all, would seem not to reach as far as the southern part of the Consols Group. No evidence other than that set out on pages 149 and 164 of Bulletin 68 is available which would help to decide this question.

#### *Conclusions.*

From the present investigations the following conclusions have been reached:—

1. There is an intimate association of the lode channel and the Paddy's Flat porphyry dyke, such that the dyke and the ore body may be considered as one.
2. The dyke is deep seated in origin and there is no likelihood of its "cutting out" within the limits of economic mining.

3. Lateral development at the southern end of the ore channel is not likely to reveal payable gold values because,

- (a) its great width (90 feet in the east crosscut of the Fenian No. 9 level) has enabled the dyke to resist the forces which further north have caused a fracturing and brecciation of the rock. Consequently, there was relatively little chance for the circulation of gold bearing solutions within the dyke such as has occurred in the fractured and brecciated zones,
- (b) circulation of gold bearing solutions has been retarded in the southern part of the ore channel by the diversion along the Fenian South-east Spur,
- (c) the encasing rock of the ore channel in its southern extreme is mainly fuchsite quartz carbonate rock, little sheared, which because of its relative freedom from shearing and its close contact with the porphyry dyke has further retarded the circulation of gold bearing solutions.

4. Although the absence of assay plans and sections makes a definite decision impossible it seems likely that the values have not cut out at the northern ends of the Ingliston Consols Extended drives, but that further northerly development was prevented by the difficulty of mining the porphyry dyke by hand labour.

5. The Fenian South-east Spur passes into the Ingliston Consols Extended lease between the No. 9 and No. 10 levels. It is identical with the main spur at present being worked at the Ingliston Consols Extended No. 11 level and No. 12 level, and in a winze below the No. 12 level.

6. Failure to find the main spur at the Ingliston Consols Extended No. 10 level is due to the displacement of the lode by faulting. The probable position of the displaced lode is indicated on the accompanying plan.\*

7. The spur vein 80 feet north of the crosscut at the Ingliston Consols Extended No. 11 level, and a similar vein opposite the crosscut at the No. 12 level are probably one and the same ore body. If the present dips observed on this spur and the more southerly main spur are maintained, the two should cut at a depth of approximately 200 feet below the present No. 12 level. Enrichment at, and for some distance above and below their junction can be expected.

8. There is no evidence available by which to make a definite prediction of the width of the porphyry dyke below the No. 12 level. Such dykes are characteristically irregular in section and the present average width of 50 feet at the No. 12 level may represent only a bulge.

9. Exploratory diamond drilling eastwards from the east crosscut at the Fenian No. 9 level indicates that, if the Ingliston Extended east lode does extend southward of its present known limits (no further evidence than that set out on pages 149 and 164 of Bulletin 68 is available on this point), it does not reach as far as the east side of the Fenian lease.

\* Plan not published.

### *Recommendations.*

1. Lateral development northwards, particularly from the upper levels of the Ingliston Consols Extended mine, where the northern faces of the drives and stopes are said to have been in ore of fair grade.

2. Exploratory driving on the footwall side of the porphyry at the No. 10 level north of the crosscut. The geological plan shows that the footwall of the porphyry has not been cut anywhere in the north drive.

3. Southwards extension of the Ingliston Consols Extended No. 11 south drive to pass under the winze sunk from the Fenian No. 11 level in which good gold values are said to have been obtained.

4. Continuation of the drive on the hanging wall side of the porphyry south of the crosscut at the Ingliston Consols Extended No. 12 level.

5. Continuation of the north drive at the No. 12 level where values should at least equal those obtained in the north drive at the No. 11 level.

6. Exploratory boring with a diamond drill below the No. 12 level in order to determine the width of the dyke at greater depth.

7. Exploration by actual mining operations below the No. 12 level to determine the tenor of the lode at greater depth. Because of the characteristically patchy nature of the ore body, diamond drilling cannot be relied on to determine the presence or absence of gold values.

### 3.—LADY CENTRAL GOLD MINE, MEEKA-THARRA.

(F. G. Forman, B.Sc.)

Whilst engaged in an examination of the Ingliston Consols Extended and Fenian Gold Mines, the writer was told of recent developments on the Lady Central Lease, where it was said that at the 210 feet level from the New Shaft—supposed to be on the Ingliston Extended East Lode—the drive, which was in a northerly direction from the shaft, had cut basaltic dolerite in the face. It was known previously that somewhere in this vicinity the East Lode was cut off by a later basaltic dolerite dyke. It seemed, therefore, that the New Shaft workings were on the southern side of the dolerite, and consequently that the east lode extended further south than was previously known. Definite evidence of the presence of the Ingliston Extended East Lode on the south side of the dolerite would open up the question of its possible extension as far south as the Ingliston Consols Extended leases.

#### *New Shaft Workings.*

The New Shaft is situated about sixty feet south of the southern end of the old Ingliston Extended open cut on the East Lode. Short northerly drives have been put out from the shaft at the 100 feet and 210 feet levels.

The No. 1 level (100 feet) extends for about 62 feet north of the shaft in brown weathered schist with flecks and patches of fuchsite. The quartz

leader in which the gold values occur, lies in and strikes parallel with the schist and has an average width of about two feet and dips east at about 80°.

The No. 2 level (210 feet) extends north of the shaft about 100 feet, the country rock being a weathered black schist similar in appearance to the wall rock of the East Lode in the adjoining Ingliston Alberts Lease. The gold values occur in a quartz leader averaging about 1ft. 6in. in width with a dip of 75° to 80° to the west. The strike of the leader is parallel to the enclosing schists. Near the face the black schist becomes much harder than elsewhere in the drive. It was the increased hardness and the fine grained black appearance of the rock which lead the leaseholder, Mr. B. Rinaldi, to believe that he had cut the basaltic dolerite dyke.

#### *Conclusions.*

The drive at the 210 feet level of the New Shaft is entirely in black schist, probably an altered peridotite. The hardness of the schist in the face of the drive is due simply to its being less weathered than the schist elsewhere in the drive, and will be found to be the normal condition of the rock at lower levels in the sulphide zone.

The position of the dolerite dyke is indicated on Sheet 5, Plate XIII. of Bulletin 68. The New Shaft is on the northern side of the dolerite and its position in relation thereto is shown on the accompanying plan.\*

There is some doubt as to whether the quartz leaders exposed at the No. 1 and No. 2 levels are one and the same because of the discordancy of their dips. The brown schist at the No. 1 level might quite easily be a more weathered form of the black schist at the No. 2 level, but the fuchsite flecks and patches seen in the schist at the No. 1 level are absent from the schist at the No. 2 level. If the dips observed in the schist at the No. 1 level are maintained in depth, similar country should be found to the east side of the No. 2 level drive. This should be tested and the extension of the No. 1 level leader looked for by an east crosscut at the No. 2 level.

#### *Western Workings.*

The workings in the western part of the Lady Central lease lie in, and along, the walls of the Paddy's Flat porphyry dyke which averages about 35 feet in thickness. Stopping has been confined to rich quartz cross leaders in the porphyry. The leaders, which apparently lie in pre-gold fault fissures, run at various angles across the porphyry. They are said usually to carry gold throughout their length, but enrichment is found to take place where two leaders intersect and cross, particularly if the intersection takes place in schisted country on either side of the porphyry. The accompanying plans\* show the relationship of the workings to the porphyry dyke, but the numerous auriferous cross leaders are not shown, as to do so would not serve any useful purpose and the work necessary to map them was, therefore, not justified. Several of the cross leaders, drives on which are already indicated on the mine plans, are shown and illustrate the mode of occurrence of the whole system.

\* Plan not published.



In an east crosscut near the southern end of the 160 feet level south drive, a small quartz leader is exposed which is said to have carried gold values where it was worked in the adjoining lease, the United. The leader as exposed in the crosscut, lies parallel to and about fifteen feet east of the hanging wall of the porphyry, but does not contain payable gold values. The values in such quartz veins and leaders in other parts of Paddy's Flat are characteristically patchy, and a northern drive on this leader, with the object of prospecting for other shoots of auriferous quartz, seems worth while.

#### 4.—INGLISTON ALBERTS G.M., MEEKATHARRA.

(F. G. Forman, B.Sc.)

The following brief description of the geological features of the East Lode in the Ingliston Alberts Lease (late Ingliston Extended\*) is written after an examination made at the request of the Syndicate.

The East Lode is a shear zone in the black schist (altered peridotites) lying parallel to and about 180 feet east of the Paddy's Flat porphyry dyke. Throughout its greater part the East Lode lies close to a fine grained basaltic dolerite dyke, which is of later date than the ore body. This dyke and the ore body are not strictly parallel, and the effect where the dyke approaches closer than usual to the shear zone of the lode, is a partial squeezing out of the lode with a consequent reduction of the normal stopping width. This is purely a mechanical effect, so that should it be found on further development that the dip of the dyke changes, and the lode is consequently entirely pinched out, it should be found again without any alteration in values on the other side of the dyke.

The present lowest level on the East Lode is at 550 feet, and is driven north from the Faithful Shaft for a length of about 380 feet. All payable ore vertically above this level has been stoped out by the Ingliston Extended Company. The present holders, the Ingliston Alberts Syndicate, have sunk two winzes each 50 feet deep below the 550 feet level. These winzes, the No. 1 winze and the No. 2 winze, are 40 feet and 145 feet respectively north of the crosscut from the Faithful Shaft.

The lode at the bottom of the No. 1 winze is exposed over a width of 10 feet. The footwall or west side of the winze at the bottom appears to coincide with the footwall of the lode, but a definite hanging wall on the east side of the winze has not yet been exposed.

At the bottom of No. 2 winze the lode is exposed over a width of 16 feet. The western side or footwall of the winze appears to coincide with the footwall of the lode, but bore holes put out into the hanging wall still show gold values continuing.

It is stated by the Manager that the average value of the ore exposed in No. 1 winze and No. 2 winze is about 15dwts. of gold per ton. The basaltic dolerite dyke which lies close to the hanging wall of the lode at the upper levels, has not yet been exposed in either of the winzes.

\* A full description of the geology and ore deposits of the Ingliston Extended mine is contained in G.S.W.A. Bull. 68.

#### Conclusions.

The East Lode is of deep seated origin and the gold values are likely to continue to much greater depths than the present deepest workings.

The widening of the lode in the two winzes below the 550 feet level is probably due to the greater distance between it and the basaltic dolerite dyke which appears to have flattened its dip and has, therefore, retreated eastward away from the lode channel.

The present width of the lode is likely to be maintained in depth, unless a further change in the dip of the dolerite dyke causes it to again enter the lode channel.

Should the lode at greater depth be completely pinched out by the dolerite dyke, it should be found again without any alteration in gold values on the other side of the dyke, the barren interval depending on the width and dip of the dyke.

#### *Ingliston Alberts (Ingliston Extended) Main Spur.*

The main spur is a body of quartz almost vertical and striking parallel to and about 70 feet east of the west lode which lies on the hanging wall side of the Paddy's Flat porphyry dyke. The Main Spur has been faulted between the No. 1 and No. 2 levels. The effect of this faulting is shown diagrammatically in the plans or plate XV. and the section on plate XIX. of Bulletin 68.

It was suggested to the writer by the Underground Manager, that instead of the faulting being on one plane as depicted in Bulletin 68, it might be on two parallel planes and that in consequence a further body of ore might exist between these two planes somewhere between the No. 1 and No. 2 levels.

After inspection of the fault planes exposed at both levels, and a study of the plans and sections in Bulletin 68, the writer is of the opinion that the conditions as depicted by the plans and sections in Bulletin 68 actually do exist, and that therefore no isolated body of ore representing a displaced portion of the Main Spur will be found between the two levels.

#### 5.—SUGGESTED BORING FOR "DEEP LEADS," GREENBUSHES TINFIELD.

(F. G. Forman, B.Sc.)

The first locality examined was an extensive sandy flat at the head of Moulton Brook (locally known as Battler's Gully). On the old Battler's Hope leases, M.L's. 313-314, two deep shafts have been sunk, with the object of prospecting for a "deep lead." These shafts are now inaccessible, but the following extract from Bulletin 32 describes the conditions as found and coincides with descriptions supplied to me by miners with local knowledge.

Battler's Hope, M.L. 313-314.\* These old leases are situated at the head of Moulton's Brook, more generally known as Battler's Gully, and upon these, close to their dividing boundary, two deep shafts have been sunk, with the object of prospecting for a "deep lead."

The southern of these two was sunk to a depth of 126 feet, cutting the wash at 96 feet 3 inches, where it was about 15 inches in thickness and composed of numerous large well water worn boulders of quartz, quartzite, greisen and mica schist, with softer much decomposed rounded boulders of clayey ironstained rock, the whole being intermixed with ferruginous earth and sand.

At a depth of 106 feet below the wash a level was driven south-west in decomposed mica schist for a distance of 120 feet, which rose into it at a distance of 50 feet from the shaft. Another drive was also carried 40 feet north, when work had to be abandoned owing to the collapse of the shaft bottom.

Another shaft was sunk a little farther north to a depth of 103 feet, bottoming upon a hard diorite bar, which was driven in 6 feet. The wash in this shaft was cut at a depth of 93 feet, whilst a level drive 60 feet south from the shaft rose into it at a distance of 30 feet.

† From the appearance of the larger boulders at surface it is evident that a true "wash" or river-worn bouldery gravel was encountered, pointing to the existence in past times of running streams of considerable carrying power, and to different climatic conditions from those now prevailing.

A little tin ore was obtained by Mr. Johnston while working the "wash," but it was altogether too poor to be payable. The presence of the ore, nevertheless, gives ground for thinking that the "gutter" of the lead, when found, is likely to carry payable deposits. Above the "wash" there was in the shaft about four feet of dark clayey matter, covered by two feet six inches of fine drift, from which a good deal of water made into the shaft. On top of this drift there was a thin hard band or layer of oxide of iron cement, then 50 to 60 feet of brown mullocky material, with iron oxide concentrations and angular pieces of quartz. Mr. Johnston tells me that this has been repeatedly mistaken in the district for the true bedrock. Near surface the ground is hard white and brown cemented grit and sand. The succession of strata is as described by Mr. Johnston; the shaft being full of water I could not further verify them.

The "wash" and boulders at this shaft were very similar to those at the "Hard Graft" and adjacent shafts above mentioned, and I think there is much likelihood of their being all on the same deep lead.

This deep lead has evidently nothing to do with the present shape of the surface, its course being quite independent of the modern watercourses, and the latter are no guide as to where it might be expected to be met with. To the westward of the "Battler's Hope" it may be entirely removed by the modern erosion of the country, in which case some trace of it should be found where the old channel emerges on the more recent surface, or it may possibly continue as a buried lead, in that case probably going out somewhere towards the junction of Cowan's and Norilup Brooks. At Johnston's shaft the belt of deep ground is some 15 chains in width with shallow ground to north and south, and as the bedrock in the levels was dipping to the north-west it is evident that the shaft must be on the south side of the "gutter," though fairly well in the centre of the belt of deep ground. The next shaft should therefore be sunk further to the north.

From the above it will be seen that the evidence for the existence at this point of a "deep lead" at a depth of about 100 feet is fairly conclusive.

\* H. P. Woodward, Assistant Government Geologist, G.S.W.A., Bull. 32, page 66.

† A. Montgomery, M.A., F.G.S., State Mining Engineer, Dept. of Mines, W.A., Ann. Report, 1903.

From the Battler's Hope leases a sandy flat extends north-westward to Paper Bark Swamp, where dredging for alluvial tin has been successfully carried on, the belt of stanniferous wash extending north-westwards to the exceptionally rich ground on the north side of Spring Gully. Paper Bark Swamp has been worked to a depth of about 12 feet, the bottom of the excavations being marked by a layer, a few inches thick, of well water-worn quartz and greisen boulders resting on a stiff brownish clay. Well holes, up to ten feet deep, in this clay "bottom" have not revealed any tin, but it is doubtful that the clay really represents the true "bottom" of the alluvial wash.

Extending south-eastwards from the Battler's Hope leases through claim 863 to the East Phoenix Lease, M.L. 571, there is a line of stanniferous wash at a depth of 28-30 feet, which has been profitably worked from numerous shafts. The tin bearing layer is a fine to medium grained well water-worn "wash" which is said to have yielded in places as much as  $\frac{1}{2}$  cwt. of cassiterite to the cubic yard. During the early stages of the development of this shallow lead, some trouble was experienced during the winter months through water rising in the workings. It was found that by putting down bore holes or wells into the clay "bottom," the water immediately drained to some lower porous stratum. This proves that the clay "bottom" beneath the stanniferous wash is not the true "bottom" of the alluvial material, and where deeper alluvium exists beneath a known stanniferous wash there is every chance of other payable "leads" existing at greater depth in the deposits. That such "leads," if they exist, are likely to be of high grade is suggested by the highly profitable nature of the shallow wash already worked.

On the East Phoenix, M.L. 571, and the ground adjacent thereto, known as the Three C's, extensive but shallow dredging operations have been carried out at a profit. An inspection of the excavations shows that what has been taken as "bottom" is not the true base of the alluvial material, and that other alluvial beds with possible stanniferous "leads" may exist at greater depth.

Referring to the locality of the Three C's Woodward says\*: "The head of this gully consists of a large water-logged sandy flat, called the Three C's after the original holders of the lease, Messrs. Cowan, Castella, and Clark. In this flat, tin in small quantities occurs in the sand from the surface downwards, it appears to be of lacustrine origin, having been deposited at a subsequent period to that at which the "deep lead" crossed this area as an open valley, and prior to the cutting out of the present deep channel of Cowan's Brook."

The next locality visited was the vicinity of the old Hard Graft Leases, where a deposit of deep alluvial ground (Elliot's "Lead") has been extensively worked, extending westwards from the old Bunbury Lease at the lower end of Bunbury Gully. At the time of my inspection all the workings on this run were inaccessible. The following extract from Mr. Montgomery's report† is of interest.

\* Bulletin 32, page 65.

† Notes upon the Greenbushes Tinflds, A. Montgomery, M.A., F.G.S., State Mining Engineer. W.A. Dept. of Mines, Ann. Report, 1908.

The Bunbury Gully has been shallow ground all the way down, and has been pretty well worked out; but at the lower end there is a deposit of deep alluvial ground, through the Hard Graft and adjoining claims, which appears to belong to an entirely older set of alluvial deposits, and to be part of a "deep lead." In this the "wash" is composed of large well-rounded boulders, and the tin ore is much rounded and water-worn. Some of it is cemented with oxide of iron and requires crushing. I had no time to more than look over the dumps of a few of the claims in this part of the field, but the evidence of a "deep lead" was very obvious. It seemed to run across the course of the present valley, towards the Battler's Hope, and prospecting along this line seems very desirable.

On its south bank Elliot's "Lead" is very shallow, but attains a depth of sixty feet on the Hard Graft Lease. In other places the "lead" is much shallower, the average depth being about twenty feet. The deeper ground appears to represent holes beneath the general level of the "lead," and it is in these holes that the richer tin deposits seem to occur. This feature is said to have been noticeable also in other "leads" on the field.

At the western end of Elliot's "Lead" the stanniferous wash ended suddenly against a bank. This bank coincides with a low southerly pointing spur at the surface and probably represents a sudden bend in the old watercourse.

When this bank was struck, further prospecting on the south side led to the discovery of tin bearing wash at a shallow depth under an extensive sandy flat, known as Poverty Flat.

Poverty Flat has been the scene of profitable dredging operations, but the ground has only been worked to a shallow depth; the bottom of the excavation is obviously not on bedrock, and as the present "bottom" carried tin, if a deeper run exists it may prove to be very rich. The logical position in which to seek a continuation of Elliot's "Lead," which has contributed so richly in the past, is beneath Poverty Flat, where it would seem to have been diverted in a southerly direction after striking the bank mentioned above.

A very brief inspection was finally made of a "lead" running southwards from the old Glasgow Lease at the western end of the town across the main road, and in a southerly direction through the old Mt. Pleasant Lease to the head of Spring Gully.

Bedrock appears to have been reached on the Glasgow and the leases immediately adjoining, but an inspection of excavations on the leases to the south of the main road makes it appear doubtful if bedrock has been truly reached in this locality. A few judiciously located bores would serve to verify this point.

#### *Conclusions and Recommendations.*

The present investigation can in no way be considered complete for the Greenbushes Tinfield or even for the special localities examined. My inspection was confined wholly to a few of the places where mining operations suggested that undevel-

oped "deep leads" might exist, and the testing of which would involve the minimum of time and expense.

Mining operations have proved the existence of a "deep lead" in Elliot's Gully. This "lead" comes against a bank to the west of the Hard Graft Lease and then appears to turn sharply southwards beneath Poverty Flat. From this point it probably turns again and follows a north-westerly course beneath the Three C's and the East Phoenix Lease to the Battler's Hope Lease at the head of Moulton's Brook (Battler's Gully), at which point it has been picked up in the two deep shafts.

A second "deep lead" may exist, running from the rich ground on the north side of Spring Gully south-easterly through Paper Bark Swamp, and joining up with the first "lead" under the sandy flat in the vicinity of the Battler's Hope.

Below their junction the two "leads" probably run westward on the north side of Moulton Brook as shown on the map accompanying Bulletin 32.

The most certain and economical method of proving the existence of "deep leads" is by a series of hand bores put down to bedrock in a systematic manner.

The deep shaft on the Battler's Hope Lease would appear to be on the south side of and close to the "gutter" of a "deep lead." The position of this "gutter" should be fixed by a line of closely spaced bores in a northerly direction from the shaft; and, on the position of the "gutter" being defined, its length and possible value should be proved by other lines of bores put down across the supposed position of the "lead" at the surface.

Other lines of bores should be put down across the supposed position of the "deep lead" at Paper Bark Swamp, the East Phoenix Lease, and on Poverty Flat, with the object of prospecting the "deep lead" in these localities.

The fact that in all these localities tin has been recovered at a profit from the shallow ground suggests that the "deep lead," if it exists, should carry valuable tin deposits.

The location of the sites for the bore holes would of necessity have to be made on the ground, and it is essential, if boring is to be carried out, for a man with practical experience in sampling tin prospects to be present to collect samples for assay, and properly to record the results of the boring.

The greatest depth to which boring would be necessary would be little over one hundred feet, while the great majority of the holes would be much shallower, probably not more than 50-60 feet. The total number of holes to be put down can hardly be judged, but as the work proceeded and the shape and direction of the "lead" became known, fewer bores would be needed than in the earlier stages. The definition of the "gutter" of the "lead" in the four localities mentioned above would probably involve the sinking of from 20 to 30 holes, varying in depth from 60 to 100 feet.



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