GEOCHEMISTRY

21. GEOCHEMICAL STUDY, MANITOUWADGE, ONTARIO (42 F/4)

Project 670097

R. G. Garrett

As part of a general program to investigate systematically the application of geochemical prospecting methods in the environment of the Canadian Shield a three-month (June-August) field program was undertaken in the region of Manitouwadge, Ontario.

The field area covered the synformal structure of Archean rocks containing the known sulphide zones. The ore assemblage consists of pyrite, pyrrhotite and chalcopyrite, with lesser amounts of sphalerite and galena. The glacial history of the area is complex (see also D. R. Grant, this report). Near the known orebodies the till is of distant origin and highly calcareous. An earlier till of more local origin was recognized in only a few localities on the south slopes of major hills where pockets were protected during a readvance of the ice sheet from the north. In the surrounding country there is abundant evidence of glaciofluvial and lacustrine activity.

Tills, soils comprising humisols and podsols, and stream sediments were collected and Cu, Pb, and Zn determined in the -80 mesh fraction by colorimetry after a potassium pyrosulphate fusion. In addition, vegetation samples, spruce twigs and birch bark were collected over the Big Nama Creek Mines orebody for later study.

Anomalous levels of Cu, Pb, and Zn were observed in the soils and at the top of the till sheet over deposits at Geco Mine and Big Nama Creek Mine when the till thickness was less than 4 feet. Where the till thickness was greater than 4 feet, anomalies were not observed in either the soil or at the top of the till sheet. Detailed profile sampling over the Big Nama Creek Mines orebody indicated that anomalous levels are generally restricted to the bottom 2 feet of till for Cu, and bottom 3 feet for Zn. No down-ice dispersion of metal caused by mechanical transport was noted. The anomalies are hydromorphic and the highly calcareous nature of the till certainly restricts the dispersion pattern, less severely in the case of Zn due to the amphoteric nature of that element. The hydromorphic nature of the anomalies makes the dispersion patterns highly dependent on the groundwater regime and subcrop topography.

The stream sediment sampling and analysis revealed patterns of Cu distribution, and to a lesser extent Pb and Zn, which could be related to the major features of the bedrock geology and Pleistocene history. Stream sediments appear to be a successful exploration tool in areas of high relief in the central and eastern parts of the synform. However, to the west where relief is gentler and the area was probably once covered by glacial lakes, the results are not encouraging. A number of weakly anomalous zones were outlined by the survey but these were not followed up.

Any general conclusions as to the applicability of geochemistry as an exploration tool on the Canadian Shield would be premature as features of the work carried out are both encouraging and discouraging. One important point, however, is clear from this past work; a thorough knowledge of the Pleistocene history of any area is very necessary before correct sampling techniques and interpretation criteria can be devised.

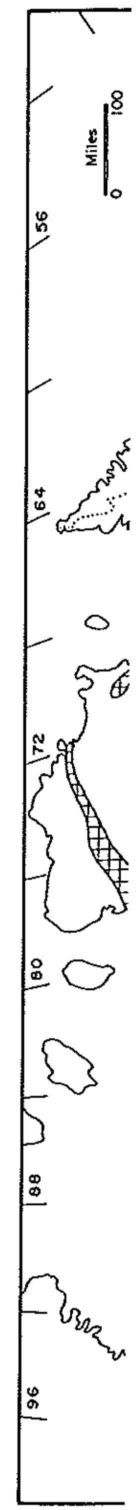
22. GEOCHEMICAL STUDY OF BLACK SHALES AND ASSOCIATED SULPHIDE DEPOSITS, ONTARIO AND QUEBEC

Project 680021

A. Baumann

The purpose of this study is to determine whether the black shales in the eastern part of the Canadian Shield are important as low grade ore deposits. Other aspects to be investigated are the problems of the possible genetic relationship of these sediments to nearby ore deposits and the sedimentary processes and the environment leading to the formation of these shales in Precambrian time.

The field work carried out in June and July 1968 consisted of the sampling of black and dark grey shales, slates, and argillites in the Precambrian of Ontario and Quebec. Rocks with a visible sulphide content and a graphite content have been preferentially sampled. Approximately 800 samples were collected from 180 localities.



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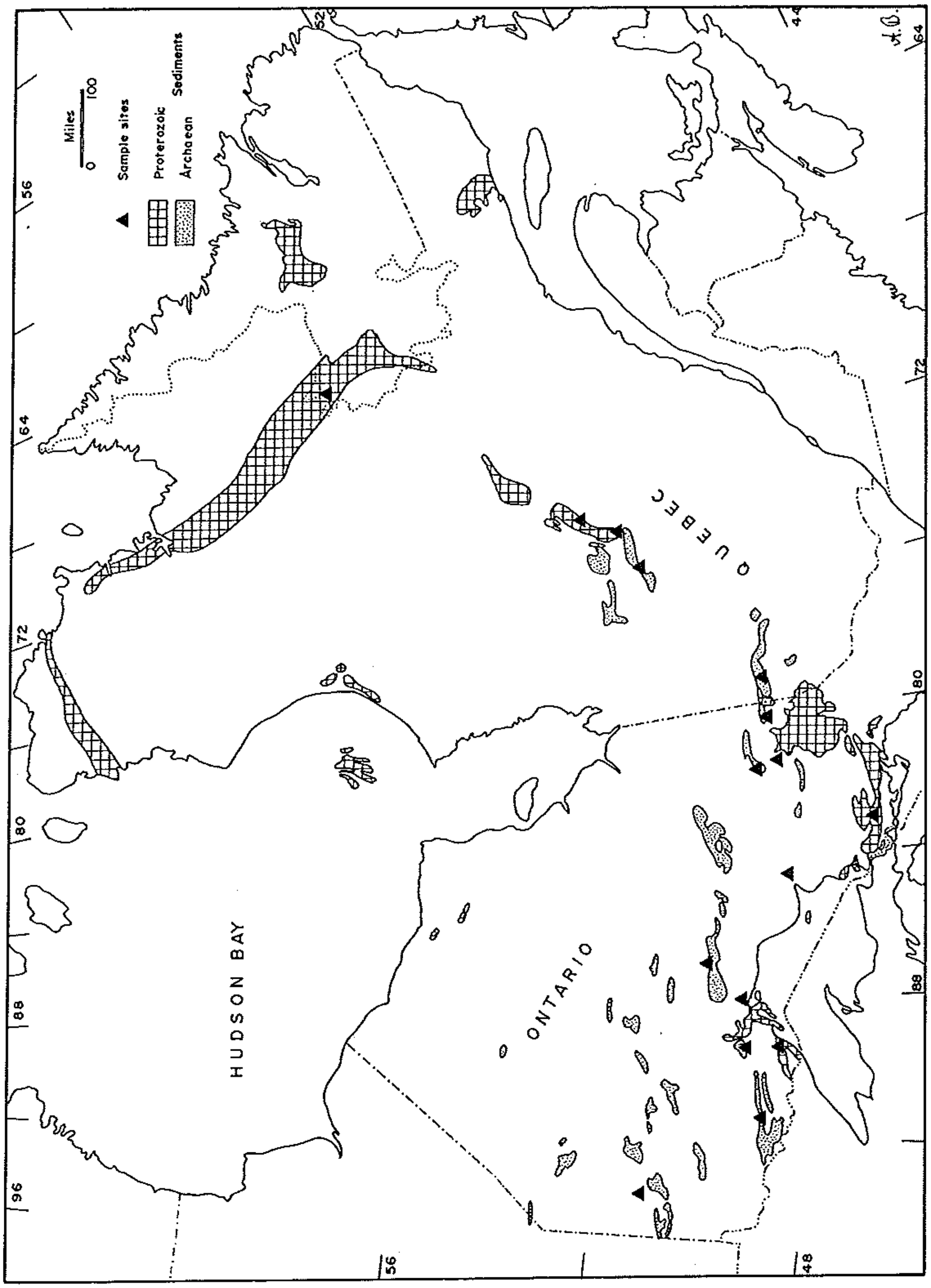

Figure 1. Map showing the Precambrian sediments in Ontario and Quebec and the main sample sites.

The main sampling locations (Fig. 1) for Precambrian fine-grained sediments and metasediments were:

in the Archean:

Lac des Iles area) Geralton area) Timmins area) Montreal River area) Larder Lake area) River Kenojevis area) Desmeloizes area)	Timiskaming
Michipicoten area) Atikokan area) Red Lake area) Amos-Barraute area)	Keewatin

in the Proterozoic:

Blind River area) Iron Bridge area) Maisonville area)	Gowganda Formation
Lakehead area	Rove and Gunflint formations
Bignell area	Chibougamau Series
Lake Albanel area	Mistassini Series
Schefferville area	Knob Lake Group (Attikamagen, Ruth and Menihey formations)

The majority of the 800 samples are surface samples. Diamond-drill core samples were collected when available. Field data cards have been prepared for a later computer analysis.

Antimony, arsenic, molybdenum, and tungsten have been determined by colorimetric methods, uranium by a fluorimetric method: 147 samples were chosen for a preliminary review; tungsten and uranium were not detectable (< 2 ppm) in these samples and thus were not determined in the remaining samples.

Cobalt, copper, lead, nickel and zinc are being determined by atomic absorption spectrometry. The data will be prepared for a statistical analysis.

23. DEVELOPMENT OF RADIOCHEMICAL EXPLORATION METHODS USING RADON, ONTARIO AND QUEBEC

Project 680028

Willy Dyck and J. C. Pelchat

Radon determinations in surface waters and soil gases made during the 1967 field season were encouraging enough to warrant the construction of an instrument which would permit in situ measurements of radon in soils as well as in waters for the investigation of the behaviour of naturally-occurring radon in more detail.

The instrument and procedure adopted for this season's work made possible the detection of both radon-222, normally referred to as radon, and radon-220, also known as thoron, in soils. In this discussion the two isotopes will be referred to as radon and thoron, respectively.

Current investigations were carried out in three different geological environments - Gatineau Hills, Quebec, Sudbury, and Elliot Lake, Ontario and consisted of detailed radon distribution studies in lakes and radon determinations in soil emanations in the respective areas.

Gatineau Hills

The high radon levels in Fortune and Kingsmere lakes in Gatineau Park, detected in the 1967 survey, are traceable to radioactive pegmatite dykes and weathered radioactive material associated with the dykes. These were traced by determining in detail the radon distribution in the lakes and measuring the radon emanating from the soil around the lakes and up the slopes. Large seasonal variations in radon concentrations (factors of two to four) were observed in individual lakes as well as in soil sampling sites, but patterns of highs and lows along traverses were roughly reproducible throughout the season.

Elliot Lake

In the Elliot Lake area the gamma ray intensity and radon-thoron emanations over a typical subcrop of uraniferous conglomerate was determined. This is shown in Figure 1. The overburden depth varies between five and fifteen feet. The three radon-thoron graphs represent three, successive, one minute counting intervals of a soil gas sample taken from a freshly made hole one foot in depth. The minute to minute decrease in the number of counts at most test sites is due to the prevalence of the short lived (54.5 sec) half life of thoron. The relatively larger minute to minute decrease in the number of counts at the lower concentrations indicates a relatively larger thoron content at these lower concentrations. The important factor to note is the activity ratio of approximately 15 for peak to background radon-thoron levels, whereas the gamma ray intensity ratio for the same soil stations is 3. Boulders and/or outcrop gamma ray intensities increase the peak to background ratio across the deposit to ten.

Determinations of radon in water were confined to a detailed study of three small lakes (approximately 0.1 square mile each) in the southern end of the Elliot Lake uranium belt, and to several sections of Ten Mile Lake. Two of the lakes had received contaminated water several years ago via a water supply line. Radon values varied from about 10 to 400 pc/l and clearly indicated the direction of surficial as well as subsurface flow. The other small lake, not in the main drainage channel, showed radon concentrations barely exceeding the sensitivity level of the instrument. Although some shore water samples from Ten Mile Lake contained easily detectable radon levels (5-15 picocuries per litre (pc/l)) and the creek deltas concentrations of up to 75 pc/l, the radon levels 50 feet offshore seldom exceeded 4 pc/l. Generally speaking, the radon abundance in uncontaminated lakes showed the following order: surface shore > offshore bottom > offshore surface.

Sudbury

In order better to evaluate the results obtained in the two areas noted above and to obtain a measure of the radon levels in geological environments without uranium deposits, a number of tests were carried out in the eastern quarter of the Sudbury Eruptive. Soil emanation determinations were carried out across outcropping and buried nickel-copper deposits, contact zones between norite and granite, norite and quartz diorite, and norite and greenstone, and across a stretch of gravel. Except for the gravel, soil

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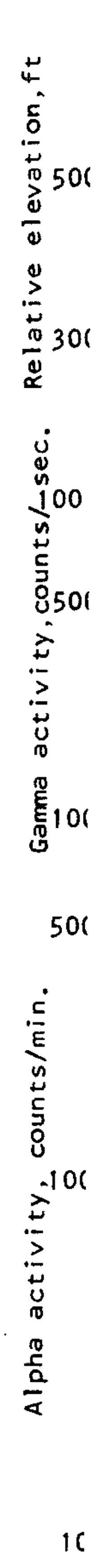
Figure 1.

A. Geological cross-section, Elliot Lake area.

B. Surface gamma ray activity at radon-thoron test sites.

C. Radon-thoron alpha activity of soil gas samples from freshly made holes, one foot deep. Dots indicate first minute-, stars second minute-, and triangles third minute counts. The dotted line indicates average first minute counts obtained from emanations from gravel sites in the Sudbury basin.



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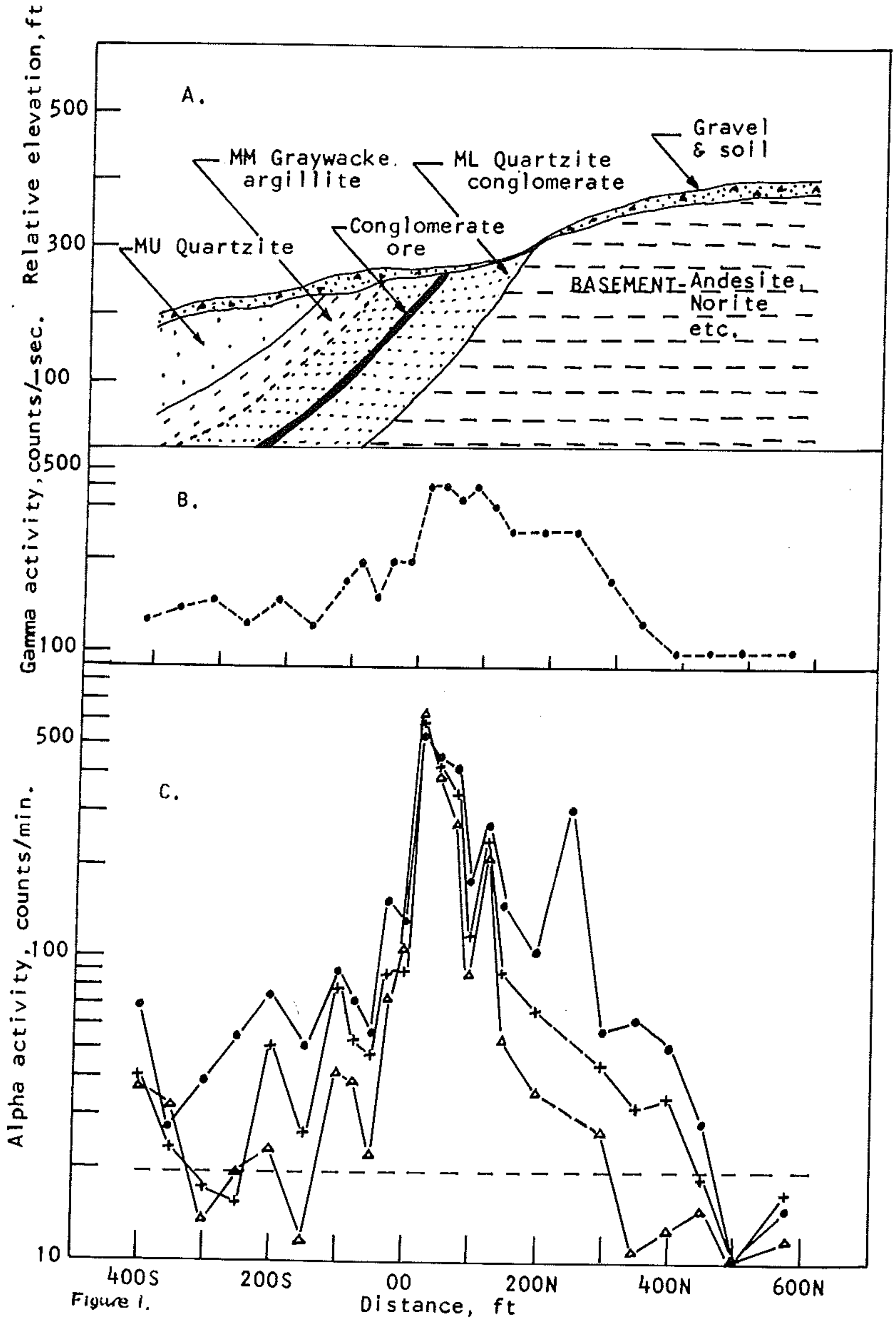

Figure 1.

thicknesses were such that it was difficult to find enough soil in which to make a hole one foot deep. Although radon and thoron were present in detectable quantities in soils over all formations, with thoron predominating, no significant variations in levels could be detected between rock formations. Only the gravel gave somewhat higher readings. The average first minute count of emanations from 16 gravel sites was 21. This average is indicated by the dotted line in the figure below. The second and third minute averages were roughly 10 and 7 counts, respectively.

Surface water radon concentrations from about 130 easily accessible sample sites, distributed over 200 square miles of the eastern quarter of the Sudbury Eruptive, ranged from 0 to 112 pc/l. The higher values can be correlated roughly with running water (creeks) and/or red, coarse-grained granite. The highest concentration was found in a small nameless beaver lake located 5 miles north of Capreol. The range and average radon concentration of 37 samples taken from sites along the shore and the middle surface and bottom were 448 to 17 pc/l and 52 pc/l, respectively. Noticeably higher radon values in the northern or inflow end of the lake suggest that the radioactive matter was carried into the lake. Except for one small granite outcrop near the lake, which gave a gamma ray activity of about 10 microroentgens per hour, or twice that of most granites in the area, no source for the comparatively high radon level in the water was evident.

24. DEVELOPMENT OF BIOGEOCHEMICAL EXPLORATION METHODS FOR METALLIC MINERAL DEPOSITS FOR WINTER USE, COBALT, ONTARIO (31 M/5 AND 12)

Project 680051

E. H. W. Hornbrook

The effectiveness of biogeochemical exploration methods for detecting the silver vein deposits at Silverfields Mining Corp. Ltd., Hi Ho Silver Mines, Ltd., and Agnico Silver Mines Ltd., in the Cobalt, Ontario area, was evaluated during the summer of 1968.

As in previous summers, all operational phases of exploration were carried out simultaneously. These included: the operation, by a three-man crew, of the spectrographic analytical facilities housed in two mobile trailer laboratories; the operation, by a two-man crew, of the atomic absorption analytical facilities set up in laboratories of the Northern Institute of Applied Arts and Technology at Haileybury; the collection, by a three-man crew, of soil and vegetation samples; the making, by a two-man crew (under the direction of G. D. Hobson), of shallow seismic investigations to determine the depth of surficial material along profiles.

Approximately 2,000 samples of soil and vegetation were collected from 560 stations, and were prepared and analyzed during two and one half months. Samples comprised B horizon and A horizon material, and bark, twig and leaf organs of trembling aspen and white birch.

As a result of a preliminary examination of about 15,000 single element determinations that have been compiled to date, the following observations are warranted: the A horizon concentrates silver and associated elements relative to the B horizon and it is a more useful horizon to examine for geochemical exploration. Certain elements, which are concentrated in specific tree organs, show anomalous amounts over silver-bearing veins. Where surficial material is less than 10 feet thick the anomalous amounts are probably related to individual vein systems. For most elements, the lowest concentrations found in tree organs collected near a silver deposit are substantially greater than those found in background areas remote from silver mineralization. Therefore, biogeochemical exploration methods may be an effective regional exploration method in the Cobalt area.

25. THE GEOCHEMICAL COMPOSITION OF ULTRAMAFIC ROCKS AND ITS RELATION TO THEIR CONTAINED MINERAL DEPOSITS, MANITOBA, ONTARIO, QUEBEC

Project 680061

Gordon Siddeley

An investigation is being made of the possibility of using rock geochemistry as an indicator of the ore-bearing potential of ultramafic bodies, and thus as a guide in mineral exploration.

Approximately 730 samples have been collected from a field area between Lynn Lake (Manitoba) and Eastern Townships (Quebec). They consist of dunites, peridorites and pyroxenites, with a few talc-chlorite schists, hornblendites, etc. During the summer, samples were sent to the Ottawa laboratories for the determination of major and trace elements by chemical and spectrographic methods.

Fifty sampling localities are represented. Fourteen of these are ore-bearing or with good ore potential, twenty-two are considered barren (from earlier exploration) and fourteen have unknown ore-potential. The chemical data (as yet incomplete) will be used to compare the ore-associated type with the barren type. If significant differences are determined, then the group with unknown ore-potential will be examined, and on the basis of its geochemistry, assigned to either the potentially ore-bearing or barren group. The chemical data will also contribute to a geochemical census of Canadian ultramafic rocks.

Geological investigations have revealed a variability in ore occurrences associated with ultramafics. This may be attributed to factors such as structural control, magmatic segregation, or wall-rock reaction. Some ores have clear genetic affinity with the ultramafic intrusion (at Werner Lake and Moak Lake), whereas others appear to have nothing more than spatial association (as at Lynn Lake and Chibougamau).

26. DEVELOPMENT OF GEOCHEMICAL EXPLORATION METHODS FOR URANIUM, BANCROFT AND ELLIOT LAKE, ONTARIO (31C, 31D, 31E, 31F; 41J)

Project 670030

A. Y. Smith

Following last year's feasibility studies on the use of radon-222 in surface water as a reconnaissance tool in uranium exploration, two programs were carried out to test this technique on a regional scale. An area of 1, 650 square miles in the Bancroft district was covered with both lake and stream water samples at a density of approximately one sample per two square miles. In the Elliot Lake region an area of 560 square miles was covered with lake water samples only, at a density of approximately 1.5 samples per square mile. The sample collection was made by means of motor vehicles, small fixed-wing aircraft and helicopters. Water temperature, air temperature, barometric pressure, pH of the water, water turbulence and other descriptive factors were recorded for each sample site. Determination of radon-222 was carried out within 24 hours of collection at centrally located field laboratories in each area. Uranium determinations on all Bancroft and Elliot Lake water samples were done fluorimetrically in a mobile field laboratory located at Elliot Lake.

Although the assessment of the large amount of data collected is not yet complete, some preliminary remarks are warranted. As was found last year, stream and creek waters contain a higher level of radon in the Bancroft region than do lake and pond waters. In the Bancroft region the method is apparently successful in outlining areas of increased uranium potential. At Elliot Lake the radon levels are markedly lower than at

Bancroft. The reasons for this may be that: (1) only lake waters were collected at Elliot Lake and would be expected to have a lower level of radon; (2) much of the most suitable drainage at Elliot Lake is contaminated with radium and radon from mine wastes and had therefore to be excluded; (3) many of the smaller lakes and ponds at Elliot Lake are apparently not in contact with the main water-table but reflect local, perched water-tables and thus do not receive supplies of radium and radon from groundwater sources. Undoubtedly many other factors are at work in the observed distribution of radon in surface waters. The method will require careful orientation studies prior to its application to an area. An understanding of many facets of the surficial landscape and groundwater regime will be required for correct interpretation of field data. Such, however, is the case with any geochemical method.

In southern New Brunswick and Nova Scotia, terrestrial sediments of Carboniferous age have been considered to have some uranium potential because of their similarity to uraniferous sediments on the Colorado Plateau. Samples from stream sediment surveys made in 1958 to 1961 were available, and it was decided to make a preliminary assessment of the area by analyzing these samples for uranium. Although this work is not yet completed, initial results from the Moncton Basin area of southern New Brunswick show an increased uranium content over certain of the Carboniferous formations, notably the Hillsborough and parts of the Albert formations. Also, the results clearly show no association of uranium with known copper sulphide deposits of the red bed type, such as the Dorchester Mine. It is too soon to tell whether economic concentrations of uranium are indicated, but investigation has already demonstrated the value of this approach.