Geological, Geochemical & Geophysical Report
on Attwood Claims, Phoenix
Eholt Area
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MAPS

FOREWORD

The geology in the accompanying map was mapped by Dr. W. H. White and Dr. R. H. Seraphim. No portion of it was taken from any previous work. Particular attention was paid to economic problems and little or no attention was paid to problems which are purely academic.

The object of the geological mapping was to determine by extrapolation what type of rocks underlie the large areas of overburden. If the rock type and structure under the overburden is considered suitable for ore deposits, then the overburdened area is prospected by biochemical and geophysical methods.

GEOLOGICAL WORK

METHOD OF 'MAPPING'

The geology was mapped directly onto matte type aerial photographs, and transferred onto a thousand foot to the inch map made from the photographs by Photographic Surveys (Western) Ltd.

Photographs are approximately one thousand foot to the inch in the center but the scale is distorted increasingly towards the borders of each photograph. If relief in the area covered by a photograph is great, the distortion is not consistent. However, mapping directly onto photographs was found very efficient. No surveying was necessary; positions could be 'spotted' on the photograph by shape of open areas and by tree configurations. Outcrops were limited practically to the open areas and thus are easily found when one uses the photographs.

Key points, points which could be found accurately on both the photograph and the thousand scale base-map, were necessary to transfer the geology from the photograph to the base map. The accuracy of transferring from the distorted photographs to the presumably accurate base map was controlled by using as large a number of key points as possible, and by limiting mapping to the center of a photograph, where distortion is less.

REFERENCES

The geology of the area has been described in

G. S. C. Summ.Report 1901 'Boundary Creek District' by R. W. Brock;

G. S. C. Memoir 21, 1912 - 'Phoenix' by LeRoy; and

G. S. C. paper 45-20, 1945 'Greenwood Phoenix Area' by D. A. McNaughton.

References are made particularly to the last mentioned report, and it is assumed that all these reports have been studied before the following report is read. The formation names used by LeRoy have been continued in this report. The formations are as follows:

KNOB HILL GROUP: Palaeozoic

The Knob Hill andesites and cherts with minor limestone and argillite are very fractured, contorted, and generally metamorphosed. In very few places can bedding be determined. The chert and limestone are knotted and lensey; no horizon markers were found.

BROOKLYN FORMATION: Palaeozoic

SHARPSTONE C.G.

The origin of the so called 'chert and jasperiod' of the Brooklyn Formation is questioned. McNaughton has grouped the Knob Hill with the Brooklyn. He states

> "Most of the Paleozoic sedimentary and volcanic rocks have undergone textural and mineralogical changes since their consolidation. They have been partly to completely silicified to form jasperiod and chert over wide areas. This silicification has so completely changed their original character that it is impossible in many places to distinguish altered limestones and argillites from altered volcanic rocks."

and also

> "It has now been found: (1) that limestone, argillite, latite, and andesite have all been altered locally to jasperiod; and (2) that the jasperiods immediately below the argillites that had been mapped with the Rawhide formation were formed by the silicification of argillites, not limestone, and, therefore, do not indicate that the argillites (Rawhide formation) are younger than the limestones (Brooklyn formation)"

The Brooklyn formation consists of:

Limestone - thin bedded, massive, and conglomerate (formerly called brecciated.)

Conglomerate - pebbles of chert and or limestone in a matrix of grit and or andesite and or limestone (formerly called chert and jasperiod breccia)

Greywacke - (or grit) - in places andesitic

Shale

Chert

The conglomerate, with interbedded greywacke, chert, and shale, is very widespread, as may be observed on the accompanying map. It is not limited to the mineralized areas, but is found in many other areas in the Boundary district, even beyond the area mapped.

Bedding is common in most of the rocks. The types of sediment suggest deltaic deposition but no structures suggesting deltaic deposition, except a few places of possible scour and fill, were found. Some of the beds are distinctly lenticular.

The conglomerate merits special mention, as it has been called a chert and jasperiod breccia in previous work. The evidence for this identification may be found in the reports of McNaughton and LeRoy. Evidence that the conglomerate is a sediment is as follows:

(1) It is in places well bedded, with shaley, and or limey and or chert beds alternating with the conglomerate beds. This bedding has formerly been called banding; the 'bands' being formed by selective replacement of limestone and or shale by chert, and subsequently brecciated. However, the 'bands' are parallel though in places lenticular, nowhere transect the regional structure, are uniform in composition along strike and variable across strike, and in places show scour and fill.

(2) The pebbles in a small volume of a single band are heterogeneous. Limestone pebbles are well rounded and chert pebbles are angular and sharp, as would be expected from differential weathering. The chert pebbles lying proximate are in places variable in color, one is jasper, one creamy, one pale green, one light grey and dark grey banded, though not parallel to the bedding of the host rock. The silicious solutions postulated in the replacement hypothesis must have changed markedly in short distances in order to form pebbles with this variety of color. If one argues that the different colors were originally formed in different bands, and these bands later brecciated; then one is left with a second problem of explaining how the rock became well banded a second time to make it as it is today.

(3) McNaughton writes,

> "Fragments of a highly altered, coarse-grained igneous rock resembling some phase of the diorite and fragments of altered andesite occur in the jasperiods in a few localities."

It is suggested that these fragments are weathered pebbles eroded from the Knob Hill formation.

(4) Some of the beds contain chert pebbles which are well

rounded and well sized. These beds are best observed near the contact with and intercalated with the Rawhide shales; and associated with limestone in the northern Gold Drop stopes.

The pebble bands near the Rawhide contain well rounded pebbles of markedly even size in any one band. The coarsest pebbles observed in a band were about one-half inch in diameter and sub-angular. Finer sized pebbles, grading into silt, were found in other bands, and tended to be more rounded.

The chert grains in the limestone are well rounded, frosted, and not mutually supported. The coarsest grains observed were about one fifth inch in diameter. The evidence suggests that these pebbles were wind-transported.

It seems logical that the grains found associated with the sediments deposited furthest off shore in these deltaic deposits, that is with the shale and limestone, were transported greater distances than the pebbles in the conglomerates, formed nearer shore. They thus underwent more abrasion and so are rounded, and as would be expected are also better sorted.

On the other hand, hydrothermal silicification and silication is associated with mineralization. In the immediate footwall of the Granby mineralized zone the rock in places is a light cream to light green chert, in places massive, in others banded. Where banded, however, the banding invariably conforms to banding found in the ore-body itself,

and to the regional attitude.

In the mineralized zone the silicates epidote, garnet, actinolite and hematite were formed replacing the impure limey beds.

Granted that silicious solutions did occur in mineralized areas, it is believed that they were limited to these areas and did not replace great volumes of limestone, argillite etc. to form the 'jasperiod and chert.'

There are usually many explanations possible for a given set of geological conditions. The simplest explanation is not always correct, but we generally prefer to accept it. It is believed more likely that the 'jasperiods' are a conglomerate rather than a tectonic breccia, and consequently the rock is renamed 'sharpstone conglomerate.'

A few brachiopods, not particularly well preserved, were found in limestone in one locality. Dr. Okulitch of the University of British Columbia has tentatively identified them as Rhynconellids, upper Palaeozoic in age.

KETTLE RIVER ARKOSE - Tertiary

McNaughton's description of the Kettle River arkose is accepted. The arkose was probably deposited with a relatively high initial dip, perhaps about twenty degrees. Local cross-bedding was observed.

MIDWAY VOLCANICS - Tertiary

Associated with the Midway Volcanics are pulaskite, syenite, and augite porphyry dykes and sills. In places the pulaskite dykes grade into the volcanics, in other places, contacts are sharp. The hypabyssals and the volcanics are probably genetically related.

ORE DEPOSITS - Age Unknown

McNaughton states "The Tertiary sedimentary and igneous rocks are younger than the ore deposits ..." but gives no evidence to support the statement. The present work has produced no evidence as to whether the ore deposits are older or younger than the Tertiary rocks.

Data suggesting that the ore may be older are as follows: No exposures have been found in which mineralization transects or replaces Tertiary rocks. A few places were noted in which ore appeared to be of higher grade close to pulaskite dykes, but these occurences may be coincidence for patches of 'high-grade' also occur with no relation to pulaskite. In two underground localities it appeared that the pulaskite had picked up inclusions of ore. However, the rock in these places was so altered and gougey from faulting that identification of the pulaskite was uncertain and the ore inclusions may have been fault 'drag.'

Data suggesting that the ore deposits may be younger are as follows: The ore bodies at Phoenix are within a few hundred feet of the footwall contact of the Tertiary rocks. It is possible that at Phoenix the Tertiary rocks provided a 'cap' for the mineralizing

solutions. The Tertiary remnants are lenticular, and irregularly distributed throughout the Boundary country. It is not known if the B. C. basin area near Eholt was covered by Tertiary rocks, and thus the structural relations of the ore found in Oro Denora, Emma, and B. C. mines to the Tertiary rocks is unknown. The pulaskite dykes in the mineralized area are in many places so strongly altered to clay minerals and sericite that they are difficult to identify until one becomes familiar with them. This alteration may be denteric or it may be caused by the mineralizing solutions; it is certainly abundant in the mineralized area and lacking away from it.

STRUCTURE:

Our mapping indicates that the oldest Knob Hill group of volcanics and cherts is conformable, at least in places, with the overlying lenses of Rawhide shales, which in turn are conformable to the overlying Brooklyn formation. Where the Rawhide shales are absent, the Knob Hill grades into the Brooklyn formation.

In the Knob Hill group near the contact with the overlying Brooklyn formation some of the chert beds show a vague mottling suggesting that the beds originally could have been chert pebble conglomerate, in which the pebbles have almost completely fused. In other places, well within the Knob Hill group, notably west of Knob Hill along the power line, interbedded with Knob Hill chert and andesite are beds of sharpstone conglomerate. In a few outcrops the contact between Knob Hill and Brooklyn is gradational; Brooklyn formation sharpstone

conglomerate formed from chert pebbles in andesitic matrix grades into andesite containing no pebbles.

Only one series of outcrops, near Hartford Junction on the old railroad grade from Summit City, shows a contact between Knob-Hill and Rawhide formations. The rocks exposed are such that one cannot distinguish where the Knob Hill andesites terminate and the Rawhide shales begin. The northernmost of the outcrops are massive andesite, and the southernmost are bedded shales.

The Rawhide Brooklyn contact is best observed in the many small outcrops between the Rawhide mine and the West Kootenay power line. Beds of well sorted light grey chert pebbles are common in the upper strata of the Rawhide; and the bedding is almost horizontal. Near the contact with the overlying Brooklyn formation these beds become more abundant. The Rawhide formation, predominately shale with minor conglomerate, grades into the Brooklyn formation, predominantly conglomerate with minor shale.

The Tertiary rocks are separated from the Palaeozoic by an unconformity. Partially oxidized rubble is found at the base of the Kettle River arkose.

Structure

The regional trend in the mapped area is north-south, with dips steeply east, but exceptions to this attitude were noted, and indicate a series of folds with axial line plunging ten to twenty

degrees north.

The Brooklyn formation south of Twin Creek forms an east to north east dipping monocline, with an apparent plunge ten to twenty degrees north. At the western contact with the Knob Hill group the Brooklyn formation dips sixty degrees easterly; further east the dip flattens to five or ten degrees north-easterly. The topography is such that the formation appears as a northerly plunging syncline. The contact with Knob Hill group and Rawhide formation forms a semi-circle extending from west of Knob Hill - Ironsides mine through Grey Eagle, War Eagle, Monarch, Rawhide, to Curlew and Snowshoe mines.

A structural 'break' probably occurs in the valley of Twin Creek, for the fifteen hundred foot thick band of limestone west of Brooklyn does not continue across the valley to the south.

The Brooklyn formation extending in bands from Phoenix towards Eholt dips steeply east in most places, but synclinal and anticlinal rolls with north-trending axes were noted (see map).

The large copper ore bodies found in the district are replacements of limestone and impure limey beds of the Brooklyn formation. These ore bodies include the Brooklyn, in limestone at the contact of sharpstone conglomerate; the Stemwinder at the contact of limestone conglomerate with chert sharpstone conglomerate; the Granby in what are probably impure limey and andesitic beds intercalated with sharpstone conglomerate; the Oro Denora and Emma in limestone at the contact with intrusive diorite; and the B. C. mine in limestone.

CONCLUSIONS:

The area is very complicated structurally, and the structures are difficult to interpret because of the metamorphism of some of the formations and because of the lack of outcrops.

However, the geological study has indicated that the over-burden-covered areas along the old Eholt road; and in the B. C. basin are the most promising for application of geophysical and biogeochemical work. These regions are close to known ore bodies, and are probably underlain by the Brooklyn formation.

Dr. W. H. White

Dr. R. H. Seraphim

GEOPHYSICAL SURVEYS

INTRODUCTION

The Geophysical work was done by Mr. Fred S. Dunn, 247 St. Clemens Ave., Toronto 12, Ontario, and one assistant. Mr. Dunn used a calibrated magnetometer and self-potential equipment from Sharpe Instruments Ltd, 690 Bay St., Toronto.

PROCEDURE

Magnetometer work preceded self-potential work in all places. Most of the Magnetometer work followed biogeochemical work, with exception in the Eholt road area, where no biogeochemical work has been completed.

A main base station was made near the campsite, and the instrument set to the same reading on this station preceding and following each field day. Local base stations were made in each area surveyed and calibrated to the main base. Checks were made several times a day at the local base stations to determine the variation in the diurnal, and this variation was taken into account in calculating the magnetic intensity of each station.

The location of the individual areas is shown on the accompanying claim map. Stations in the B. C., Summit City, and Loon Lake areas were taken at 50 foot intervals on lines 100 and 200 feet apart as shown on the accompanying maps. The lines were surveyed with Brunton compass, cut out, and pickets put in at the stations by W. E. McArthur

and associates of Greenwood. The pickets are numbered, and corresponding numbers are shown on the biogeochemical maps. The geophysical stations and biogeochemical stations correspond in all places where both methods have been applied.

A base line was surveyed in by Brunton and tape along the Eholt road, and Brunton and tape cross lines to the west were surveyed in from the base line. A tree has been blazed and numbered - K 1, K 2, R 1, R2, etc. at each station, and the number is shown to locate these stations on the accompanying map of the Eholt Road area.

Magnetic anomalies were tested for electric current by self-potential survey. The results of the self-potential survey are shown on the geophysical maps - negative readings in millivolts are recorded below the mapped lines and at the stations.

Interpretation of the geophysical surveys of each area is as follows: (Please refer to the map of each area).

Eholt Road

Outcrops are few, small, and altered, so that interpretation of geophysical data is necessarily hypothetical. The area is on strike of the Granby mine. At least one of the outcrops in highly altered limestone. The weak magnetic anomalies trend parallel to the regional strike in neighbouring areas where outcrops occur, and these anomalies could be caused by either replacement ore lenses with low content of magnetic minerals or slight variations in amount of magnetic minerals in the country rock.

Self potential survey over these magnetic anomalies gave very

strong self-potential anomalies, not exactly co-incident but invariably close to the magnetic anomalies.

This area certainly warrants checking with a biogeochemical survey, and should be tested with a diamond drill unless the results of the biogeochemical survey are completely discouraging.

B. C. Area

The magnetic intensity shows considerable variation with no consistant trends. Several of the magnetic highs are on or close to outcrops of pulaskite dykes, but magnetic lows also occur on the same dyke or by similar dykes. This leads to the conclusion that the dykes are 'phasey' that is, vary in content of magnetic minerals from place to place. In neighbouring areas the dykes are numerous, and dip flatly west. They would tend to blanket out possible anomalies from underlying ore bodies in the steeply dipping Brooklyn formation.

The self-potential survey did not disclose any anomaly.

Loon Lake Area

The entire area is much more magnetic than the adjoining areas where fresh limestone outcrops. Variations in the magnetic intensity trend north south, parallel to the regional attitude of the bedding. Pulaskite dykes, dipping flatly westerly, are very abundant in outcrops north and south of the area, and probably occur in the area. These dykes may produce the anomalies.

The strongest magnetic 'high', in the south-west corner of the map, is very close to a pit showing fresh basalt. Basalt has been found

associated with limestone elsewhere in the district, and it, as well as the pulaskite, may cause the anomalies.

However, the area is on strike of the Oro Denora, Emma, and Jumbo mineralized zone, and notwithstanding the above mentioned discrediting factors, may merit a check by diamond drilling where magnetic and biogeochemical anomalies are proximate.

Summit City

Very little magnetic variation was found. The high in the south-west corner may be caused by an augite porphyry dyke which outcrops about one hundred feet south west of the high. No outcrops were found in the area, but the regional geology indicates that the area is underlain by limestone. No self-potential anomalies were found.

R. H. Seraphim

Dr. R. H. Seraphim

D. F. Kidd

Dr. D. F. Kidd

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BIOGEOCHEMICAL SURVEYS - ATTWOOD

INTRODUCTION

A three man crew was employed for biogeochemical surveys. Mr. T. Allen, who had one season's previous experience, did all analyses. Mr. A. Wason, mining engineer, and an assistant collected samples and did field surveying.

Surveying followed the method described for the Eholt Road area. Samples were taken from the year-before-last's growth of twig from as large a tree as possible, and preferably fir. All samples were analysed by the dithyzone method for both copper and zinc, and the Cu:Zn ratio was computed. The method follows that described by Dr. H. V. Warren and Dr. W. H. White and used by Dr. White in his work for the B. C. Dept. of Mines during the 1950 field season. All analyses are recorded on the accompanying map.

The Railroad Area is the only area surveyed by Attwood which we wish to record. All other areas were on crown-granted claims. The area is in a belt of Brooklyn limestone, hence favourable for ore deposits, but showed almost a complete lack of anomalous assays. No further work is warranted in the immediate area.

BIOGEOCHEMICAL SURVEYS - W. E. McARTHUR and ASSOCIATES

W. E. McArthur and associates biogeochemical surveys were done with the same technique as that employed by Attwood. They were instructed in the technique by Dr. H. K. Warren at the University of British Columbia. Surveying was done as described in procedure of Geophysical Surveys. Dr. M. Hedley of the B. C. Dept. of Mines has visited McArthur's project, and Dr. W. H. White has acted informally as contultant on several occasions.

Mr. McArthur has turned over his data to Attwood, and we have compiled it and endeavoured to interpret it. A map of each area is included in the report.

B. C. Area

An anomalous area of high Cu:Zn ratio is found in the southern portion of the sheet. This area is just off strike of the B. C. ore body. The anomaly was later checked by Attwood, and similar results were obtained.

W. E. McArthur diamond drilled one hole under this anomaly, but unfortunately cored pulaskite dyke under the strongest part of the anomaly. No cupiferous minerals were noted in the pulaskite or in the sharpstone conglomerate on its contacts. The area does not merit further work until the other more important areas have been investigated.

Loon Lake Area

Biogeochemical anomalies in this area trend north-south, as do the geophysical anomalies. Unfortunately, almost all the trees

along the lake shore, where the strongest anomaly was found, are alder. Our experience with analyses from alder is limited, but it appears that the Cu: Zn ratio tends to have a greater range than the ratio from other trees. Alder is thus more sensitive than other trees, and perhaps too sensitive.

The area as mentioned in the report on geophysical areas, merits further check, and should perhaps be diamond drilled where geophysical and biogeochemical anomalies coincide.

Summit City Area

An anomaly trends north-south through the area. However, about half of the trees sampled in this anomaly were alder, about which trees we have little information.

The lack of co-incidence of magnetic with biogeochemical anomalies, and the complete lack of self-potential anomaly, tend to discourage further work in the area.

Dr. W. H. White

Dr. R. H. Seraphim