GEOCHEMISTRY

34. GEOCHEMICAL METHODS OF EXPLORATION IN PERMAFROST AREAS

Project 700046

R. J. Allan, E. M. Cameron, C. C. Durham and J. J. Lynch

Introduction

R. J. Allan

Canada's land area can be crudely divided into three parts: (1) nonpermafrost; (2) discontinuous permafrost; and (3) continuous permafrost. Most study sites for this program, which began in 1969, have been in the continuous permafrost zone. This has been for three reasons: (1) geochemical exploration techniques for nonpermafrost areas are fairly well established; (2) geochemistry as an exploration method in permafrost areas was virtually untested prior to 1969; and (3) should geochemistry be successful in the continuous permafrost zone, it follows that it will likely be successful in the discontinuous zone. Three widely spaced locations were visited during the summer of 1971. The results of the studies are described. As evidenced by the variety of sample media and the variable sample densities employed, the program is designed to devise and test detailed and regional techniques simultaneously.

(a) Low Sample Density Limnic Geochemistry – A New Technique For Reconnaissance Geochemical Exploration Within The Canadian Shield

R. J. Allan, E. M. Cameron, C. C. Durham and J. J. Lynch

Much of the Canadian Shield may be characterized as country of low relief dotted with many lakes. Although some areas are covered by thick glacial deposits, which partly mask the geochemical expression of the underlying rocks, most of the Shield is bare rock or is covered by thin Pleistocene or Recent drift. This terrane is quite suitable for certain geochemical methods of exploration. The low relief has produced an often complex drainage system within which inorganic sediments are irregularly developed. Thus, conventional methods of reconnaissance geochemical exploration, using stream sediment sampling, is impractical for most parts of the Shield. An obvious alternative is to sample lake waters and sediments – limnic methods of geochemical exploration.

Because of the difficulty of travelling across typical Shield terrain, geochemical sampling must be carried out using aircraft, generally helicopters. Sampling costs are high and to cover large areas economically the sample medium must be effective at a wide sampling interval.

Sampling and analysis of lake waters has been carried out previously in the Coppermine area (approx. 68° N, 116° W), N. W. T. for copper[1], in the

Kaminak Lake area for mercury[2] and for uranium within the Beaverlodge district of Saskatchewan[3]. In all of these cases sampling at site densities as low as 1 sample per 10 square miles gave positive results. At Coppermine this density outlined a 200-square-mile zone of copper mineralization in the Coppermine basalts. At Beaverlodge, the regional pattern of uranium distribution at 1 sample per 10 square miles is essentially similar to that at 1 square mile. Within the Kaminak Lake area the mercury in water distribution at 1 sample per 10 square miles correlates well with the known distribution of bedrock types underlying glacial drift.

In addition to the study of lake waters at Coppermine, lake sediments were collected and analyzed from the same 1,500-square-mile area.[4] These samples successfully outlined the areas of anomalous mineralization at a 1 per 10-square-mile sample density. The sediments of this area give far superior results compared to water. In part this is due to the difficulty of analyzing indicator elements at the low concentrations present in lake waters.

Concurrently with the lake water and sediment sampling program in the Coppermine area, a geochemical study of the rocks of the area was made.[5] This showed that parts of the Coppermine basalts contained widely distributed minor copper mineralization or "microdeposits". It was suggested that the deposits and microdeposits of the Coppermine basalts are genetically related, the deposits being the extreme right tail of a more general frequency distribution curve of copper mineralization within the basalts.

By combining the two sets of Coppermine data, that for the rocks and that for the lake sediments and waters, it was apparent that the enrichment of copper in the limnic materials throughout the 200-square-mile anomalous area was not due to copper derived from copper ore occurrences. Instead it was caused by copper derived from copper sulphides widely distributed through the rocks of the anomalous area. Thus the successful application of reconnaissance geochemical sampling programs at a density of 1 sample per 10 square miles depends on there being a suitable dispersion through the rock unit of the economic trace element sought. This dispersion should be in the same mineralogical form as the element is expected to take in economic ore occurrences. Prior to an extensive limnic geochemical survey planned for parts of the Bear and Slave provinces of the Canadian Shield in 1972, a combined lake sediment and water and rock geochemical study was carried out during the summer of 1971 in a number of areas within these geological provinces. Transport was by a Beaver aircraft. The purpose of the study was to establish the most generally useful indicator elements for a variety of mineral deposits; and to establish the types of deposits whose associated zones of mineralization could be picked up at a coarse sampling density. Eight areas were chosen and averaged 200 square miles in size. Seven contained known or suspected mineral occurrences of varied type; one contained no known mineralization. The areas were chosen to represent other varied conditions: north and south of the treeline; discontinuous and continuous permafrost; and high and low relief.

The results of this work indicate that water methods are best used only to confirm sediment methods because the background levels of most interesting indicator elements in natural waters are often below present analytical detection limits. Analytical methods are already of sufficient sensitivity for mercury. Future efforts in our laboratories to lower detection limits will increase the effectiveness of water sampling for exploration in the Shield. This is important because waters may be collected more readily and

therefore more cheaply than sediment samples. Of significance is the fact that copper levels in lakes in the Coppermine area were virtually the same in 1969, 1970 and 1971.

The sediment data successfully outlined areas of higher trace element concentration around known economic deposits; again this appears to be caused by the microdeposit population associated with them. The size of the "anomalous" areas appears to be quite suitable for their discovery on a coarse sampling grid. "Anomalous" is used here to indicate areas of interest. These areas of interest have either very high concentrations of one trace element or higher concentrations of several trace elements relative to surrounding areas. Areas of interest because of their increased regional trace element content provide positive focus for detailed exploration to locate ore deposits. For instance, around two known greenstone belt sulphide deposits of copper-zinc and lead-zinc-silver, there were "anomalous" zones of 40 and 25 square miles respectively given by a number of different indicator elements. Although exploration can be focused in such areas of interest, this does not positively mean that areas of low trace element content do not contain mineral deposits. Because the range of trace element levels defining an anomalous zone is small, the interpretation of large scale surveys of this type can be critical.

For the Bear-Slave provinces, limnic methods of reconnaissance geochemical exploration are effective for outlining zones of higher than background metal content. These areas which are likely to be associated with mineralization serve as foci for more detailed mineral exploration. At a cost of approximately seven dollars per square mile, the methods are attractively economic. There is every possibility that the limnic method can be equally well applied to most areas of the Canadian Shield.

(b) Surficial Dispersion of Trace Elements in the Vicinity of a Ni Deposit, Raglan Area, Cape Smith–Wakeham Bay Belt, Ungava, Quebec

R. J. Allan

Samples of surface silty frost boils, sandy frost boils on eskers, stream and lake sediments and waters, snow and moss were collected above and around the ore zones of a Ni deposit (New Quebec Raglan Ltd. – approx. 61° 51'N, 73° 50'W) in Ungava. The NiS ore at this location is associated with a serpentinite sill, part of a Proterozoic geosynclinal volcanic-sedimentary sequence. Nickel is one of the elements which if present in large enough quantities can now be economically mined in the Arctic.

(i) Frost Boils

The ore areas have been disturbed by drilling activity; however, by careful selection, frost boil sample grids at approximate 100-foot spacings were collected above the main ore zones. The boils are developed in fine textured glacial drift. At locations where the serpentinite sill suboutcrops the surface is one of large angular frost-rived ultrabasic boulders and intervening silty frost boils. There is no difficulty anywhere in the area in finding frost boils, even in areas which at first glance appear to be completely felsenmeer. Silty frost boils were previously found to be the best sample medium for detailed prospecting for copper in the Coppermine River area[6].

Frost boil surface soil samples were collected from grids above three ore zones. The first ore zone suboutcrops beneath the shallow glacial cover. Ni contents in the frost boils were 300 to over 1,200 ppm in the < 80 mesh fraction. Analysis was by hot nitric acid leach and atomic absorption spectrophotometry. At the second zone, which is at shallow depth under the overlying rocks, the frost boil Ni concentrations were mainly from 150 ppm to 300 ppm. At the third zone, which is at the 700-foot-level, frost boil Ni concentrations were around 75 ppm to 150 ppm. This variation of 300 to 150 to 75 ppm Ni may be related to the formation of trace element haloes around the serpentinite and accentuated around ore pods within the sill.

These haloes may have been formed during emplacement of the sill eventually with accumulation of ore in pods, or during the serpentinization process when hot solutions may have redissolved sulphides and carried the Ni in solution along fractures and zones of weakness in the overlying and underlying rocks; in the case of Raglan, these were shales and basalt flows. The surface frost boil Ni concentrations may reflect the intersection of three haloes, in the immediately underlying bedrock, by the sample grids.

Frost boils at the edge of grid three, that above the 700-foot-level ore pod, had Ni concentrations less than 75 ppm. Also frost boils taken on a serpentinite sill thought to be unmineralized had Ni values less than 75 ppm. Should this halo hypothesis be correct, then surface frost boil sampling and analysis over large areas of mineralized serpentinite sill outcrop and suboutcrop would be a relatively inexpensive method of attempting to locate ore pods. The present method of location depends heavily on geophysics and diamond drilling. Should geophysical anomalies also be found to be geochemical anomalies or vice versa, this would be a considerable asset in deciding which to drill to locate other pods in the Ungava Ni belt.

(ii) Lake and stream sediments

Dispersions of Ni from the Raglan ore zones into stream and lake sediment reflects the presence of the mineralized serpentinite sill but did not define the location of the Raglan deposit in relation to other showings on the same sill.

The highest sediment concentrations were found in the bed of the Povungnituk River (now diverted by exploration operations). These were 100 to 200 ppm Ni. Lesser values of 75 to 125 ppm Ni were found in stream and river sediments close to the other showings immediately west of the Raglan area. Sample spacing to locate drill targets via stream sediments would have to be less than 1/4 mile to be meaningful.

(iii) Waters

The water results could not be directly used to assess the effect of the ore due to diversion of Povungnituk River by exploration activities. Samples of water taken from lakes and rivers near the Raglan sill had concentrations of 4 to 8 ppb Ni as opposed to samples taken in the vicinity of other sills which had 4 or less ppb Ni. The waters were analyzed by an organic extraction procedure and atomic absorption spectrophotometry. It would seem that collection of stream and river water samples at a sample spacing of less than 1,000-foot intervals, a very simple and rapid procedure, could help to separate stretches of sills with greater mineralization and therefore possibly greater ore potential.

(iv) Snow

The central part of the Raglan surface showing was covered with snow to a depth of 4 feet in late June. Samples of the snow from about one foot above the ground surface were collected which, on melting, produced crystal clear water apparently uncontaminated by aerosols. The snow samples contained 20 to 50 ppb Ni. Snow in general contains less than 1 ppb Ni (I. R. Jonasson, pers. comm.). Although only 15 samples were collected they did indicate the possible use of snow in the detection of underlying mineralization. The mechanisms of transport of the Ni into the snow are unknown.

(v) Colour photography

One of the significant observations was that in certain areas the frost boils with the highest Ni contents had a green coloration visible to the naked eye. There is a possibility that low-level airborne colour photography may prove useful in regional geochemical exploration in the Cape Smith–Wakeham Bay Belt.

(vi) Eskers

Samples were collected from sandy frost boils along the crests of two eskers, one about 2 miles southwest of Raglan and one about 2 miles northeast of Raglan. The sandy boil sediments were sieved to less than 40 but greater than 80 mesh and the solution obtained by hot nitric acid leach used for the determination of Ni. Ice movement was from south to north. The Ni concentrations in the surface frost boil samples from the esker to the south of Raglan were all less than 40 ppm. Those in the esker to the north ranged up to over 120 ppm and averaged 65 ppm Ni. There is some indication that sampling of surface sandy frost boils on eskers will act as regional indicators of mineralized sills. The present river drainage is in the opposite direction to the south to north glacial esker drainage and perhaps a combination of the two may be a useful regional technique.

(vii) Summary

(1) Silty frost boils are the best detailed soil sampling media.
(2) Stream sediments are not in themselves particularly successful. However only a small area was sampled due to lack of air support.
(3) Stream sediments provide greater focus when collected in conjunction with esker sandy frost boils and stream and river waters.
(4) Snow may be a possible detailed sample medium in early spring.

(c) Surficial Dispersion of Trace Elements in the Vicinity of a Pb-Zn Deposit, Little Cornwallis Island, District of Franklin

R. J. Allan

Samples of surface silty frost boils, and stream and lake sediments and waters were collected above and around the Eclipse ore zone (about 1 million tons 12.43% Zn, 2.18% Pb) on little Cornwallis Island (approx. 76° N, 97° W). This is a Pb-Zn deposit, owned by Bankeno Mines and

Cominco Ltd., that is associated with Paleozoic carbonates. Only recently another Cominco owned Pb-Zn deposit at Polaris on Little Cornwallis Island, has been reassessed to be of potentially large tonnage based on widely spaced drill holes. Pb-Zn is a commodity that along with Cu and Ni could possibly be economically mined in the Arctic.

(i) Frost boils

The surface frost boil samples taken from immediately above the ore zone contain between 3 and 7 per cent Zn. Contents in a false pedogeochemical anomaly located by soil sampling (Cominco Ltd., pers. comm.) were 0.1 to 0.6 per cent Zn in surface frost boils.

(ii) Stream and lake sediments

Sediments from two streams possibly draining the ore zone to the north and south contained 500 to 600 ppm Zn. Higher values relative to streams not affected by known mineralization were maintained up to 1.5 miles from the ore zone. Concentrations of Zn in stream sediments were considered anomalous when greater than 100 ppm in the < 80 mesh fraction. There are not sufficient lakes in the area to make lake sampling a feasible regional exploration method. The small lakes closest to the ore zone, about 0.5 mile away, had 190 and 84 ppm Zn, whereas those distant from the ore zone contained 30 to 50 ppm Zn in their sediments. However, streams in the area are easily visible, often appearing from the air as dark black lines on a brown and yellow background. Although the streams dry out, sediment can always be readily obtained. Weathering is intense and the rock types in the area, shales and carbonates, are reduced to deep weathered overburden. At least on Little Cornwallis Island, glacial transport appears to be minimal, as subcropping rock boundaries can be traced by changes in the colour of the silty surface frost boils. Based on these conditions, and similar pilot study results, the area is ideal for regional stream sediment geochemistry. Such a regional geochemical survey was carried out in the late 1960's by Cominco Ltd. Anomalies were located on favourable rock types on Cornwallis Island and certain of these are now being explored in more detail. Regional stream sediment geochemical surveys in this part of the Arctic Islands is a feasible and useful exploration technique.

(iii) Stream and lake waters

Water samples from the stream draining the ore zone to the north had up to 40 ppb Zn. The presence of the ore zone could be detected by higher than normal zinc concentrations for up to 1 mile. None of the other streams, including that possibly draining the ore zone to the south, had anomalous zinc contents. Pb concentrations were anomalous only at sites immediately above the ore zone. Collection of waters at sample spacings of 1,000 feet maximum, at the end of the spring run-off, could be used as a confirmation technique for stream sediment sampling later in the season.

Future Analytical Determinations and General Conclusion

R. J. Allan

The samples of surficial materials, soils (frost boils), and stream and lake sediments collected at three main locations mentioned so far, i. e. Coppermine, Ungava and Little Cornwallis Island areas, will be analyzed in detail to investigate the dispersion phases and mechanisms for these elements in the permafrost zone. Selected samples of specific materials will be analyzed in several ways to determine the physical, chemical and mineralogical controls on the dispersion process. The three sample locations are in the western, eastern and high Arctic respectively.

The results presented above already show that at all locations the surficial dispersion of trace elements is sufficient to indicate the successful use of geochemical exploration at both detailed and regional levels. It will not be successful in all cases but, as geochemistry is a relatively inexpensive exploration tool, this should be no deterrent to its use in mineral exploration in permafrost areas.

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35. GEOCHEMISTRY OF GOLD DEPOSITS

Project 650438

R. W. Boyle

During the field season June–November 1971, sampling of materials for the study of the distribution of gold and silver in rocks was carried out in southwestern Ontario, eastern Ontario, and northern Ontario.

Point Pelee National Park was visited and samples of the soil, glacial and lake sand, and surface waters were collected for ecological studies.

The E. G. M. A. area of northern Ontario and Quebec was visited for two weeks by J. P. Lalonde preparatory to beginning a study on the ground waters in the area in 1972 (Project 710078).

36. PORTABLE INSTRUMENTATION FOR DETECTION AND MEASUREMENT OF Hg, As and Se

Project 700087

Q. Bristow

Work has continued on the development of the quartz crystal mercury vapour detector for soil gas measurements and several modifications were made to the injection system to improve the collection efficiency of the gold electrode surfaces. Approximately half of the mercury in the air stream is now purged out by the gold surfaces, even though their total area is only 0.4 cm^2. A series of laboratory calibrations were carried out to check the reproducibility of the crystals after heating to drive off accumulated mercury; the results were not as good as had been hoped for in this regard and an explanation is still sought for the discrepancies which have arisen.

A very brief field test was made over the cinnabar showing at Clyde Forks, Ontario to see if significant amounts of mercury could be detected in the soil gases there. The method consisted of drilling a 1-inch diameter hole with a hand auger, and inserting a tube around which a sealing cone was fitted, to a depth of approximately 1 foot, the cone sealing the top of the hole. A hand pump was then used to inflate a small air cushion, volume approximately 4 litres, which acted as a reservoir buffer to maintain a flow of one litre/minute over the crystal electrodes via a pressure regulator. Significant readings were obtained with the instrument but contamination of the pump by soil particulates threw doubt on the later results. However, the results are considered sufficiently encouraging to warrant a further field test using a more efficient type of probe.

A commercial high sensitivity mercury vapour detector, working on the atomic absorption principle and designed primarily for atmospheric monitoring, was tested both at the Clyde Forks location and in the Noranda area. No clear evidence of atmospheric mercury aureoles was found at ground level over any of the test areas selected. High soil gas readings (120-1300 nanograms/m^3) were obtained at Clyde Forks but much lower levels (less than 200 nanograms/m^3) were found at the selected test sites in the

Noranda area. A more efficient method of gas extraction and a smaller absorption cell might well effect a considerable increase in the overall sensitivity technique.

A prototype version of an atomic absorption instrument specific to mercury, and having a relatively small absorption cell volume, has been designed and is now under construction.

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37. FEASIBILITY STUDY OF GEOCHEMICAL SAMPLING OF ARCTIC COASTAL STREAMS BY HELICOPTER FROM DEPARTMENT OF TRANSPORT ICEBREAKER

Project 710009

Willy Dyck and G.M. Thomas

To determine the feasibility of sampling streams along coastal waters of Arctic Islands using the helicopter on board a Department of Transport icebreaker, without interfering in the routine operation of the ship, a two-man party boarded the John A. Macdonald at Dartmouth early in July, 1971.

During the period July 9 to August 19, 1971, 69 water and sediment samples from 54 stream sites were collected from 8 regions. At 15 of these sites another sample from the brackish water zone, where the stream entered the sea, was also collected. Of the factors influencing sampling, the ship's route and weather were most decisive. The approximate location of the areas and the number of samples from each area are: Hudson Bay–Churchill River (19); Hudson Strait–Barrier Inlet (3); Deception Bay (9); Frobisher Bay–Buerger Point (7); Chase Island (5); York River (7); Ungava Bay–George River (4); Devon Island–Hope Monument (6); Croker Bay (9). The most striking features near glaciers, like those encountered at Frobisher Bay and Devon Island, are the short V-shaped stream beds, the unglaciated mountains with evidence of extensive weathering, large talus slopes, and abundant sediment at the mouth of streams. The well-rounded hills and gentler topography in the Ungava Bay and Hudson Strait and the flat relief around Churchill provided marked contrast.

The water samples were analyzed on board ship for radon, alkalinity and, using specific ion electrodes, pH, eH, oxygen, calcium, divalent, and chloride ions. A one-litre water sample was acidified with nitric acid for further analysis at headquarters. The 5- to 8-pound samples of sediments were dried in the helicopter hangar before packing for shipment to headquarters.

The analyses on board ship showed that the waters were essentially saturated with oxygen at the temperature and pressure at the sample site and fluctuated around 11 ppm; eH values were found to be about 160 to 210 mv with respect to the platinum electrode. Radon concentrations were generally near zero; however, waters from granitic regions contained easily detectable amounts of radon. The alkalinity test and the determinations of pH, calcium-, divalent-, and chloride ions gave clear evidence of rock types comprising the hinterland (e.g. limestone) and the intermixture of traces of sea water.

It is considered that the additional effort and cost required to obtain immediate analytical results on board ship is not warranted in view of the

small number of samples that can be collected in any one season. Such analytical work could be done in the Ottawa laboratories by sending samples back during stops made by the ship at points served by scheduled aircraft. A detailed report will be prepared when all analytical results are available.

On the basis of this year's feasibility study, it is evident that, by omitting the laboratory and putting only one experienced student on a ship for the summer months, the method is an attractive and economical way of collecting geochemical information from the Arctic coastline, a region where normal field operations are very expensive.

38. REGIONAL GEOCHEMICAL CENSUS OF PLUTONIC ROCKS IN EASTERN YUKON TERRITORY (95 E, L, parts of 105 H, I)

Project 690036

R. G. Garrett

The regional rock sampling program commenced in 1970[1,2] was continued and completed. The Cretaceous acidic intrusions lying in NTS sheets 95 E and L, and the northeast half of 105 H and the southeast half of 105 I, were sampled. Approximately 8,000 square miles of mountainous terrain in the Yukon and Northwest Territories were covered, of this area only 1,750 square miles are intrusive acidic rocks. In 15 working days 934 samples were collected from 467 sites with the aid of a Bell 47G-3B helicopter; the majority of sites were between 5,500 and 7,000 feet above sea level, with extremes at 3,500 and 8,100 feet. Samples of the enclosing sedimentary rocks were also collected as had been done during the 1970 field season.

The sampled rocks of the southern part of the Selwyn plutonic belt can be divided into three groups. Firstly, coarsely porphyritic granodiorite and quartz monzonite, typical of the larger intrusions. Secondly, a finer grained variety of similar rocks mostly found around the margins of the larger intrusions and in small stocks; however, it should be mentioned that some small stocks are formed of porphyritic varieties. Lastly, in the northeast part of the Francis Lake sheet (105 H) an extensively altered variety occurs in which there is evidence of post-intrusive movement, as indicated by foliation and a generally sheared appearance together with a development of chlorite and epidote.

Three features of interest were noted which may have some relation to areas of mineral potential.

Firstly, in the intrusion southeast of Skinboat Lakes (NTS 95 E) two sites, approximately six miles south and on the western edge, were of interest. The first (UTM 09 626300 6774900) is a local area of hematitized quartz monzonite containing some arsenopyrite; and the second (UTM 09 627900 6775100), one mile to the east, is a local area of quartz diorite with minor tourmaline veins.

Secondly, at the southern end of the large intrusion lying between Coal River and West Coal River (NTS 95 E) two sites were visited where fine-grained quartz monzonite (UTM 09 567900 6773700) and a coarser grained variety (UTM 09 568600 6775900) were found to contain 2 per cent disseminated pyrite.

Lastly, a number of sites were visited in a pluton 11 miles south of Canada Tungsten (NTS 105 H) and within 2 to 3 miles of the Cantung Road, where evidence of mineralization and alteration were found. In a cirque at the south end of the intrusion (UTM 09 541200 6850700) porphyritic quartz monzonite float was found to contain rosettes of molybdenite. One mile to the north (UTM 09 541400 6852300) on the edge of a small glacier, float of both fresh quartz monzonite and greisen was obtained. One and one half miles northwest (UTM 09 540000 6854600) a schorl dyke 2 feet wide was found in an area of alaskite intrusive into the quartz monzonite of the intrusion. It is considered that the proximity of these occurrences indicates that this pluton was a focus of late stage magmatic activity and the area warrants further investigation.

The samples are currently being analyzed for a wide range of elements and any data of possible economic significance will be made available as a Geological Survey open-file report during 1972.

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39. FEASIBILITY PILOT STUDY OF GEOCHEMICAL RECONNAISSANCE METHODS IN THE ENNADAI-RANKIN BELT, DISTRICT OF KEEWATIN

Project 700062

E.H.W. Hornbrook

Field studies were conducted near Kaminak Lake in the Ennadai-Rankin Belt of volcanic and sedimentary rock, Keewatin District, Northwest Territories, in order to determine the effectiveness of regional geochemical methods, particularly those of hydrogeochemistry.

Similar studies in 1970, in which 500 ml samples of water were collected, produced useful hydrogeochemical anomalies varying in size from a few square miles to 150 square miles, in the study area of 2,500 square miles[1]. Interpretation of the data and the preparation of geochemical anomaly maps was restricted by the very low, less than 1 ppb, background element concentrations which were below analytical detection limit. In order to improve the effectiveness of the technique by developing more sensitive analytical methods, large water samples were collected this year to enable the determination of the very low background concentrations; the analytical work is in progress.

Major emphasis was placed this summer on the collection of lake and stream waters, and stream sediments, to measure the occurrence of Hg in inlet bays and streams. Stream sediments have the highest Hg content and, in general, inlet bay water samples are equal to, or greater than the inlet

stream waters in their Hg contents. It would appear that the Hg concentrations in inlet bay water samples correspond better to the Hg concentrations in stream sediments than do stream waters. The sampling carried out this year, at a density of approximately one sample per one-half mile of shoreline, is seen to be an improvement on that of last year (1 sample/10 square miles) because of the greater detail obtained. Mercury anomaly maps based on last year's data delineated major structures and discriminated between granitic plutons and sedimentary and volcanic rock in geological complexes extensively overlain by glacial deposits. The more detailed work has, in addition, indicated areas of till underlain by acid volcanics or sediments as well as the location of some of the known sources of mineralization.

Hydrogeochemical Hg surveys can thus be useful both for geological mapping and mineral exploration in these and, probably, similar till-covered sedimentary and volcanic belts, and in providing data of interest to environmental scientists.

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40. GEOCHEMICAL AND BIOGEOCHEMICAL SURVEYS IN THE TIMMINS–VAL D'OR AREA

Project 710079

E. H. W. Hornbrook

Mining Camps in the Timmins, Kirkland Lake, Rouyn–Noranda and Val d'Or areas were visited during August, 1971.

Samples of rock, basal till, clay, developed soil horizons, peat, vegetation, both lake and stream waters and sediments, and natural spring waters were collected with emphasis upon sediments and waters.

Intensive sampling was carried out adjacent to known mineralization in order to detect the presence of element haloes and to determine their intensity in various surficial materials and their size. Samples were also collected on a regional basis to obtain element background values and to determine, if possible, the relationship of the geochemistry of surficial materials to geology, structure, and the distribution of glacial sediments. At present, only the determination of Hg has been completed; no significant Hg occurrence or distribution was found, although a few sample sites had Hg concentrations above background.

There is a good potential for geochemical exploration, although its present use is not as common as that of exploration geophysics. In the selection of a drill target, use can be made of the geochemistry of basal till in clay

terrain to discriminate among several geophysical anomalies. The application of rock geochemistry can be effective where outcrops are abundant and, where lacustrine clays are absent, surficial geochemistry may also be effectively used for local studies.

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41. MERCURY IN SOIL GAS APPLIED TO EXPLORATION FOR SULPHIDE ORES

Project 690091

I. R. Jonasson

Work continued through 1970-71 on various aspects of the above project. Field work was restricted to short excursions into the Clyde Forks area, Lanark County, Ontario in both summer and winter. During the summer, routine sampling of soils, rocks, waters and sediments over a small mineralized area continued, with a view to further detailing geochemical distribution of mercury about known mineralization.

A beginning was made on a sampling program designed to assess the value of using mercury vapour in soil gases to map, in this case, the extensions of mineralized veins consisting mainly of tetrahedrite. So far, the results are quite favourable – soil gas mercury does in fact show anomalous levels along the strike of the mineralized veins. Anomalies produced from soil gas data coincide with those outlined by conventional pedogeochemical methods (see Geol. Surv. Can., Paper 71-1, Pt. A, p. 74). The instrumentation used for soil gas measurements was designed by Scintrex Canada whose scientists co-operated in the testing program (see Bristow, Q., this publ.).

Because of the anticipated mobility of soil gas mercury, it was considered reasonable to assume that mercury vapour may find its way into winter snows overlying mineralization. To check this possibility a series of samples of snow were taken at different depths over soils known to contain >500 ppm Hg and over soils known to contain <1 ppm Hg. Over unmineralized ground the mercury content of three feet of snow sampled at one-foot intervals was less than the detection limit of 0.01 ppb. Over mineralization, a concentration gradient was found for mercury in five feet of snow which ranged from <0.01 ppb at the surface of the snow to 0.52 ppb at one foot above ground level. Moreover, similar fifty-fold concentration gradients were found for Cu, Zn and Pb in the same samples.

These findings add considerable impetus to the search for other vapours emanating from sulphide deposits and which may find application in geochemical prospecting. It is considered likely that the source of all of the metals in snow, including mercury, is from volatile compounds produced in some way within the soils.

The recent acquisition of an integrated gas chromatography-mass spectrometer unit has provided for the project a capability which will enable direct measurement of concentrations of such vapours in soil gases as well as to assist in defining their chemical character. The instrumentation has been installed and is undergoing testing and adaption to the needs of the soil gas program.
