ELECTRICAL PROSPECTING
METHODS

Report on the Electrical Survey
carried out for

BRITISH COLUMBIA NICKEL MINES LTD

1. Introduction

The object of this report is the discussion of the results of an electrical survey undertaken by the Schlumberger Electrical Prospecting Methods, during the months of August and September, on the properties of the British Columbia Nickel Mines Ltd., near Hope, B.C.

The first aim of the survey was to ascertain, whether or not, the type of mineralization occuring on the property was amenable to electrical prospecting. If such was the case, it was the intention of the company to apply the method for the study of a known ore body and for the exploration of a virgin territory.

The test was carried out by our Mr. J. Brunschig, from August 15th to August 18th. This test being satisfactory, it was followed by a regular survey, which was commenced on August 28th and lasted to September 4th.

A description of the property is given in the Annual Report of the Minister of Mines of British Columbia for the year 1929, pp 239, 240 and 241, to which the reader will kindly refer.

In the following pages, we shall first endeavour to give a summary description of the electrical techniques of exploration employed. This will be followed by a discussion of the results obtained. We shall close with our conclusions and recommendations.

2. Summary description of the methods of exploration employed.

1. Reconnaissance by the Spontaneous Polarization Method.

The most convenient and rapid method of undertaking a preliminary examination for metallic minerals consists of studying the phenomena of spontaneous polarization.

A mass of metallically conductive material (the metallic sulphides, except sphalerite and cinnibar, the arsenides, native metals etc.) enclosed incountry rock, acts as a natural battery, the moisture in the encasing rock being the electrolyte, and the metallically conductive minerals acting as the metallic elements of the cell.

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GEOPHYSICAL DATA

Near the surface, where the weak ground water solutions are oxidizing, the mineralization acts as the negative pole, whereas at depth the solutions are neutral or reducing, and the mineral mass is therefore positively charged. The electric current consequently generated by this natural battery, flows down the apex through the conductive mass, out into the wall rocks, and back to the surface, where it completes the circuit by returning into the apex of the body (Fig. 1). Hence an observer studying the ground overlying such a concealed generator of electricity will discover lines of current converging on one or more "negative centers" located about the conductive mass.

This ensemble of effects constitutes the phenomena of "spontaneous polarization" which we abbreviate S.P.

The method is not of absolutely general application, since two conditions must be fulfilled to permit spontaneous current generation to take place:-

a. Metallic electrical conductivity of the ore minerals.

b. Continuity of the mineralization of the deposit, so that an unbroken metallic path is offered to the current.

These conditions are, for example, generally well fulfilled by masses of veins of pyrite, chalcopyrite etc.

The study of the spontaneously generated currents is very expeditiously carried out by measuring the differences of potentials which occur at the surface of the ground, along straight and parallel lines. Using the distances along these lines as abscissae the corresponding potential values are plotted as ordinates, thus producing a profile of potentials. When this profile is flat or only slightly wavy, no electrical activity is noted. Areas of current generation are indicated by pronounced peaks of negative potentials in the S.P. profiles where they cross such areas.

The S.P.method is a very simple process of exploration since it necessitates only the location of the negative zones of potential at the surface of the ground, by means of a very light apparatus.

2. Potential Method

This technique is more general in its application, since it can be used for studying stratigraphical and structural problems as well as in the search for ore.

The operation consists of creating an electrical field in the ground by means of passing an electrical current between two widely separated ground contacts. The form of the resultant field can then be studied by means of a short, movable line used to shunt off a portion of the current in the ground through a measuring instrument. (see Fig.2)

The principle can be applied through a variety of techniques of which one of the most rapid is the determination of the resistivities of the sub-soil from observations of the drops of potential. A series of such observations frequently reveals valuable data concerning concealed geological occurrences.

In the case of the B.C.Nickel Mines property, it was, however, another technique of the potential process, known as the "map of the potentials" which was applied. It consists of sending the current into the soil (at the surface or underground) as described above, and studying the distribution of the current at the surface, by tracing and mapping the equipotential curves, noting their form, and drawing therefrom conclusions regarding the electrical conductivity of the underlying material.

3. Discussion of the Results

Two distinct investigations were carried out on the properties of the company, which are discussed below:

a. Study by current of the major outcrop.

Map No.1 shows the results obtained. An orebody underlies the area under consideration. It outcrops, as shown on the map, and is partially known through drilling exploration. An insulated cable was lowered into drill hole No.4 and the elctrical current was sent into the orebody itself, at a depth of 27 feet. Since the ore possesses a conductivity which is practically infinite in comparison with that of the surrounding country rocks, the entire mass of the orebody is practically thrown at the same potential and its exterior is an equipotential surface. Other equipotential surfaces are somewhat parallel to the first one. By tracing equipotential curves at the surface it is possible to get an idea of the form of the mineralized mass and of its position.

Curves C_1, C_2 and C_3 were traced. Curve C_1 gives, we believe quite accurately, the form of the orebody near the surface. Curves C_2 and C_3 show the current progresses with more ease towards the north east than in any other direction. From this we infer, that at depth, the orebody dips steeply towards the north-west.

A point to be considered is the two refractions which occur on equipotential curves C_2 and C_3 along lines L_1 and L_2. With the limited amount of work performed, we cannot very definitely establish the cause of these refractions, but believe that they are probably due to contacts between rocks of different electrical conductivity. It will be interesting to see if further exploration will confirm this point.

b. Reconnaissance by spontaneous polarization at the B.C.Cut

This reconnaissance was carried out on virgin territory of the property where no mineral occurrences were known to exist. The results are shown on Map No.2. This is not, strictly speaking, a map since the scale which is 1" for 150 feet along the profiles, is 1" for 50 feet perpendicular thereto. It is therefore, merely an ideal representation of the reconnaissance work, the purpose of which is to outline broadly the area of electrical activity discovered.

Five profiles of spontaneous polarization number P_1 to P_5 were traced. They show a large belt of intense negative electrical activity running all through the property in an east-west direction from Profile P_1 to profile P_5. The axis of this zone of activity may be approximately located along line M'M.

As soon as the elctrical results were obtained, our observer advised that a shallow pit be dug in the neighbourhood of Profile P_2, where the elctrical reaction is particularly strong. This first mining research led to the discovery of a massive orebody under a very shallow overburden. We are of the opinion that this orebody extends across the property between profiles P_1 and P_5, and we advise a systematic investigation of it. In all probability the orebody dips steeply towards the north.

4. CONCLUSIONS

1. A short electrical survey was carried out by the Schlumberger Electrical Prospecting methods on the property of the British Columbia Nickel Mines Ltd., near Hope, B.C. Its purpose was two-fold; firstly, the studying of an outcrop already known, and secondly, the exploration of some virgin ground in the neighbourhood.

2. At the major outcrop the study was carried out by artificial current which was sent into the orebody itself. The equipotential curves drawn enabled us to outline the form of mineralization near the surface. Also, from the electrical results it may be surmised that the mineralized mass dips towards the north-west.

3. In the area of the British Columbia Cut a survey by spontaneous polarization on a virgin area led to the discovery of a new ore body. This ore body, according to the electrical results, is of very large proportion, and we advise a methodic exploration by trenching and drilling.

4. This short survey demonstrated that the mineral occurrences on the properties of the British Columbia Nickel Mines Ltd., are perfectly amenable to the potential and the self potential systems of electrical exploration, and we believe that a general survey would prove useful in determining the complete value of the Company's holdings.

Respectfully submitted,

E.G.Leonardson.

New York City.
6th October 1930.

INTER-OFFICE CORRESPONDENCE

RECEIVED AUG 22 1973

TO MESSRS: R. GONZALEZ, L. DE ROUX, & F. HOLLAND

DATE August 21, 1973

CC:

FROM L.P. STARCK

SUBJECT GIANT NICKEL GEOPHYSICAL REPORTS

Attached is a copy of all the geophysical reports which are now in the Vancouver office files.

Please advise if you know of any other geophysical reports that are in existance which should be incorporated in the master file if you do have any such reports then please send copies to Vancouver.

Yours truly,

L.P. Starck

LPS/pw

Encl.

3M-MP-173

INTER-OFFICE CORRESPONDENCE

DATE August 21, 1973

TO MESSRS: A. MULLON, L. DE ROUX, R. GONZALEZ AND F. HOLLAND.

CC:

FROM L.P. STARCK

SUBJECT GEOPHYSICAL REPORTS

Further to my letter and/or memorandum of August 20th, 1973, please find enclosed the following reports marked item 15 to 25 in the table of contents which have subsequently been located.

Yours truly,

L.P. Starck

LPS/pw

Encls.

Discovery of the Brunschwig orebody near Hope, B. C., was the result of an electrical survey carried out for the British Columbia Nickel Mines in 1930. The large body of pyrrhoite contained nickel and copper. Inclosing rock in this formation is a dike of peridotite.

No surface indications suggested the presence of an orebody in this area. The electrical survey was completed in less than two weeks. Two examples of practical surveys for ore by the self-potential method have been given. In both, the electrical conclusions agree satisfactorily with the geological information.

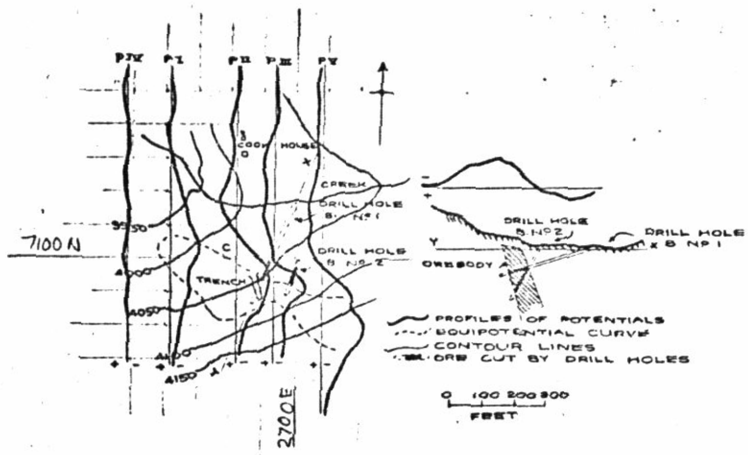

Fig. 3 -- Surface map and cross-section illustrating the discovery of an orebody at Hope, B. C., by self-potential measurements.

The reconnaissance was conducted by means of self-potential profiles oriented north-south. These profiles are numbered P.I. to P.V. on Fig. 3. The survey resulted in the rapid discovery of an area of strong spontaneous electrical activity, in the southern part of the territory surveyed. An equipotential curve C gives roughly the trend of the mineralization. Two diamond drills, bored in the vicinity of profile P. 111, resulted in the discovery of a massive orebody about 55 ft. wide, of good grade nickeliferous and cupriferous pyrrhotite. A tentative cross-section of the deposit along the line XY is given on the figure.

Discussion of such concrete examples of field work should be beneficial to the mining fraternity in enabling the geologist and the mining engineer to understand better the practic[al] use of electrical exploration, and to appreciate the services it may render for the study of a given problem.

Among the numerous geophysical methods which can be employed for th[e] study of a mineral claim and the reconnaissance of such, the self-potential method is quick and cheap. It is also one of the most reliable, inasmuch as it detects only the metallically conductive masses buri[ed] in the ground. It gives, therefore, indications entirely independent of the electrical conductivity of the rocks, which is of an electrolytic nature.

CBN/JWW

In the central part of the anticline, the andesite has been eroded, and rhyolite lavas outcrop. Toward the east, these rocks dip gently under the andesite flows. Of significance in electrical prospecting is the fact that contact between the two eruptive rocks is well mineralized on most of its surface with a thin sheet of conductive sulphides. Part of the uninterpretable results obtained with the electro-magnetic methods were probably a consequence of the presence of this thin and continuous layer of conductive material.

Fig. 1 illustrates the results obtained by the self-potential survey over the F orebody. Four profiles of potential were made. Two of them encountered strong negative reactions caused by the upper part of the deposit. The detailed work consisted in determining accurately the position of the negative centre C, and tracing an equipotential curve L around it.

On the map, the horizontal section of the commercial orebody at the 300 ft. level has been drawn, and the orebody is shown in the shaded area. The electrical phenomenon is evidently not centered on the section of the orebody. This is because the general axis of the deposit is not vertical. It outcrops approximately in the vicinity of the negative center, and dips steeply toward the southeast of the map, under the swamp.

The fact that the apex of the orebody lies under the negative center has been further demonstrated by sending an electric current directly into the orebody by means of an insulated wire lowered into the drill hole A (Fig. 2), which encountered the mineralization at about 150 ft. Inasmuch as the ore possesses a conductivity that is almost infinite in comparison with that of the surrounding rocks, the entire mass of the ore-bodyis energized at about the same potential, and its exterior is an equipotential surface. Other equipotential surfaces are somewhat parallel to the first one. By tracing equipotential curves at the surface, the center of emergence of the electrical current was determined. This point corresponds approximately to the position of the apex of the orebody.

Fig. 2 shows the equipotential curves obtained by this work, centered around point O, the point of emergence of the current. Note that this point is only 50 ft. from the self-potential center C (Fig. 1), thus leading to the same practical conclusion as to the position of the upper part of the conductive deposit. This experiment proves that the conductive material underlying point O is well connected electrically with the orebody encountered by drill hole A.

Of interest to note is the fact that Curve 3, which possesses the lowest potential, is of large size. It extends abnormally toward the west as far as the outcropping contact between the rhyolite and andesite. This demonstrates particularly well, in my opinion, the electrical continuity of the thin meneralized sheet that occurs at this contact.

The whole survey demonstrates that the F deposit of the Amulet Mines gives rise to an important phenomenon of spontaneous polarization (more than 250 millivolts). A deposit of this type is consequently amenable to the self-potential method of exploration.

The apparent discrepancy between the horizontal section of the orebody at the 300 ft. level and the center of the spontanious electrical phenomenon at the surface is explained by electrical investigations. The conclusions thus reached are in accordance with geological information. In the area of points O and C is an upper part of the orebody, investigated by drilling and of small commercial value; this upper part, nevertheless, is a good conductor of current, and constitutes the apex of the whole electrically conductive meneralization. The apex is on the western side of the commercial mineralization, as could be expected, inasmuch as the deposit is dipping toward the east.

Such an example of field work shows how electrical indications given by the self-potentiol method should be carefully and thoroughly investigated before being considered useless. In this particular example, a geologist who would have put down merely a vertical diamond drill at center C would have missed a valuable orebody, and unjustly condemned the electrical method of exploration, in an application where results are logical and satisfactory.

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This indicates one of the advantages of the self-potential method -- that an indication discovered by it corresponds to a mass possessing a metallic conductivity. Such an indication cannot, in any instance, result from a mere difference in the conductivities of the rocks, this latter phenomenon being of an electrolytic nature. With several other electrical methods of exploration experience, difficulties are encountered in interpreting field data, on account of numerous pseudo-indications of conductors -- such as wet faults, geological contacts, thin conductive beds in a resistant formation -- caused by variations in conductivity of the underground rocks.

Some authors have stated that the phenomenon of spontaneous polarization may not exist for certain types of orebodies. This is correct if the deposit is not metallically conductive, such as is the condition with a body of galena or pyrite crystals inclosed in a quartz or calcite gangue. But, in such case, it must be borne in mind that no other method of electrical exploration will detect them. My experience, on the contrary, proves that the self-potential method always detects the metallically conductive orebodies. This is in accord with the opinions of numerous geophysicists who consider the process as the most efficient that can be utilized for ore exploration.*

Under one circumstance, however, --with graphitic schists--the self-potential methods will register numerous indications of spontaneous activity that do not correspond to buried mineralization. This is natural. Graphite is a metallically conductive mineral. In this application of the method, the importance, of the reactions, their size and nature, will generally permit the geophysicist to differentiate them from the indications caused by metallic deposits. If necessary, such a differentiation will be completed by a summary geological reconnaissance.

The remarks presented in the foregoing do not infer that other methods of electrical exploration are not efficient or interesting. On the contrary, every process has its special advantages and field of usefulness. In particular, in the course of an electrical survey, the results obtained by one method should be controlled and supplemented by checking against those from a second independent process. In this connection, the potential and electromagnetic methods will prove valuable in the detailed study of the indications discovered in the course of a self-potential reconnaissance. These technical qualities constitute only a part of the advantages of the self-potential method. To them must be added the fact that the apparatus is easily transportable and that the measurements can be made speedily.

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*Cf. Canadian Geological Survey. Memoir 165. Studies of Geophysical Methods, 1928 & 1929.

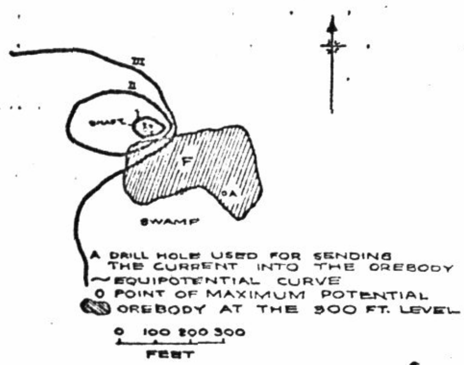

Fig. 2 -- Equipotential curves obtained by sending an electric current into F orebody by means of insulated wire lowered into drill hole A.

In consequence, the cost of exploration per acre is reasonable; it is the cheapest and most reliable method of exploration for ore in virgin territory.

An electrical survey of the F orebody of the Amulet Mines, in the Rouyn district of Quebec, was of particular interest. The area had been previously examined by various geophysical operators, without satisfactory result. Geological and physical conditions of the ore occurrence are complex. The orebodies are found at the contact of two lava flows (rhyolite overlain by a flow of andesite), on the eastern flank of a broad anticline, the direction of which is N.N.W.--S.S.E.

(Cont'd).

ELECTRICAL PROSPECTING IN CANADA.

by

J. J. BREUSSE.

Societe de Prospection Electrique, Paris,
and Schlumberger Electrical Prospecting
Methods, New York and Toronto.

The purpose of this paper is to illustrate, by two examples of practical surveys, the use of the self-potential method in ore exploration. This method was discovered in 1912 by Prof. Conrad Schlumberger, and was in practice in Europe before the War. It was introduced into the western hemisphere, and to Canada in particular, in 1921, by Sherwin F. Kelly, being instrumental in the discovery of the E and G orebodies at Noranda Mines, Quebec, in 1924.

For the reconnaissance of mining claims, recourse may be had to various geophysical processes. Even considering only the electrical methods, the geophysicist may choose the self-potential method; the potential method (by the study of the deformation of equipotential curves, or by resistivity measurements):

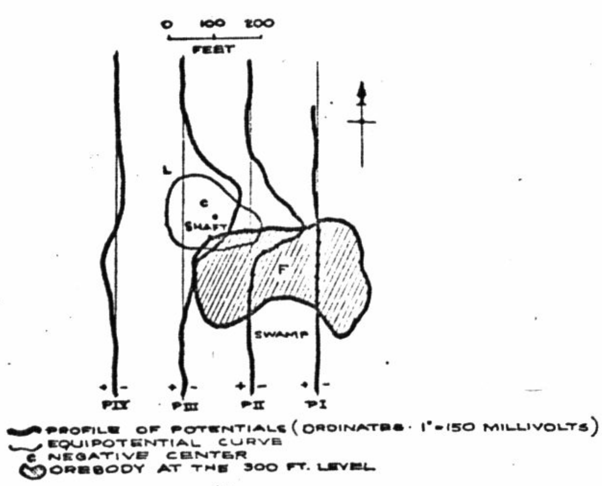

Fig. 1 -- Results of self-potential survey over F orebody, Amulet Mines, Quebec.

and the electro-magnetic method. Each has its advantages and limitations, and, according to the problem under consideration, one of them may be especially recommended. Mathematical and physical principles underlying these methods have been outlined in technical publications, to which the reader is referred for detailed information.

E.G. Leonardon and S.F. Kelly: Canadian Inst. Min. & Met. Bulletin, January, 1928. Max Mason: Technical Publication 45, A.I.M.E., February, 1928. E.H. Guilford: Can. Inst. Min. & Met., Bulletin, May, 1928. Hans Lundberg: Can. Inst. Min & Met., Bulletin, May, 1928. E. G. Leonardon and S. F. Kelly: Can. Inst. Min, & Met., Bulletin, May, 1928.

This article will discuss briefly the conditions under which the phenomenon of spontaneous polarization occurs, and the reasons why it is one of the most reliable and rapid techniques in the exploration for ore.

A body of metallically conductive sulphides buried in the ground can be compared to a conductive mass plunged in a non-homogeneous electrolyte. At the upper part of the body, near the surface, the water contained in the rocks is rich in oxygen; at depth the reverse condition occurs. An electrical battery is then constituted by the conductive ore and the surrounding rocks. It will act in such a manner as to correct the dissymmetry existing between the upper part and the lower part of the orebody. Negative ions will be carried toward the top of the orebody where oxygen exists in abundance. As a result, a negative region of potentials will be observed at the surface, on the apex of the orebody. Such a zone, toward which the current is flowing, is called a negative center.

The object of the self-potential survey of a region is to locate the negative centers existing within it, the conductive deposits being regularly connected with them.

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