# A. G. & G. S. OF N. A.

# REPORT

(Queensland No. 5).

## GEOPHYSICAL REPORT ON THE TREKELANO AREA, CLONCURRY DISTRICT.

1182.

By Authority: L. F. Johnston, Commonwealth Government Printer, Canberra.

# THE AERIAL, GEOLOGICAL AND GEOPHYSICAL SURVEY OF NORTHERN AUSTRALIA.

## GEOPHYSICAL SURVEY AT TREKELANO, NEAR DUCHESS, CLONCURRY DISTRICT, QUEENSLAND.

## TABLE OF CONTENTS.



1182.

TABLE OF CONTENTS—*continued*.

## PLATES.

# GEOPHYSICAL SURVEY AT TREKELANO,

## NEAR DUCHESS, QUEENSLAND.

### I. INTRODUCTION.

The geophysical survey was carried out in the vicinity of the Trekelano mine which is situated 10 miles south-east of Duchess, and about 80 miles south-west of Cloncurry, in the north-western portion of Queensland. This mine is at present the main supplier of sulphide ore to the Chillagoe State Smelters. The ore, which contains approximately 10 to 13 per cent. copper and $1\frac{1}{2}$ dwts. gold per ton, is of particular value to the Smelters owing to the increasing amount of siliceous ores from other sources now being treated.

The mine lies in an extensive plain which is well soiled and contains a limited number of outcrops. Since other copper-gold occurrences are known some miles both to the south and to the north of the Trekelano mine, there appeared to be a reasonable chance that in the intervening areas other bodies might lie hidden beneath the plain. Thus the area was considered to be well suited to geophysical methods of prospecting.

A geological survey was made concurrently with the geophysical survey. A report and map were prepared by Mr. E. O. Rayner, under the direct supervision of the Executive Officer, and are included in this report.

The geophysical survey was carried out under contract by the Electrical Prospecting Company of Sweden, who supplied the technical equipment and the services of Mr. S. Horvath as field superviser. The Survey supplied the staff of geophysicists (Mr. R. Thyer, party leader) and assistants, and the facilities for surveying, transport and accommodation.

A report on the geophysical survey and the results thereof was submitted by the Electrical Prospecting Company of Sweden, per Mr. Horvath. It was edited to conform to the general form of report required, but without alteration of sense, and is presented herewith.

In accordance with the results of the survey a programme of preliminary testing is being carried out.

### II. GEOLOGY.

#### A. Introduction.

Geological maps were prepared to cover the four electro-magnetic layouts of the Trekelano geophysical survey, but have been combined as one (*see* plate 1). Layouts 1, 2 and 3 adjoin one another, and include the Trekelano leases, the mine being situated on a wide soil plain which covers portions of the three layouts. Layout 4 is situated about 6 miles south of Trekelano mine, its northern end being about a mile south of Maiden Creek. The last-mentioned layout includes a number of leases, all now forfeited, and is accessible from Trekelano by a track crossing the Pilgrim and Maiden Creeks.

Owing to the large area without outcrops, the form of mapping adopted is one which shows, in addition to actual outcrops, areas where the probable nature of the underlying rock has been inferred from soil, fragments, exposures in potholes, &c. It seems evident that the soil mantle over the plain areas is chiefly derived by weathering of the underlying rocks, and is not transported alluvium.

#### B. General Geology.

The predominant rock types of the Trekelano area are schist and granite, the latter intrusive and inducing contact metamorphism in the schists. In the altered margins a graduation of types is found in both the intrusive and invaded rocks.

The granite itself exhibits a succession of phases from fine-grained pink aplitic types to coarse-textured pegmatites. The pegmatite veins are probably the youngest phase of the intrusion, and are generally found marginal to the granite and within the schist belts. A single pegmatite vein may vary considerably over its length, being in places almost pure orthoclase felspar, elsewhere highly quartzose. This is particularly the case for the injections in the eastern part of layout 2. It is probable that the granite batholith extends under the schist, as it is found outcropping in all directions ; but the irregular nature of its roof is emphasized by the fact that the present deepest level of the mine, namely 700 feet, is still in schist, although granite outcrops not far to the east, as shown by the map.

Further notes on the geology are included hereunder, each layout being dealt with separately. The general statements in regard to composition, texture, &c., mentioned under layout 1 apply also to layouts 2 and 3, unless otherwise stated. Owing to its remoteness from the other layouts, layout 4 is described separately.

1182.—2

(1) *Layout* 1.

Layout 1 covers traverses from 3,200 north to 2,400 south, the traverses extending 410 meters east and west of the baseline. The layout includes the present Trekelano leases, namely, M.L. 3,582 ("Trekelano") and M.L. 3,580 ("Trekelano No. 2"). The Trekelano mine lies towards the northern end of a wide plain covered by soil and rock fragments. As shown on the map, the major portion of this flat is schist country, as evidenced by slight outcrops, surface fragments, and exposures in mine workings and prospecting holes.

The schist is a hornblende-biotite variety, the biotite content having a large range in different parts of the field. Thus the schist in the vicinity of the granite contact, as revealed in the trenches between 100 north and 550 north, is biotite-rich in comparison with the schist in the mine.

The country rock of the Trekelano lode is a hornblende-biotite schist, the lode formation occurring within the schist and being about 40 feet wide (as seen in the large open cut). The lode formation carries pink and white calcite and hornblende, the chief copper ore minerals being chalcopyrite in the sulphide zone, and malachite, chalcocite, and chrysocolla in the oxidized zone. There is a good deal of surface silicification in this region, and chrysocolla is a common development in mineralized zones. The shafts to the north of the mine, on M.L. 3,580, are also sunk on a formation in biotite-hornblende schist carrying malachite and chrysocolla.

The schist exposures are not as numerous as those of granite, and the main schist zones occur under a thick soil mantle. The mine is covered by heavy overburden, and the ore-body was discovered by floaters in the soil.

Below the subsoil, as shown by the trenches, the upper zone of schist is extremely weathered to a greyish micaceous schist, with altered hornblende, limonite, kaolin, &c. The trenches on layout 1 show a light green mineral which is probably chloropal, the hydrous silicate of iron. The same mineral was also seen in the lode formation exposed in the southern cliff of the open cut. The chloropal is probably the result of surface silicification and not necessarily of mineralization, though it is common in the outcrops of lode and is probably formed under similar conditions to those of chrysocolla.

Granite outcrops strongly in the north-western corner of the layout, forming high hills. Outcrops of granite are again met with along the entire length of the eastern portion, and in the centre of the layout. The normal granite, as typically exposed in the creeks to the east of the layout and the hills to the north, is a medium even-grained variety with orthoclase, quartz and hornblende the predominant minerals. There are all graduations from fine-grained aplite and chilled margin varieties to extremely coarse pegmatites. A special marginal type is found in a zone to the immediate east of the trenches 100 north to 550 north, where the rock consists almost entirely of hornblende and orthoclase, the former usually with a well-formed crystal habit. In places, but more particularly on layouts 2 and 3 to the west, the granite exhibits a fine banded structure.

Probably the most interesting development of the granite intrusion are the pegmatites, which occur in long narrow dykes of late magmatic origin. A prominent outcrop of pegmatite extends from 550 north to 1,385 north, in the vicinity of 260 east, situated within the schist zone. Further pegmatitic crops or lines of boulders are met with to the east and at the extreme southern end of the layout. The texture of the pegmatites is very coarse, the chief minerals pink orthoclase and quartz with hornblende in places. The orthoclase frequently is developed to the exclusion of the other minerals. A feature of some of the outcrops is the graphic intergrowth between felspar and quartz.

Ilmenite is commonly developed within the granite, more particularly in the contact metamorphic zones, where it is frequently found as large pebbles on the surface. In connexion with the geophysical work it is possible that the presence of this mineral has some significance in the magnetic results.

A prominent band of muscovite schist is developed within the granite, outcropping strongly at 1,600 south, 500 east. Quartz veins, probably late magmatic, are found in the extreme east of 1,400 south and 1,800 south. Patches of dark rock with intermediate composition are occasionally found in the granite, probably representing relatively basic segregations.

(2) *Layout* 2.

Layout 2 extends as a southern continuation of layout 1, from 2,400 south–8,900 south. The main schist zones are situated centrally but narrow to the south where granite outcrops become more prominent and numerous both to the east and west. Pegmatite veins are more common in the north-east sector than elsewhere, extending from layout 1. A prominent ridge of quartz outcrops from 3,200 south, 450 east–2,600 south, 500 east; but is co-linear with and represents the continuation of a vein of orthoclase pegmatite to the immediate south. A prominent ridge of granite occupies the south-western portion of the layout, and associated with it are several narrow bands of muscovite schist, parallel to the trend lines of the granite.

The schist is hornblende-biotite schist, as on layout 1, showing in numerous fragments at the surface, as for example at the roadside on 5,900 south. South of this place, from the creek on 6,100 south to the base line at 6,900 south, the schist is characterized by the presence of epidote. The latter appears to be a development of the exomorphic zone, and is not found in the igneous contact zone.

In the central northern portion of the layout, a narrow belt of schist extends from 4,550 south–2,400 south, east of the base line, and, adjacent to the schist, a long line of pegmatite boulders marks the site of a fissure. Granite outcrops are strong along the course of the creek from 6,500 south–8,900 south.

(3) *Layout* 3.

Layout 3 adjoins layouts 1 and 2 on the west, overlapping the other layouts by 40 metres, and extending from 3,200 north–4,000 south, and from 150 west–950 west.

Granite outcrops strongly in the north-eastern corner, forming the hills referred to under layout 1. Another prominent granite area forms a ridge in the west-central portion with isolated exposures in the central-eastern and north-western portions. Prominent outcrops are found within the limits 4,000 south (700 west–350 west), and 2,800 south. This area is occupied by outcrops of granite, and particularly marginal types with schist inclusions in the northern part. In this vicinity the granite is surrounded by a wide contact aureole, while within the granite mass occur pegmatite veins curving with the trends of the granite structure.

In the extreme north-western corner, between 3,000 north and 3,200 north and 700 west–950 west, there are a number of small outcrops of hard schist, striking a little west of north, and associated with these are several pegmatite veins. Several small potholes in the vicinity reveal biotite schist on the dump, with malachite staining. Epidotization has occurred to a slight extent in this northern portion.

The shafts between 2,000 north and 1,385 north are all infilled, with the exception of that on 1,385 north, which has a depth of 25 feet. This is sunk on biotite-hornblende schist formation carrying small quantities of malachite and chrysocolla. The dump reveals also fragments of dark rock with large and well developed hornblendes. The adjacent infilled shafts show weathered schist on the dump. The small potholes at approximately 1,600 north, 680 west appear to be in hornblende rock within granite country, and show traces of chrysocolla.

(4) *Layout* 4.

Layout 4 is situated about 6 miles south of the Trekelano mine, from which it is accessible by a road crossing Pilgrim and Maiden Creeks. It covers a number of now forfeited leases, namely :—Little Bernie (M.L. 1077), Everton (M.L. 1078), Everton South (M.L. 1079), and Hawk (M.L. 1091) in the northern and Pershore (M.L. 1080) in the southern portion. Mining work on the area consists of several shafts and potholes which are now infilled.

Owing to the scarcity of outcrops, and the thick blanket of soil over most of the area, difficulty was experienced in mapping this region, some of the soil regions being quite indefinite and swampy at the time of visit following heavy rains. The delineation of the boundaries of the various rocks cannot therefore be regarded as being as accurate as on the other three layouts.

The layout consists almost exclusively of schists which vary in composition from a dense hornblende schist to an intensely foliated muscovite schist. Quartz veins are abundant, and several boulders of pegmatite, orthoclase and quartz bearing, occur in association. In addition, granite outcrops on all sides of the layout, and it is thought that the area represents a roof pendant, probably not of great thickness, above the granite batholith.

Hornblende schist is the predominant rock type, and probably covers most of the eastern and western extremities of the layout. Centrally, however, there is developed a very definite zone of mica schist, ranging from an intense muscovite schist to a quartz-mica schist at the northern end.

The shaft on the Pershore lease has been infilled, the dump showing mica schist with malachite and chrysocolla, and has been sunk approximately near the boundary of hornblende schists and muscovite schists. The old shaft dump at 800 south, 480 east shows the country rock to be hornblende schist, with mineralization in the form of malachite and chrysocolla in small quantities. The shaft on Little Bernie shows malachite and chrysocolla in a siliceous iron-stained matrix.

## III. REPORT OF THE ELECTRICAL PROSPECTING COMPANY OF SWEDEN.

### A. Analysis of Operations

The party consisted of R. F. Thyer, B.Sc., as party leader, and B. P. Oakes, B.Sc., B.E., as trainee geophysicist, while C. A. Jarman, B.Sc., applied geophysicist, was with the party till 30th September, 1935, when he left to join another party at Dobbyn. The number of field assistants varied between four and five.

The party started at Trekelano on the 9th July, with the erection of camp, transport, &c., and commenced the geo-electric work on the 16th July. The survey was continued under Mr. Thyer as party leader till 13th December, when the electro-magnetic work was finished. Mr. Oakes continued, however, with potential work until Christmas. Determination of the specific electric resistivity of soil and rocks in trenches as well as in the mine was started by Messrs. Oakes and Dickinson on the 21st January, 1936, and continued until the 8th February, 1936.

Four large electro-magnetic layouts were surveyed with nearly 300,000 feet of traverses and 9,230 observation points, the area covered being 1,571 acres. The following table shows the distribution of the work carried out on the four layouts :—

| Layout. | Area. | Number of Traverses. | Length of Traverses. | Number of Observation Points. |
|---|---|---|---|---|
| | Acres. | | Feet. | |
| 1 .. .. .. .. .. | 337 | 29 | 75,800 | 2,300 |
| 2 .. .. .. .. .. | 392 | 34 | 89,000 | 2,720 |
| 3 .. .. .. .. .. | 434 | 32 | 68,000 | 2,090 |
| 4 .. .. .. .. .. | 408 | 31 | 63,000 | 2,120 |
| Total .. .. .. | 1,571 | 126 | 295,800 | 9,230 |

Layouts 1, 2 and 3 covered the neighbourhood of the Trekelano mine, while layout 4 was about 6 miles to the south of the mine, and included some old and abandoned mining leases (*see* B. (4) above).

The four layouts are shown on plate 1 on a scale of 400 feet to 1 inch, and include both abandoned and existing leases. The relative positions of the four layouts are given in the inset on plate 1.

## B. The Nature of the Problem.

The general geology of the area covered by the geophysical survey has already been described in detail (p. 2) and the geological map is shown on plate 1. It is proposed to refer here only to those geological features which are of special significance to the application of the geophysical methods. The Trekelano district consists essentially of schistose rocks intruded extensively by granite rocks, the schist belts appearing as roof pendants to the granite batholith. The Trekelano ore-body occurs in one of the widest belts of schist. The main ore-body is lenticular in shape, being 300 feet long and 40 feet wide. It has a general strike slightly west of north and dips to the west at 60°. The gangue consists essentially of pink calcite. In the primary zone the chief mineral is chalcopyrite, but in the oxidized zone chalcocite, malachite and chrysocolla were present. The depth of the oxidation zone was approximately 100 feet and sulphides appear at that depth. The mine has now reached a depth of 700 feet and no decrease in size or grade of the ore-body is apparent. In fact, the junction with a similar ore-body at depth has increased the amount of ore obtainable from mining operations.

If there were other ore-bodies of a similar nature in the surrounding district, there appeared to be a reasonable possibility of detecting the presence of sulphides directly by the electro-magnetic method and also of locating the presence of oxidizing sulphides by the self-potential method.

Pieces of ilmenite have been found, usually in the vicinity of the contact zone of the granite intrusions, and have apparently been shed from veins in the bedrock. It was thought that this would have a bearing on the interpretation of the magnetometer surveys.

## C. Methods Used.

Details of the methods used are given elsewhere.* The geophysical survey at Trekelano depended primarily on electro-magnetic methods of prospecting. While the Turam method was used to a slight extent, the greater part of the surveys was carried out with the Compensator equipment. Other methods—Racom, self-potential and magnetic—were used to supplement the above.

### (1) *Compensator.*

Using this method, the in-phase and out-of-phase components of both the horizontal and vertical electro-magnetic fields were measured.

The components used in the interpretation were selected according to the ground conductivity conditions.

* *See* report entitled "The Geophysical Methods of the Electrical Prospecting Company of Sweden used in the Aerial, Geological and Geophysical Survey of Northern Australia."

(2) *Turam.*

Whereas the Compensator can be used to greatest advantage where it is desired to compare profiles, rapid relative determinations of the electro-magnetic field can be made with the Turam method.

This method was used only to a slight extent, viz., on layout 2, since the advantages of this method compared with the Compensator method, are not so apparent on open flat country.

(3) *Racom.*

This method, on account of its slower speed, was used only to a limited extent to check the electro-magnetic work in a number of places.

It is difficult to make a good earth contact in an area such as Trekelano. It was, however, found with the new Racom that readings were possible even with the poor grounding of the potential electrodes.

(4) *Self-Potential Method.*

This method by which an oxidizing sulphide body can be detected was applied to check indications obtained by the electro-magnetic method.

The self-potentials show a pronounced negative centre of approximately 70 millivolts over the lode, but elsewhere much smaller values were obtained. It must be remarked, however, that the lowering of the ground water level in the mine exposes a large sulphide body to oxidation and tends, therefore, to increase the size of the indication. It is to be expected that in new areas where the ground water has not been lowered, the indications of a similar but unworked ore-body would be smaller.

(5) *Magnetic.*

Since it is always desirable to make a survey dependant upon more than one physical property of the rocks, a magnetic survey was started on the area. The electric methods are based upon the specific electric resistivity of the rocks in the surveyed area, while the variations of the Magnetic Vertical Intensity depend upon the magnetic susceptibility of the rocks, which is a function of their content of highly magnetic minerals such as magnetite, ilmenite, pyrrhotite, &c. No relation between the geological and magnetic profiles could be found. The difficulties in arriving at a correlation between the magnetic profiles and the geological section arise from the following :—

(*a*) The susceptibility of the schist probably varies with the amount of weathering and biotite content.

(*b*) The susceptibility of the granite is not uniform, due to the varying content of ilmenite.

(*c*) Position of the geological boundaries cannot always be accurately determined.

On layout 1 a Watts Vertical Balance No. 15,977 was used, and several profiles on layout 2 were surveyed with the Askania Balance No. 92,957.

D. Resistivity Determinations.

It was considered desirable to obtain information about the absolute values of the specific resistivity of the different rocks in the field.

For the resistivity determinations a Megger Ground Resistance Tester was used.

All resistivity values are calculated in ohm cm., and the line for 1,000 ohm cms. is drawn on each resistivity profile for reference, as this allows a quick comparison of the resistivities obtained in the different places. Logarithmic scale is used for plotting the resistivity values. A number of profiles with the results of the resistivity determinations are shown on plates 2, 4 and 6.

Attention is drawn to the profiles containing the results of resistivity determinations on the 700 feet level in the mine and in the open cut respectively. It will be noted that the difference in the resistivities between the lode and country rock is far more pronounced on the 700 feet level than in the open cut, both profiles being drawn to the same scale on plate 2. The very low resistance values of 35 ohm cms. prove the lode a good conductor. Some intermediate values were taken close to the lode on the foot wall side from a place where slight mineralization still occurs. The resistivity values in the hanging wall side (800 ohm cms.) are not as high as in the foot wall proper, where the values exceed 8,000 ohm cms. ; these last determinations were made in the crosscut between the shaft and the lode.

Resistivity determinations were also made through the big southern open cut across the main ore channel. The resistance values are higher than underground (approximately 1,000 ohm cms.), and the ore-body cannot be noticed on this profile, which is rather irregular but shows no minimum over the ore. The reason for this is that silicification plays an important part in the surface weathering of the lode. Resistivity determinations on the surface might not therefore reveal the lode.

Several resistivity determinations were made over rock out-crops and gave the values shown in the table below.—

TABLE OF RESISTIVITIES.

| Type of Rock. | Location. | Ohm Cms. |
|---|---|---|
| Granite .. .. .. .. .. | Layout 1, Prof. 2,600 north/0 .. .. | 16,500 |
| Granite .. .. .. .. .. | Layout 2, Prof. 3,800 south/450 east .. | 7,000 |
| Granite .. .. .. .. .. | Layout 3, Prof. 6,700 south .. .. | 10,000–20,000 |
| Granite with overburden .. .. .. | Layout 1, Prof. 550 north, east of trench .. | 5,000–6,000 |
| Contact metamorphic zone on granite-schist contact | Layout 1, trench 350 north .. .. | 1,500–2,600 |
| Contact metamorphic zone on granite-schist contact | Layout 1, trench 100 north .. .. | 800–1,100 |
| Biotite schist .. .. .. .. | Layout 1, Prof. 100 north/410 east .. .. | 1,200–1,600 |
| Biotite schist without overburden .. .. | Layout 1, Prof. 460 north/410 east .. .. | 2,000–3,000 |
| Biotite schist mineralized .. .. .. | Layout 1, trench 460 north .. .. | 1,000–1,500 |
| Muscovite schist .. .. .. .. .. | Layout 4, Prof. 3,200 south .. .. | 2,000–14,000 |
| Hornblende schist .. .. .. .. | Layout 1, Prof. 0/100 west, 100 east .. | 800–2,000 |
| Hornblende schist .. .. .. .. | Layout 4, Prof. 3,200 south .. .. | 700–2,000 |
| Hornblende schist—with mineralized overburden | Near open cut .. .. .. .. .. | 400–1,400 |
| Ore (oxides and carbonates) .. .. .. | Open cut (partly silicified) .. .. .. | 700–1,100 |
| Lode formation .. .. .. .. .. | Trench 510 north/425 east .. .. .. | 800–1,200 |
| *Underground.* | | |
| Hornblende schist .. .. .. .. | 700 feet level, hanging wall .. .. | 800 |
| Hornblende schist .. .. .. .. | 700 feet level, foot wall (silicified) .. .. | 8,000 |
| Sulphide ore .. .. .. .. .. | 700 feet level .. .. .. .. | 35 |

The resistivity values show the granite as a rather poor conductor, but the conductivity increases in the zone of contact metamorphism. The resistivity values for the schists show a considerable range, some of the values being extremely low. The determinations offered little hope of distinguishing between the different types of schist. A muscovity schist with high resistivity values was found on layout 4.

Resistivity determinations with increasing electrode spacing were also made with the object of trying whether the thickness of overburden could be determined. The results, however, were not satisfactory, probably due to the fact that the change from overburden to country rock is not a sharp one, the uppermost portion of the country rock being considerably weathered.

## E. Tests made over the Trekelano Ore-Body.

Plate 2 illustrates the results obtained over the Trekelano ore-body.

### (1) *Electro-Magnetic.*

To see whether an electric indication could be obtained over the known Trekelano ore-body the first electro-magnetic profile 0 was laid across the old stopes between the two open cuts south of the main shaft.

The greater part of the ore-shoots down to 600 feet has already been worked out, but in spite of this the indications obtained were quite distinct. Plate 2 shows all four components of the electro-magnetic field—the in-phase or real and the out-of-phase or imaginary horizontal components, and the real and imaginary vertical components.

The outcrop of the lode can be seen in the open cut, and its projection is plotted against the profile 0 lying between the open cuts.

The arrows show the position on the profiles of the indications for all four electro-magnetic components. It will be noticed that the indication coincides quite well with the lode, except that it is offset about 40 feet to the west of the outcrop. This is due to the westerly dip of the lode and to the fact that the indication arises from an appreciable depth. The oxidized part of the lode shows a less pronounced difference in electric conductivity from the country rock than does the zone of sulphides. Oxidation has a strong influence on the electrical conditions in the lode, as malachite and especially chrysocolla are rather poor conductors. The differences in the electric conductivity are usually more pronounced under the ground water level than above it.

The influence of the good conductor is appreciable over a considerable distance, the total width of this influence being nearly 600 feet. The intensity of the indication reaches nearly 3 microgauss in the horizontal component and nearly 4 in the vertical component. At several other places on the layouts the intensities of the indications exceeded those over the known ore-body, but the size of an indication depends upon several factors, such as the distance of the good conductor from the cable, its length, the ratio of its conductivity to that of the country rock, and finally the depth of the good conductor beneath the surface.

The intensity of the indications decreases with increasing distance from the cable line, with increasing depth of the good conductor. The width of the indication increases with increasing depth of the conductive zone, which will give a strong indication if close to the surface, but a wider indication, but of less intensity, at greater depth.

(2) *Racom.*

The potential gradients computed from the potential ratios with 20 metre electrode spacing showed a distinct indication of a good conductor at 10 west, nearly coinciding with the electro-magnetic indication as well as the position of the lode (*see* plate 2).

(3) *Self-Potential.*

As already mentioned above (p. 7), the self-potential caused by the oxidation of the sulphide ore-body was measured and showed a negative centre of about—70 millivolts over the lode.

(4) *Magnetic.*

The magnetic vertical intensities show also a pronounced change from a maximum at about 60 east (2,900 $\gamma$) to a minimum at 60 west (400 $\gamma$). The high intensities east of the lode continue to about 150 east. They must be caused by a wide body with higher magnetic susceptibility, and the geological map shows schists where the high magnetic intensities are found. It might be that the " high " corresponds to a special schist—the exposures are too rare and too poor to distinguish between the schists—but following to the north the magnetic " high " corresponds to some granite outcrops (prof. 1,000 north/0, 1,200 north/0, 1,385 north/20 east), and it might therefore be inferred that a granite batholith not exposed is the source of the " high ". As previously mentioned, the magnetic material in the granite is the ilmenite. The ilmenite probably belongs to the later phase of the granite intrusions, so that it is assumed as a working hypothesis that the magnetic " high " is a favorable indication, owing to its association with the probable ore carrier.

(5) *Summary.*

Summarizing the results obtained over the lode with the different methods, it is seen that the electro-magnetic methods and potential gradients show the ore-body to be a good conductor, which agrees with the resistivity measurements taken in the mine and open cut. The self-potential method shows a negative centre—again in agreement with theoretica considerations—and the magnetic profile shows a magnetic " high " not far from the lode.

## F. Results.

The final results of the geophysical surveys are shown on numerous maps, profiles, &c. A large number of such maps, &c., were prepared but only a limited number of these are presented with this report. These, however, show the essential results of the work.

(1) *Layout* 1.

The results of layout 1 are shown on plates 3 and 4, plate 3 showing the contour lines of the imaginary horizontal component, and plate 4 showing typical profiles resulting from the methods used.

(*a*) *Extension of the Trekelano Ore-body.*—The extent of the influence of the ore-body can be seen to advantage on the profiles close to 0. The next profile to the south is 350 south. The horizontal component shows a less pronounced anomaly at about 60 east, but the area of the direct southern extension of the lode is practically undisturbed. The same results are shown in the potential gradients on 350 south. The well pronounced indication from profile 0/10 west has disappeared. The profiles 350 south and 350 north also show a marked decrease in the strength of the self-potential, and the profiles 600 south and 600 north show practically no signs of the self-potentials originating from the electro-chemical activity accompanying the oxidation of the copper ores. The strongest anomaly is on profile 0, and the negative centre corresponds closely to the position of the ore-body, while the other profiles show that the centre of electro-chemical activity does not extend either to the north or south. The magnetic profile 350 south on the other hand, shows, as a change from 0, a move of the " high " to the east, the maximum being between 100 east and 150 east.

Thus there is a suggestion that the lode does not extend to 350 south, but on acconnt of the anomaly at 350 south–60 east and the displaced magnetic " high ", it might be inferred that some mineralization exists east of the known channel but at a greater depth. A horizontal borehole from the lower levels on the southern end of the mine towards the south-east would test that area.

The profiles further to the south, 800 south–1,200 south and so on, show no marked electric anomaly in the portion where the extension of the ore-body could be expected ; this is the case for the electro-magnetic profiles as well as for the potential gradients. The self-potential profiles in this area are practically undisturbed.

The magnetic " high " continued due south to at least 1,200 south without major changes in character.

(*b*) *Indication* 1,600 *south,* 85 *west*–2,400 *south,* 140 *west.*—At the profile 1,600 south–90 west–120 west, another electric anomaly (a weak one) commences and continues towards the south, but being enclosed throughout in schist, the indication should be noted, even though it is not strong. It continued to profile 2,400 south on layout 1 and continues on to layout 3, especially in the real components. The direction of this indication is towards the south-west.

From profile 0 to the north the indication from the ore-body is very well pronounced on profile 100 north, weak on 350 north, well pronounced on 550 north, and becomes quite weak on 800 north and 1,000 north. The results here were discussed with Mr. Shepherd, Geologist of the Queensland Geological Survey, who thought that the indication on 550 north corresponds with an ore-shoot that had been worked only on the deep levels, but was overlooked on the upper levels.

(*c*) *Indication* 2,000 *north,* 150 *east*–3,000 *north,* 185 *east.*—A strongly developed indication can be noticed between 1,600 north, 150 east–2,600 north, 145 east where it bends towards the east and continues on 2,800 north, 160 east, 3,000 north–185 east, and 3,200 north–215 east. The maximum of the indication is between 2,400 north and 3,000 north. The indication coincides with an ore-body that had been prospected by two shafts from which some good ore has been sent. The self-potential profiles show an anomaly starting on profile 1,200 north with a very weak deviation and increasing in size to the north. The best indication appears on profile 2,600 north, with a negative potential of about 20 millivolts between 150 east and 160 east. The negative centre obtained with the self-potential method coincides with the electro-magnetic indication in this point, but whereas the strongest electro-magnetic indication was obtained on profile 2,400 north–145 east the strongest anomaly with the self-potential method was obtained at 2,600 north between 150 east and 160 east. The negative values of the self-potentials continue eastwards somewhat further than should be expected from the electro-magnetic results, and even show a second weak negative anomaly at 2,800 north–240 east.

The contour lines of the imaginary horizontal component show sharp bends between 1,800 north and 2,200 north. This is assumed to be due to the north-westerly continuation of the fault which is used to explain a similar abrupt change in direction of the contour lines at 1,200 north on indication (*e*) (*see* page 18).

(*d*) *Indication* 800 *north*–290 *east to* 1,000 *north*–320 *east.*—A short indication, rather well pronounced in the imaginary component but not so well in the real component, is found at 800 north–1,000 north near 300 east. A resistance profile laid across the maximum of the indication gave values from 1,200 to 1,500 ohm cms.

(*e*) *Indication* 400 *east, profiles* 1,800 *north*–1,000 *south.*—A strong indication was obtained in the eastern part of the layout. The indication extends from 1,800 north near 400 east–1,000 south–380 east, with the maximum between 800 north and 0. The width and strength of the indication is well pronounced, and suggests that it is not confined to the surface. The indication, being quite clear, was selected as the first one to be tested. As a westerly dip was assumed and the indication comes from a certain depth, the trenches were sited to the east of the maximum of the indication.

The self-potential method showed nothing on profiles 0 and 350 north except a small deviation at 350 north–430 east, but further north on the same electro-magnetic indication there appears a slightly better pronounced negative anomaly of about 15 millivolts.

The results of the electro-magnetic method and the self-potential method differ in this part in so far as the electro-magnetic indication has its maximum between 350 north and 100 north, while a weak negative potential obtained with the self-potential method lies between 1,200 north and 1,385 north.

On the magnetic profiles a change can be noticed similar to the one crossing the lode, with a maximum in the east and a minimum in the west of the electric indication.

A number of resistivity measurements were made in and alongside the trenches. Generally 6 feet spacing was used for the observations. The resistivity profiles (profile 550 north is illustrated on plate 4) show clearly the sharp minima on the traverses 350 north and 550 north (600–1,000 ohm cms.) while on 100 north the minimum is wider but less pronounced. It was noticed that on 510 north the minimum does not correspond to the lode formation but is slightly west of it, the same relationship having been noticed in the Trekelano open cut (the ore close to the surface does not show very low resistivity values due to silicification). For the reason that the ore in the oxidized zone is not so good a conductor as that deeper down, it is inferred that the source of the indication might be below ground water level. The ore-shoots in the Trekelano mine pitch to the south. If by analogy with the ore-shoots in the Trekelano mine other ore-shoots in the area have a southerly pitch, then the part closest to the surface could be expected slightly north of the maximum of the indication.

Plate 4 shows marked displacements of the contour lines at 1,800 north going towards 1,200 north on the east side of the layout. This could be explained by an east-west fault running across. The fault was actually observed by Mr. Shepherd in the shaft between 1,200 north and 1,385 north–420 east.

(2) *Layout* 2.

Layout 2 extends southwards from layout 1 and traverse 2,400 south was surveyed in both layouts. Results are given on plates 5 and 6. Plate 5 shows the contour lines of the imaginary horizontal component. Plate 6 shows selected profiles of the imaginary vertical component, and also Turam, Racom and Self-potential profiles.

On layout 1 the general conductivity of the ground increases to the south, and this continues on layout 2. This increase is probably due to a rise in the ground water level. The rather high conductivity can be noticed from the increasing slope of the imaginary vertical component in the more southern profiles, as the values were plotted without correction for the ground conductivity.

The indications of the horizontal component become narrower and more sharply defined towards the south, mainly on account of the shallower depth of the ground water level.

The plan of the horizontal component (plate 5) shows several strongly pronounced indications. The subsequent trenching and the geological observations, however, disclosed the fact that rather narrow bands of schists are enclosed within the granite. As the resistivity profiles of 3,800 south and 7,500 south show (plate 6), the schist at the contact has a very low electric resistivity compared with that of the surrounding granite and can hardly be distinguished from a lode by electrical prospecting methods.

(*a*) *Indication* 2,000 *south*–3,400 *south*, 380 *east*.—A series of indications which started in layout 1 at about 2,000 south continues with practically unchanging character to 3,400 south, with the maximum between 360 east and 380 east. They resemble in width and strength the indications of 800 north to 0 about 400 east on layout 1. The series of indications has also been followed by measurements of the vertical component. In the imaginary vertical component a good conductor is noted by a rise from a minimum on the side close to the cable, to a maximum on the side furthest from the cable. The cable positions were 210 east for the eastern and western parts of the traverses and 400 east for the middle part (between 60 east and 300 east).

Several magnetic traverses were observed, of which those on 2,400 south and 3,800 south are shown on plate 6. They show in the eastern portion lower intensities than further north, but a relative " high " is found at 350 east–400 east on 2,400 south with a sharp drop to the east of 400 east.

(*b*) *Indication* 3,800 *south*–4,200 *south*, 300 *east*.—A narrow but strongly pronounced series of electric indications is found between 3,800 south and 4,200 south. These indications were tested with a trench at 300 east on 3,800 south. The trench revealed a schist-granite contact, the schist having very low resistivity values (600 ohm cms.). This series of indications becomes weaker to the south and finally vanishes.

(*c*) *Indication* 5,700 *south*, 300 *east*–6,500 *south*, 240 *east*.—At 5,700 south a new series of very similar character—strong, sharply defined and narrow—commences. The imaginary vertical component of this point is illustrated on plate 6. The indication, which continues to 6,500 south and afterwards becomes faint, was tested on 5,900 south and revealed the schist-granite contact, as at 3,800 south.

(*d*) *Indication* 7,500 *south*, 380 *east*–8,100 *south*, 240 *east*.—At 7,500 south a new series of the same character begins and can be followed to 8,100 south. It was tested on 7,500 south, the short trench revealing schist. The resistivity measurements alongside the trench show very clearly a narrow band of low resistivity (down to 400 ohm cms.) enclosed within high resistivity material (5,000–8,000 ohm cms.). Granite occurs to the west and schist to the east, the low resistivity corresponding to the schist-granite contact due to a slight mineralization on the contact.

(*e*) *Area east of* 300 *east*.—The area east of 300 east shows practically no electrical anomalies and is mostly granite country.

(*f*) *Indication* 2,600 *south*–3,200 *south*, 100 *east*.—In the western part of the layout a well pronounced indication is found with the maximum between 2,600 south and 3,200 south. Favorable aspects of this anomaly are the curving of the contour lines and the short length of the indication.

The magnetic vertical intensities on 2,400 south and 2,600 south show very high values to the west between 0 and 100 west.

The self-potential profiles covering the area of the indication showed only very weak and irregular deviations and cannot be regarded as giving any signs of indications coming from ore.

(*g*) *West side of layout.*—The west side of the layout shows little else of interest. Another indication is found between 6,300 south and 6,500 south, 60 east–80 east. The indication possibly corresponds to a schist-granite contact, which is situated a slight distance west of the indication.

(3) *Layout* 3.

Layout 3 lies directly west of Trekelano mine and of layout 1. The traverses were continued from layout 1, and the pegs were numbered in direct continuation. The following plates show the results of the survey :—Plate 7—Contour lines of the Real Horizontal Component ; plate 9—Real Horizontal Component profile 600 north–0 ; Real Vertical Component profiles 600 north–0 ; Imaginary Horizontal Component profiles 2,000 south–3,000 south.

No Racom, Resistivity or Magnetic work was done on layout 3, and only a few quite short traverses with the self-potential method.

The plotted values for the horizontal component are corrected in the usual way, the values for the real vertical component are corrected for a primary electro-magnetic field due to the cable. No correction was made for the general damping effect of the ground on the primary field. This latter correction, however, affects only the absolute values and slightly also the slope of the graphs, but the indications remain practically unchanged. The cable positions were at 550 west for the eastern and western parts (950 west–600 west, 500 west–150 west) and at 350 west for the middle part of the layout.

(*a*) *Indication* 4,000 *south*–1,000 *south.*—The strongest indication of the whole layout extends from profile 4,000 south between 300 west and 400 west northwards. For this indication all components are very strong. The maximum is not sharply defined on profiles 4,000 south and 3,800 south, but further north the indication becomes narrower with a well defined maximum trending through 3,600 south–358 west, 3,400 south–374 west, 3,000 south–385 west, while the profiles 3,200 south and 2,800 south show subsidiary minima superimposed on the maxima, which may indicate silicification close to the surface. It is suggested that trenches be dug on both traverses and should silicification be found, the above feature might provide an important factor in the interpretation of other anomalies.

The indication continues north-westerly to about 1,000 south and is the only indication of considerable length and size in the layout. A slight bend occurs between profiles 2,400 south and 2,600 south. The southern part of this indication is parallel to and slightly east of a schist-granite contact, but the southern part traverses a wide belt of schists.

(*b*) *Indication* 4,000 *south,* 700 *west*–2,000 *south,* 450 *west.*—Granite occurs between this indication and another at 4,000 south–700 west. The maximum of the latter series lies between 3,400 south and 2,800 south. At about 2,000 south it seems to join the major indication referred to above.

(*c*) *Indication* 3,400 *south,* 240 *west*–2,400 *south,* 160 *west.*—Another line of indications branches off from the large southern indication at about 3,400 south, and runs north towards layout 1, where it connects with an indication previously described (*see* page 16). The indication is less definite in the imaginary than in the real component, but is generally rather weak.

(*d*) *North-western part of layout.*—The indications generally are decreasing in intensity from south to north due probably to the ground water level being deeper in the north.

Some prospecting work had been done in the past in the northern part of layout 3. The indications at these places, however, are generally small and narrow, which would indicate that these prospects are probably small narrow leaders. The shafts in the north-west corner of layout 3, between 3,000 north and 3,200 north, are, however, close to an indication which is better pronounced even though a considerable distance from the cable. It is suggested that this portion (3,200 north–775 west, 3,000 north-838 west) be tested.

(*e*) *Indication* 2,400 *south,* 330 *west*–1,800 *north,* 780 *west.*—There is a long continuous line of indications on the west side of the layout and this should be tested in a few places where the indications are more intense. Such places are 350 north–815 west, 1,200 north–795 west, and 1,600 north–788 west. In addition there are a number of minor indications on layout 3.

(4) *Layout* 4.

Layout 4 is about 6 miles due south of the Trekelano mine and covers a heavily soiled plain that had been prospected only by a few shallow shafts. It would appear that the prospecting shafts were sunk where floaters were found, since no outcrops can be seen in the neighbourhood.

Layout 4 is 7,400 feet long and the traverses 2,400 feet long, and was surveyed with intervals of 30 feet between observation points. The results of the survey are shown on plates 8 and 9.

The most remarkable feature in this area is the very high ground conductivity which is far higher than that on the other three layouts. For this reason the real components have been used for the interpretation. In the north end of the layout the general ground conductivity is so high that the lines 0, 400 south and 800 south have been omitted because the results are uncertain. On the other hand, it is possible that the very high conductivity points to the presence of either saline or mineralized water. If the latter is the case, then it becomes significant in regard to the occurrence of ore, and it is interesting because floaters of copper ore gave on assay several dwt. of gold per ton.

No self-potential surveys or testing were carried out on this layout.

Except for two Racom profiles and some short resistivity profiles (one at 3,200 south over the outcrop of hornblende and muscovite schists, and the other at 400 north), the survey was carried out with the compensator. Originally the traverse spacing was 400 feet, but later some intermediate traverses were surveyed. The intermediate traverses were surveyed with the lower frequency of 300 cycles, as it was considered to be of advantage to use the latter on account of the high ground conductivity, as the depth penetration with lower frequencies is better.

(*a*) *Indication* 7,000 *south*, 630 *west*–3,600 *south*, 390 *west*.—The most southern profiles covered the Pershore lease on which a small prospecting shaft had been sunk. The shaft is approximately 80 feet east of a very well pronounced indication which extends from 7,000 south, 630 west–5,800 south, 520 west, with a maximum of over 7.0 microgauss between 7,000 south and 6,400 south. The shaft is almost opposite the maximum of the indication and might be a suitable place to test the indication.

This series of indications continues northerly with slight bends but gradually loses intensity. Between 5,600 south and 5,000 south the intensity becomes weaker but increases again at 4,800 south and continues to about 3,600 south.

The end of the indication coincides with a feature which is probably a fault striking south-west–north-east. At least two more such cross features are notices still further to the north, striking parallel to the first one.

(*b*) *Indication* 7,000 *south*, 100 *east*–400 *south*, 300 *east*.—On the southern profiles there is a second series of indications running north and south to the east of the first mentioned. It starts at about 7,000 south, 100 east, and continues to 6,400 south, becomes weaker and then again increases gradually to a second maximum between 4,800 south and 3,200 south and again to a third one between 2,200 south and 400 south. At 5,000 south a Racom profile showed good conductors coinciding with the electro-magnetic anomalies. It also showed some narrow poor conductors (probably quartz or pegmatite veins) within the zone of good conductivity. Some attention might be paid to these, as such veins within a shear zone are often associated with mineralization. On profile 3,200 south some resistivity determinations were made over outcrops of muscovite schist and hornblende schist. The resistivity of muscovite schist is relatively high. It is not impossible that the good conductor referred to above is hornblende schist occurring as narrow bands within muscovite schist. The shaft on M.L. 1091 seems to be situated on the most northern of the cross features mentioned above.

(*c*) *Indication* 2,800 *south*, 450 *west*–1,200 *south*, 300 *west*.—In the northern part of the layout the shaft on M.L. 1079 at 1,200 south is in a similar position to the one of the Pershore lease, being opposite and slightly east of an electro-magnetic anomaly. One of these shafts might be used for a more thorough testing of the indications. At present they reveal very little.

Owing to the strong indications and the high conductivity, it would be advisable to re-survey the northern part with closer traverses and using a lower frequency.

## G. Summary.

### *Problem.*

The problem in Trekelano was to see if other ore-bodies could be found in the plains surrounding the mine.

### *Tests over Ore-body.*

The survey was started over the known ore-body with several methods, with the object of comparing the geophysical results with known geological conditions. Clear indications of a good conductor were obtained over the ore-body and are shown on plate 2. The other tests confirmed the indication of the electro-magnetic survey.

### *Methods of Survey.*

The electro-magnetic method was chosen as the main basis for the routine survey and four layouts were surveyed, covering an area of about $2\frac{1}{2}$ square miles, and in addition, self-potential measurements, potential ratio determinations, resistivity measurements and magnetic surveys were made. Plate 1 shows the situation of the four layouts the geology and the electric indications being divided into strong and weak. Plates 3, 5, 7 and 8 each show one layout in more detail and also some of the results in the form of contour lines of the in or out-of-phase horizontal component of the electro-magnetic field. Plates 4, 6 and 9 show some results in the form of graphs.

### *Character of Indications.*

A number of electric indications of good conductors were obtained and were of similar strength and character to those over the Trekelano ore-body. The limited length of these indications was considered favorable and the eastern series of indications on layout 1 was selected for testing the electric indications. Signs of mineralization were found and bunches of copper ore as well as gold values to 1 dwt. per ton, but no ore-body was located. The self-potential method was selected as a check for the electro-magnetic indications, but except the one indication over the Trekelano ore-body and one north of the mine coinciding with an electro-magnetic indication, no indications were obtained with the self-potential method.

### *Testing.*

The trenching campaign showed that the high electric conductivity alone is not sufficient as an indicator for ore, as probably slight mineralization or strong shearing has the effect of increasing the electric conductivity considerably. It was, therefor, considered advisable to use the other methods to check the electric indications and preferably test such places where all methods give favorable indications. A combined electro-magnetic and self-potential survey seems to be promising, as in this way it should be possible to distinguish between electro-magnetic indications caused by ore and those caused by mineralized schists or similar good conductors. In Trekelano, the electro-magnetic method was hampered by the fact that a weak mineralization gave the same electrical effect as a payable ore-body, the reason probably being the silicification of the lode formation near the surface.

### *Results.*

The results of the geophysical survey summarized are—

*Layout* 1—

(1) A clear indication over the Trekelano ore-body, obtained with all electric methods. The indication does not extend to the north or south beyond the known limits of the ore-body.

(2) An indication north of the Trekelano mine (maximum 2,600 north, 145 east), obtained by the electro-magnetic method and confirmed by the self-potential method. No testing has yet been carried out.

(3) An indication east of Trekelano mine (maximum 350 north, 410 east) obtained by the electro-magnetic method. No confirmation by self-potential results except on the northern end. Testing showed no well defined copper ore-body, only bunches of copper ore at one place and some low gold values.

(4) Several indications of minor importance were obtained.

*Layout* 2—

Several electro-magnetic indications were obtained, most of them proving to be on the granite and hornblende-biotite schist contact. Evidence of shearing and slight mineralization can be noticed in the trenches. The self-potential method showed only a few very weak deviations coinciding with the electro-magnetic indications.

*Layout* 3—

Excepting the large and wide anomaly in the south-eastern portion of the layout, the indications were of less strength than on layouts 1 and 2. More extensive checking by the self-potential method should precede the testing campaign.

*Layout* 4—

Two main series of very strong electro-magnetic indications were obtained with a north-south striking direction and with a marked increase in the strength of indications along the strike. No self-potential work and no testing has been done on this layout, but on account of the strong indications further work is recommended.

## IV. TESTS.

Preliminary testing of the electro-magnetic indications was carried out by means of trenches and shallow shafts.

*On layout* 1, there were three indications in addition to those over the Trekelano ore-bodies. One of these (at 2,200 north, 150 east–3,000 north, 185 east) is situated largely on leases held by the Trekelano Syndicate. Arrangements are being made by the Survey to test this indication.

The indication at 800 north, 19 east–1,000 north, 310 east was tested by one trench. A considerable amount of testing was carried out on the indication between 0, 400 east and 450 north, 400 east. Five trenches and two shafts have been excavated.

*On layout* 2, testing was confined to one trench to each of the six electro-magnetic indications.

*On layout* 3, testing has proceeded only to the extent of two trenches.

*On layout* 4, no testing has yet been carried out.

Results of the testing are shown in tabular form below.

LAYOUT 1.

| Position of Trench. | Length. | Depth. | Geology. | Sampling. Gold in grains per ton. Copper in percentage. |
|---|---|---|---|---|
| 1,000 north | 38′ | 8′ 6″ to 9′ 0″ | Weathered biotite schists with numerous minute horizontal veins of quartz and pegmatite; little chloropal; veins of coarse biotite | W. 10′; 12′; 11′ E.<br>Tr.; Tr.; 12 |
| 510 north, 422 east | 27′ | 2′ 0″ to 6′ 0″ | Weathered biotite schists with pegmatitic quartz veins giving place to chrysocolla, opaline quartz and limonite; schist stained with chloropal | W. 2′ 6″; 2′ 0″; 2′ 0″; 1′ 0″; 5′ 0″ E.<br>Gold 35; Tr.; 41; 20; Tr.<br>Copper 0.35; Tr.; 0.85; 12.10; Tr. |
| Shaft 510 north, 422 east | ... | 50′ 0″ | Similar to trench. Formation passed out of shaft to west | Depth 25′<br>Sample 5′ wide, Cu. 0.8, Gold 12.<br>Selected formation, 1.15, Gold 14.<br>Crosscut west at 50′, length 21′ 9″<br>W. 5′ 6″; 6′; 6′ E.<br>Gold Tr.; Tr.; Tr.<br>Copper Tr.; Tr.; Tr. |
| 458 north, 410 east | 30 | 8′ 0″ to 9′ 6″ | Weathered biotite schists with chloropal | W. 4′ 0″; 4′ 0″; 6′ 8″; 7′ 6″; 7′ 6″ E.<br>16; 12; 16; 13; 16 |
| 350 north, 404 east | 16 | 5′ 0″ to 8′ 0″ | Weathered biotite schists with seams of chloropal and limonite, widest vein being in shaft | Shaft sunk in eastern portion to 20′<br>Sample, depth 19′, width 4′ 3″, Gold 12. |
| 350 north, 423 east | 43 | 5′ 0″ to 8′ 0″ | Weathered biotite schists with minute veins jaspery quartz; some chloropal; schistosity dips high to west | W. 7′ 0″; 8′ 6″; 8′ 0″; 10′ 0″; 9′ 0″ E.<br>Tr.; 16; Tr.; 14; 16 |
| 100 north, 420 east | 57′ 6″ | 4′ 0″ to 6′ 6″ | From west to east 9′ coarse biotite schist; 19′ massive biotite schist; 34′ biotite schists with schistosity highly developed; weathered and with narrow red quartz veins and some earthy calcite; schistosity dips high to west | W. 8′ 0″; 8′ 0″; 10′ 0″; 6′ 6″; 10′ 0″; 10′ 0″ E.<br>Tr.; 16; 12; Tr.; Tr.; Tr. |

LAYOUT 2.

| Position of Trench. | Length. | Depth. | Geology. | Sampling. Gold in grains per ton. |
|---|---|---|---|---|
| 3,800 south, 300 east | 44 | 5′ 0″ to 8′ 0″ | Schist in western part and granite in eastern part | W. 12′ 0″; 11′ 6″; 10′ 0″; 10′ 0″ E.<br>12; Tr.; 20; 12 |
| 3,800 south, 400 east | 40 | 4′ 0″ | In partly weathered granite | W. 15′ 0″; 15′ 0″; 10′ 0″ E.<br>16; Tr.; 16 |
| 5,900 south, 290 east | 44 | 5′ 6″ to 6′ 0″ | Schist in western part and granite in eastern part | W. 6′ 0″; 8′ 0″; 10′ 0″; 10′ 0″; 10′ 0″ E.<br>Tr.; 12; Tr.; Tr.; Tr. |
| 7,500 south, 284 east | 40 | 6′ 0″ | In weathered biotite-hornblende schist | W. 10′ 0″; 10′ 0″; 10′ 0″; 10′ 0″ E.<br>Tr.; 12; Tr.; Tr. |
| 2,800 south, 100 east | 61 | 7′ 6″ to 8′ 6″ | Schist in western part and granite in eastern part | W. 6′ 0″; 4′ 0″; 4′ 8″; 5′ 0″; 5′ 0″; 5′ 0″; 5′ 0″; 10′ 0″; 10′ 0″; 10′ 0″ E.<br>12; 16; 12; 20; 18; 16; 18; 13; 12; Tr. |
| 3,600 south, 30 west | 45 | 5′ 0″ | Granite in western part passing into schists to east | W. 15′ 0″; 10′ 0″; 10′ 0″; 10′ 0″ E.<br>Tr.; Tr.; Tr.; Tr. |

LAYOUT 3.

| Position of Trench. | Length. | Depth. | Geology. | Sampling Gold in grains per ton. | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 350 north, 815 west | 40 | 5′ 0″ to 5′ 6″ | Hornblende-biotite schists; dip west 80 degrees | W. | 10′ 0″ | 10′ 0″ | 10′ 0″ | 9′ 0″ | E. |
| | | | | | Tr. | 12 | 16 | 14 | |
| 3,200 north, 775 west | 48 | 5′ 0″ | Hornblende-biotite schists with pegmatite veins, epidote-bearing | W. | 12′ 0″ | 12′ 0″ | 12′ 0″ | 12′ 0″ | E. |
| | | | | | Tr. | Tr. | Tr. | Tr. | |

With the exception of that at 510 north, layout 1, the testing did not expose any copper ore. It became apparent that the testing was exposing weathered biotite schists on the site of every indication. These schists, particularly on layout 1, contained minute veins of quartz and pegmatite, and were stained by, and contained, veins of chloropal. For this reason, the later trenching was confined to one trench per indication. Granite was also exposed in some trenches on layouts 2 and 3. Every sample taken showed a gold content ranging from traces to 20 gr. per ton.

To make the testing complete, shafts or boreholes would have to be sunk to test the electro-magnetic indications at the depth from which they arise, viz., a short distance below the underground water level. A few calculations of the depth of current concentration gave a result 100 to 150 feet. To carry out such work economically, it is helpful to show the position of the outcrop and the strike and dip of the lode or formation. It was partly for these reasons that the preliminary testing was undertaken.

## V. CONCLUSIONS AND RECOMMENDATIONS.

The Trekelano mine occurs at the northern end of a plain tract of country and the ore-body did not have a prominent outcrop. Similar geological conditions appear to exist to the south and there were reasonable expectations that a geophysical survey would reveal other ore-bodies which outcropped poorly or not at all. The electro-magnetic method of survey was used in the hope of locating bodies of sulphide ore by virtue of their high conductivity.

On layout 1, good geophysical indications were obtained over the Trekelano ore-body, and at three other places. The strengths of the latter were comparable with that over the Trekelano ore-body and it was thought possible that they represented sulphide ore-bodies, although the possibility of them being due to other types of good conductors was not overlooked.

The electro-magnetic survey was extended to layouts 2, 3 and 4. Testing of the indications by trenches and shallow shafts started on layout 1 was continued on layouts 2 and 3 (in part) as the surveys proceeded. The first trench at 510 north revealed a small amount of oxidized copper ore in a weathered biotite schist. The remaining trenches revealed weathered biotite or biotite-hornblende schists and in a few cases, granite, but no copper ore. In general it may be stated that the testing proved that the sites of the electro-magnetic indications were represented at the surface by weathered biotite schists (and in a few cases, granite), the schists being in most cases traversed by minute and irregular veins of quartz and pegmatite and stained yellowish green by chloropal. The latter mineral is presumably formed near the surface by conditions of silicification similar to those for the formation of chrysocolla, but it does not necessarily follow that the conditions are restricted to lode formations. Assays revealed the presence of small quantities of gold (up to 20 gr. per ton) in the schists and the granite exposed in the trenches. This gold content is so universal that it cannot be accepted as a criterion for the presence of an ore-body.

Resistivity determinations of the schists in the trenches proved that the schists had an extraordinarily low resistivity which was comparable with that of the Trekelano ore-body. It is evident, therefore, that the exposed bands of schist would account largely, if not wholly, for the indications of good conductors obtained.

Self-potential surveys were later carried out over a number of the indications, but only a few anomalies were obtained, the strengths of which were small compared with that over the Trekelano ore-body. Further self-potential surveys will be necessary to thoroughly test the whole of the four layouts.

About one-half of the indications have been tested, and although those tests have more or less proved that the indications are due to bands of highly conductive schists, the most favorable of the remainder should be tested. Before this is done, however, further self-potential surveys will be carried out.

A comparison of the geological structure with the geophysical indications gives the following results :—The geological features on layouts 1, 2 and 3 are similar, but differ from those on layout 4, and the latter will therefore be considered separately. On layouts 1, 2 and 3 the rocks consist essentially of hornblende-biotite schists (weathered specimens of which appear as biotite schists) and granite. A small area of muscovite schist occurs on layout 1. Partly altered sedimentary rocks occur on the east side of the Trekelano open cut, but are not found elsewhere. This occurrence may have some significance in connexion with the Trekelano ore-body. The numerous bodies of granite suggest that the main intrusion of granite is at no great depth and that the belts of schists represent roof pendants of varying size.

The indications have been classed as strong and weak. They occur mainly in the schist, but a small proportion of both strong and weak indications occur in the granite (either entirely or as extensions of indications from the schist). The schists are generally uniform in nature and no relationships between different types of schist and the location of indications could be found. The position of the indications in relation to the schist-granite contacts is readily ascertainable from plate 1.

All the strong indications in the schists occur within 200 feet of the schist-granite contact, but 80 per cent. are within 100 feet and 50 per cent. of them are along, the contact. The weak indications exist at distances ranging to 400 feet or more from the contact, but 50 per cent. of them are within 200 feet of the contact. The schist-granite contact is therefore the main geological control in the position of the indications. The width of the schist belt appears also to play an important part as the majority of the strong indications are in narrow belts of schist between granite. However, not all of the narrow belts of schists contain indications. The position with regard to the Trekelano lode should be mentioned, as it apparently occurs in a wide belt of schists remote from large granite outcrops. However, one small outcrop of granite occurs to the east of, and within 100 feet of the lode (the indication is further west owing to the dip of the lode). It is possible that granite may occur at shallow depths in continuation of the outcrop, and Mr. Horvath believes the magnetic results confirm this. Apart from this apparent exception, all other wide belts of schists carry only weak indications. Thus on layouts 1, 2 and 3 it may be claimed that the indications appear to correspond generally to zones at or near the schist-granite contacts, and that the majority of strong indications are in narrow belts of schists.

There is still the question as to whether any mineralization is associated with the schist-granite contacts in narrow belts of schist. Mr. Horvath believes that the schists at the contacts may contain impregnations of pyrite ; that the chloropal is an oxidation product of the pyrite ; that the ground water along these zones would contain sulphates, &c., derived from the pyrite and any other sulphides present ; and that electrolytic conductivity would tend to account for the electro-magnetic indications. The above explanation would account for the indications, but it must be pointed out that it depends upon the assumption that the chloropal is derived from pyrite and has only been found where the test trenches have been put in and in the Trekelano open cut, but it must be realized that other places have not been trenched. It must be pointed out that the oxidized portions of lodes provide conditions suitable for its formation, but do not necessarily provide the source of iron per medium of pyrite, although the latter would in most cases be the most important source.

The above correlations are, however, subject to the reservation that the rock types and schist-granite contacts might be somewhat different from those shown in the " inferred " areas. The mapping is the best possible under the conditions of lack of outcrops and depth of soil, and could only be improved upon by extensive pitting to determine the bedrock. However, it is probable that any alteration would rather tend to support the above correlations.

The pegmatite dykes and quartz veins have no relationship to the indications. However, the general trend of the indications is parallel to the pegmatite dykes, but is controlled by the strike of the schist-granite contact.

On layout 4 the rocks are chiefly hornblende-biotite schists, but there is a central belt of muscovite and muscovite-quartz schists. Granite is present as five small outcrops only and has no control on the location of the indications. The indications occur generally in association with the zone of muscovite schists. They appear mainly at the contacts of the muscovite and the hornblende-biotite schists. The belt of muscovite schists and its contacts with the horblende-biotite schists, appear, therefore, to be the controlling features on layout 4.

In order to complete the testing of the areas surveyed, it is recommended that—

(1) Further self-potential surveys be made over the strong indications on layouts 1, 2 and 3, which occur at or near schist-granite contacts which have not been tested.

(2) Subject to the results from the self-potential surveys showing anomalies, the indications to be tested by trenching, &c.

(3) The indication traversing M.L. 3,580 to be tested by trenching, &c.

(4) Further self-potential surveys be carried out across the electro-magnetic indications on layout 4.

(5) Testing on layout 4 be dependent on the results of the self-potential surveys.

As the above testing is dependent upon further self-potential surveys, it will have to be postponed until such time as the surveys are made and the results become available. These surveys will be made during 1936, and any testing arising from the results of same will be completed before the end of the year.

J. M. RAYNER,
Consultant Geophysicist.

P. B. NYE,
Executive Officer.

SEPP HORVATH,
For the Report of The Electrical
Prospecting Company of Sweden.
(Part III).

Cloncurry,
June, 1936.

By Authority: L. F. Johnston, Commonwealth Government Printer, Canberra.

# LIST OF PUBLICATIONS.

## PERIODICAL REPORTS.

Report for Period Ended 30th June, 1935 .. } In one publication.
Report for Period Ended 31st December, 1935 }
Report for Period Ended 30th June, 1936.

## INDIVIDUAL REPORTS.

### WESTERN AUSTRALIA.

No. 1, McPhee's Patch Area, Pilbara Gold-field, by K. J. Finucane, M.Sc.

No. 2, The North Pole Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc.

No. 3, Lalla Rookh Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc.

No. 4, The Nullagine Conglomerates, Pilbara Gold-field, by K. J. Finucane, M.Sc.

No. 5, The Nullagine River Concessions, No. 695 H, Pilbara Gold-field, by K. J. Finucane, M.Sc.

No. 6, Talga Talga, Pilbara Gold-field, by K. J. Finucane, M.Sc.

No. 7, The Blue Spec Gold—Antimony Quartz Veins, Middle Creek—Nullagine District, Pilbara Gold-field, by K. J. Finucane, M.Sc.

No. 8, Marble Bar Mining Centre, Pilbara-Gold field, by K. J. Finucane, M.Sc.

No. 9, Bamboo Creek Mining Centre, Pilbara, Gold-field by K. J. Finucane, M.Sc.

### NORTHERN TERRITORY.

No. 1, The Pine Creek Gold-field, by P. S. Hossfeld, M.Sc.

No. 2, The Union Reefs Gold-field, by P. S. Hossfeld, M.Sc.

No. 3, The Golden Dyke Mine and Adjacent Areas, by P. S. Hossfeld, M.Sc.

No. 4, Report on Magnetic Prospecting at Tennant Creek, by J. M. Rayner, B.Sc., and Appendix, by P. B. Nye, M.Sc., and J. M. Rayner, B.Sc.

### QUEENSLAND.

No. 1, The Mount Freda—Canteen Area, Soldiers Cap, Cloncurry District, by C. S. Honman, B.M.E.

No. 2, The Gilded Rose Area, Cloncurry District, by C. S. Honman, B.M.E.

No. 3, The Geophysical Methods of the Electrical Prospecting Company of Sweden, used in the Aerial, Geological and Geophysical Survey of Northern Australia, by Sepp Horvath.

No. 4, Geophysical Report on the Soldiers Cap Area, Cloncurry District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc.

No. 5, Geophysical Report on the Trekelano Area, Cloncurry District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc.

No. 6, Geophysical Report on the Dobbyn Area, Cloncurry District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc.