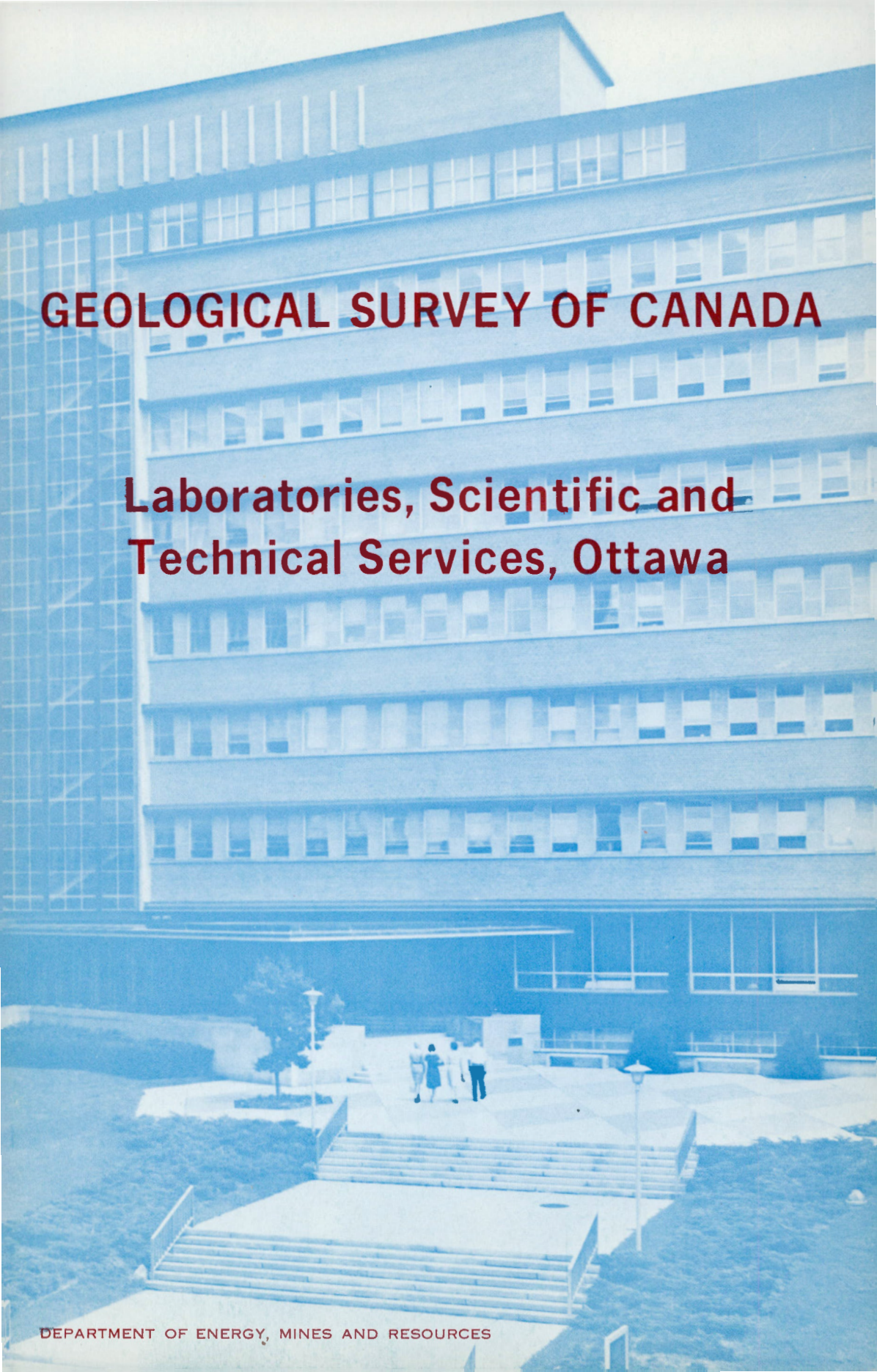
GEOLOGICAL SURVEY OF CANADA

Laboratories, Scientific and Technical Services, Ottawa



DEPARTMENT OF ENERGY, MINES AND RESOURCES

GEOLOGICAL SURVEY
OF CANADA

CANADA

Miscellaneous Report 17

LABORATORIES, SCIENTIFIC AND TECHNICAL SERVICES, OTTAWA
1972

Peter Harker

DEPARTMENT OF ENERGY, MINES AND RESOURCES

Information Canada
Ottawa
1972

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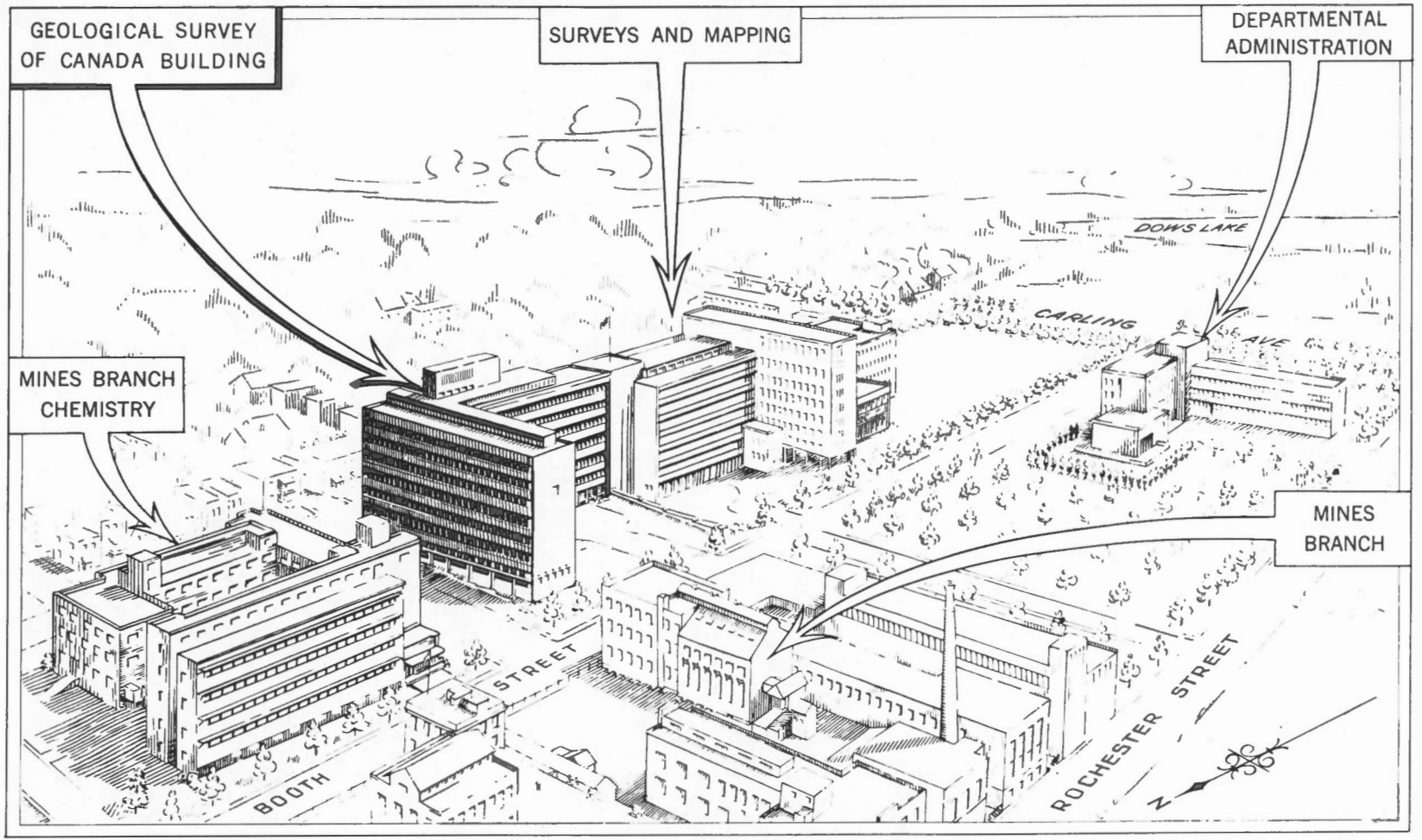
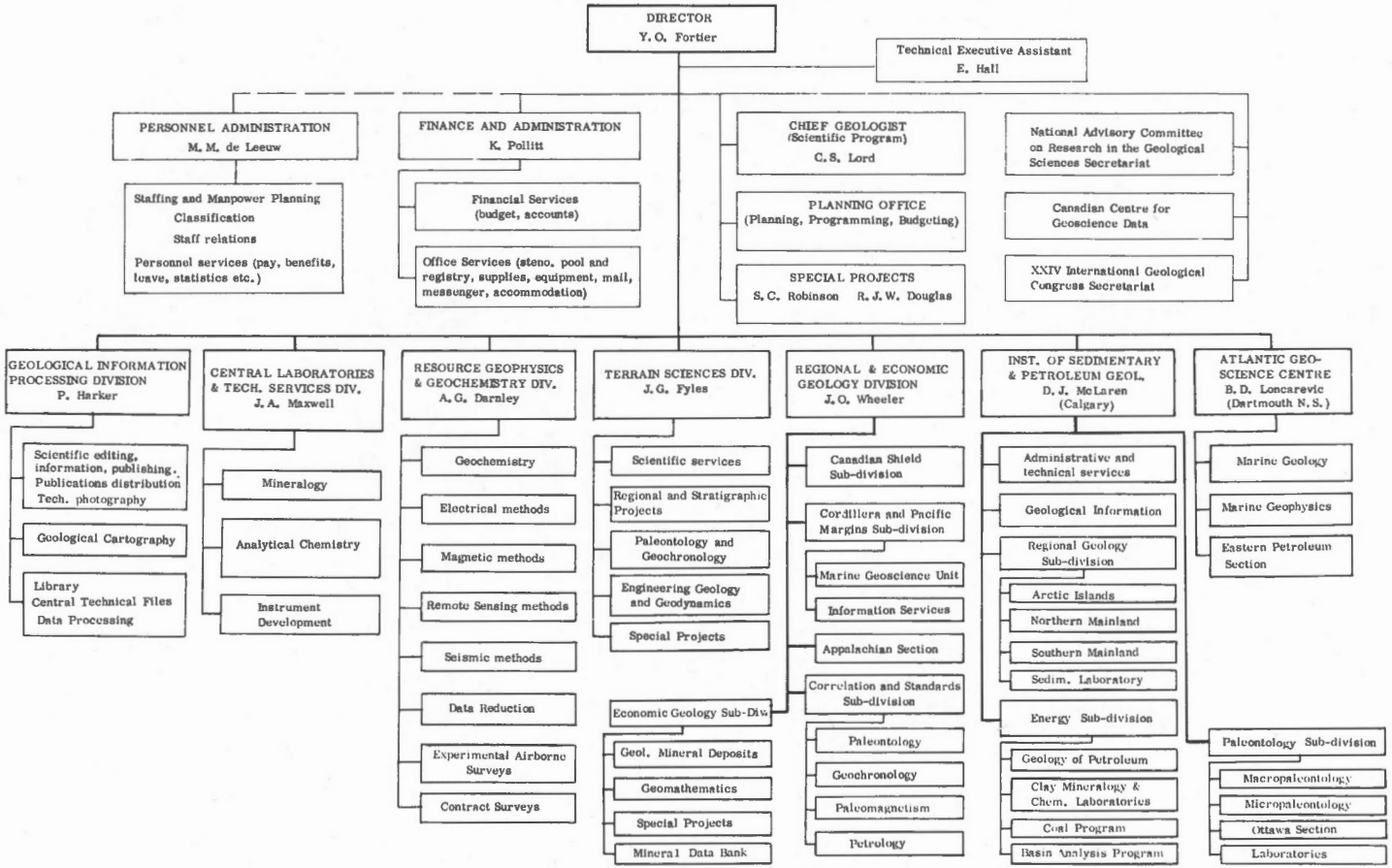
DEPARTMENT OF ENERGY, MINES AND RESOURCES



VIEW SHOWING BOOTH STREET DEVELOPMENT

GEOLOGICAL SURVEY OF CANADA



INTRODUCTION

The Geological Survey Building was officially opened in May 1960 by the late Paul Comtois, then Minister of Mines and Technical Surveys. Comprising eight floors, ground floor and basement, the building fulfils several requirements: it provides office space for scientists; accommodation for the various services that a modern geologist requires such as geological cartography, photography and laboratory facilities for the study of rocks and fossils; laboratories for basic research in geological sciences, and storage space for reference collections of fossils and rocks. In addition to these special requirements, the building houses a large library and the usual administrative offices required for the proper functioning of a large government organization.

This booklet describes the major laboratory, scientific and technical services provided in the building. Most of the laboratories are situated in the north end of the building on the fifth, sixth, seventh and eight floors. By grouping them together in this way it was possible to concentrate all the necessary services, such as fume and waste disposal, gas and air, in one part of the building. In addition, there are certain facilities at other locations in the Ottawa area, including a hangar and associated laboratories at Uplands Airport, for airborne instrumental surveys and development.

Many of the laboratories have been established to sustain a particular phase of the Survey work; others serve a wider need for all scientists of the Branch. Similarly, many of the services are provided on a Branch-wide basis and this is reflected in the organization of the Branch: two divisions, Central Laboratories and Technical Services, and Geological Information Processing, provide essential support to the operational divisions in the overall programs of the Geological Survey.

The Geological Survey is one of the Branches of the Department of Energy, Mines and Resources. The internal organization of the Branch, under its Director, Dr. Y. O. Fortier, is shown on page vi. Of the seven divisions, five together with the Director, Chief Geologist and Director's staff are in Ottawa. The remaining two divisions are located at Calgary, Alberta (Institute of Sedimentary and Petroleum Geology), and Dartmouth, Nova Scotia (Atlantic Geoscience Centre), each with appropriate local supporting facilities. An office of the Survey in Vancouver houses geologists of the Cordilleran Section of the Regional and Economic Geology Division and an information office.

NATIONAL MINERAL COLLECTION

Location: G12-14, G48

Division: Central Laboratories and Technical Services

Section: Mineralogy

Staff: H. R. Steacy, Curator

Mineral collections of the Geological Survey of Canada date back to 1843 and are part of the present National Mineral Collection. Formally established in 1961 as a joint project of the then Department of Mines and Technical Surveys and the Department of Northern Affairs and Natural Resources, the National Mineral Collection consists of two Series, namely: a Display Series at the National Museum of Natural Sciences and a Systematic Reference Series for which the Geological Survey of Canada is responsible. An active working collection, the Reference Series has shown steady growth since its establishment, with the representation of valid species and varieties increasing from approximately 700 in 1961 to approximately 1650 at present. This growth to the current representation of approximately 70 per cent of all known minerals has improved the Mineralogy Section's service capabilities in mineral identification and recognition, and established a strong "library of minerals" for consultation and use by Survey Officers. Related studies have alerted the mineral industry to uranium and vanadium occurrences in Prince Edward Island, the possibilities of zirconium in carbonatities and the nature of uranium and thorium mineralization in radioactive discoveries. The Series has provided a wealth of specimen material to government agencies, universities and industry for applied and basic research programs. Specimens and related services have also been provided for several Canadian government exhibits in Canada and abroad, including both Expo '67 and Expo '70.

MINERAL AND ROCK SETS PREPARATION

Location: G07, G11, G53

Division: Central Laboratories and Technical Services

Section: Mineralogy

Staff: J. M. Larose (in charge)
J. Turpin
T. Racine

For more than 50 years, the Geological Survey of Canada has prepared and sold sets of minerals and rocks to the Canadian public, and to educational institutions. The advertised sets include:

(1) Prospector's set of 35 mineral chips
(2) Prospector's set of 35 rock chips
(3) Set of 120 specimens representing the raw materials of the Canadian mineral industry

Orders are shipped post-paid to addresses in Canada. About 10,000 sets are prepared annually and this involves collection in the field of more than 25 tons of materials, and the breaking and trimming of some 350,000 rock and mineral specimens. Special sets have been supplied to schools in the Yukon and Northwest Territories, to Canadian embassies throughout the world, and to the National Film Board.

MECHANICAL SERVICES AND EQUIPMENT DEVELOPMENT

Location: G63, G64, G67

Division: Central Laboratories and Technical Services

Section: Mechanical Services and Equipment Development

Staff: G. A. Meilleur, Head
A. Y. Cregheur
J. P. Fournier
B. A. Walker

Equipment: Drafting equipment, calibrating and precise measuring equipment, a complex of machine tools such as lathe, milling machine, grinding machine, welding equipment, heat treating furnace and a number of hand tools normally employed for scientific instrument fabrication.

Function: The efforts of the Section are chiefly oriented towards support of Branch Laboratories and field projects through the provision of technical services such as engineering, drafting and the fabrication of instruments and equipment, and of the maintenance and repair services required to ensure continued operation of laboratory and field equipment. It also provides the necessary liaison between commercial firms and Branch scientific staff when similar work is to be contracted out.

LAPIDARY LABORATORY

Location: G18, G20, G26

Division: Regional and Economic Geology

Staff: A. Whitehead (in charge)
J. M. Beaulne
A. Y. Demers

Well equipped with modern rock cutting machinery,the laboratory provides an essential service available to all geologists of the Survey. Thin sections, polished thin sections, mounted polished sections of opaque materials and any other types of lapidary work can be provided on request.

SCIENTIFIC EDITING

Location: 262, 264, 267

Division: Geological Information Processing

Section: Scientific Editing

Staff: R. G. Blackadar, Chief Scientific Editor
L. E. Vincent (French language services)
E. J. W. Irish (I. S. P. G., Calgary)
Tamara A. DeVreeze (Terrain Sciences)
Leona R. Mahoney
Carol T. Wilson

All reports and maps submitted for publication by the Geological Survey are processed through the office of the Chief Scientific Editor, although some of the actual scientific editing is carried out in other Divisions. The staff also provide advice on many aspects of scientific publication, arrange for the printing of a variety of documents and prepare annual indexes of reports and maps.

The scientific editors together with the Chief of the Division provide scientific information on the work of the Survey and on a wide variety of earth science matters to other agencies and to the public. Many requests are handled annually by mail and through the general technical enquiries telephone number.

LIBRARY SERVICES

Location: 350, 353, 355, G70 (Map Library), G27 (Data Processing Unit)

Division: Geological Information Processing

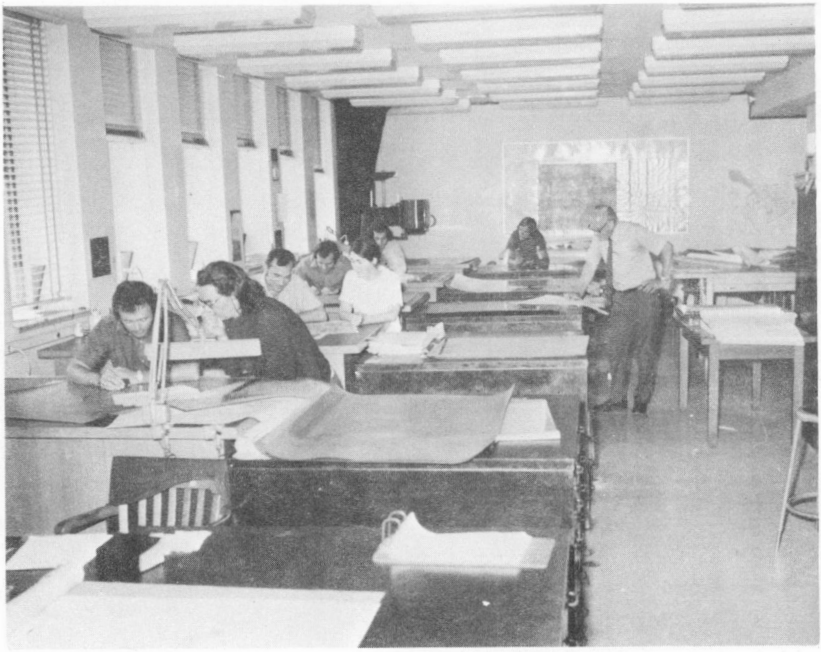
Section: Library Services

Staff: Doreen M. Sutherland (Head)
Mary E. Williams
Irene S. L. Yee
P. E. Laurendeau (Map Library)
Thelma G. Stewart
Beverley A. Roe
Carol E. Broad
W. H. Eyre (Central Technical Files and Open File)
B. H. Storey
Carol D. Segall (Data Processing)
Susan M. McKinley (Data Processing)

Main Library: The Library of the Geological Survey contains a large and nationally important collection of books and periodicals on geology and related sciences, occupying more than two miles of shelving. It comprises over 125,000 volumes as well as a large number of microfilm and microfiche. As a result of exchanges of long standing with foreign scientific institutes, many unique sets of serials are held here.

Part of the Geological Survey's large library. (350)

Keypunching is an essential part of electronic data processing. (G27)



One of the drafting units of the Cartography Section. (406)

In addition to providing bibliographic service for the research program of the Survey, its resources are used by the scientific community at large, by industry and universities. Interlibrary loans follow standard procedures and many requests are filled by provision of photocopies for which a service charge is made.

A new bibliographic service has recently been added. The Geological Survey now provides a geological data base to the National Science Library's system of selective information retrieval and dissemination (CAN/SDI). It is expected that this computer-based service, operated in cooperation with the National Science Library will materially assist Canadian geologists in keeping abreast of the information explosion.

Map Library: The Survey has a very extensive collection of geological maps from all over the world and operates a map library in conjunction with a topographic map library administered by the Surveys and Mapping Branch.

Central Technical Files: These files contain a collection of technical, classified information. Access is restricted to members of the permanent staff in the course of their official duties.

Open File System: A new method of releasing the results of research to the public was inaugurated in 1970 by means of an open file system. This avoids some of the inevitable delays of the regular publication program. Copies of all open file items are available in the library for examination, and depending on the nature of the material users may purchase copies through a commercial reproduction firm. The open file method has been very well received.

Data Processing Unit: The Departmental Computer Science Centre operates a batch terminal to the main computer in the building, and the library provides back-up facilities for the research staff comprising two key-punches, card sorter, de-bugging room and clerical staff to manage the unit, schedule work and provide key-punching services. The unit also manages three computer-based data files: GEODAT — a file of chemical rock analyses which has been announced as available to the public through the open file program; PLI — a photo negative index with retrieval capabilities; and a Periodical Finding List — to assist library users.

GEOLOGICAL CARTOGRAPHY

Location: 3rd and 4th Floors, and City Centre

Division: Geological Information Processing

Section: Geological Cartography

Superintendent of Cartography: C. E. McNeil, Room 408

Supervisory Staff: Unit A. E. P. Nunn, Rooms 405-419
Unit B. L. W. Babcock, Rooms 390-397A
Unit C. E. A. Dumbrell, 2nd Floor - City Centre
Photomechanical Unit. N. E. Buck, Rooms 406, 431-439, 450, 550

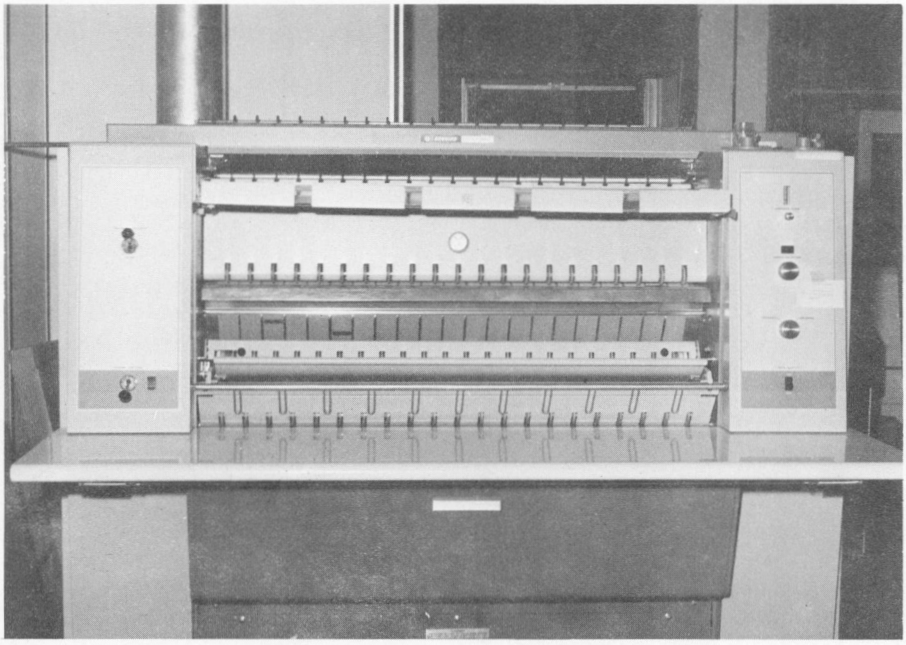
The section consists of three production units, with a total staff of 47 cartographers. The principal tasks performed include the preparation of suitable topographic base maps on which field officers plot and compile their data and prepare manuscript geological maps; the compilation, drafting and related procedures required to prepare edited manuscript material for printing as multicoloured final maps, uncoloured preliminary maps and figure illustrations for Memoirs and other reports. In addition the section performs a great variety of drafting, reproduction and related services for the Survey.

Base-maps are prepared according to requirements of field officers as to scale and amount of detail from negatives supplied on a loan basis from the Surveys and Mapping Branch. Where base-map requirements are not covered by existing material, projections are calculated and plotted and mosaics prepared from published and unpublished maps are enlarged or reduced to accomodate the desired scale. Geologists are supplied with stable mylar base transparencies of the base-map on which they compile their geological manuscript map. On a paper print made from this transparency they colour the map units as a guide to the draftsman. Manuscript geological maps as prepared by the geologist are approved by Chief Scientific Editor prior to being forwarded to the Geological Cartography Section.

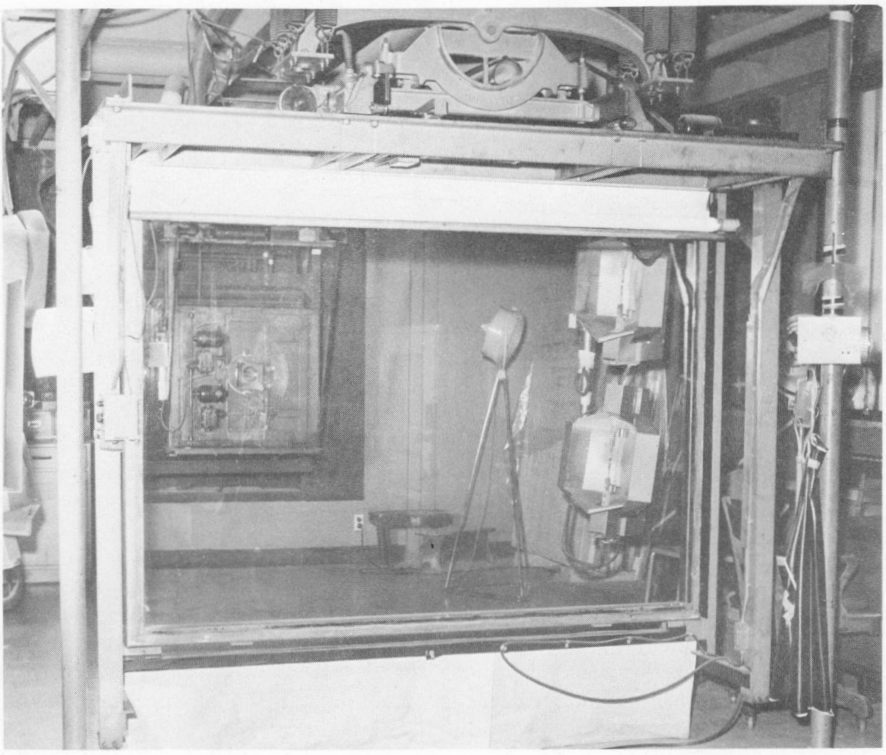
Final Multicoloured Maps: If a published topographic map is available separate negatives are made from negatives borrowed from the Surveys and Mapping Branch. The geological manuscript transparency is photographed to precisely fit the base-map, an image transferred onto negative scribecoat material and the geological detail then scribed. Reference numbers, geological symbols, legends etc. previously printed on thin film positive material and waxed on the reverse side for adhesive purposes are applied on a positive overlay. If no published topographic map is available the map is prepared in the Geological Cartography Section using the previously compiled mosaic map as a base for the final scribing of the topography, drainage and culture detail. Colour separation negatives are made by the peelcoat method, separate peelcoats being prepared for each colour. These are then converted into negative form as are the other positive overlays. All scribecoats and film overlays are kept in perfect registration throughout the entire mapping process through a system of corner mark controls and a three-hole punch system. After careful checking, colour proofs are then made by coating a sheet of white plastic with a light sensitive solution, exposing it in a vacuum frame with the appropriate colour negatives and then developing it. This step is repeated for each colour on the map. After the proof is checked and any necessary corrections made to the negatives they are forwarded to the Surveys and Mapping Branch for plate making and printing.

Preliminary Maps: In order to expedite the distribution of geological information uncoloured preliminary maps are published. The procedures are similar to those used for final maps, but these maps are printed with the base all in one colour of blue and the geological information in black.

Figure illustrations are prepared to illustrate reports and represent a considerable part of the work of the section. Text figures are incorporated in the body of the report. Larger figures are prepared as 'tip-in' items or for inclusion in a pocket. Some pocket figures are printed in colours and are as complex as many geological maps.



Automatic film processor speeds handling of large negatives. (550)



The large mapping camera is suspended in vibration-free mounting and was installed during the construction of the building. (431)

Photomechanical Unit

Staff: N. E. Buck (in charge)
A. C. Major
D. G. McNeill (Camera)
R. W. Wilkinson (Camera)
R. G. MacKenzie (Special printing)
M. F. Thibault (Film printing)
G. Wilson (Proof press and typesetting)

The Photomechanical Unit of the Geological Cartography Section, provides pre-press reproduction services to the Geological Survey. The Unit is staffed and equipped to reproduce high quality geological map and figure illustrations for compilation or press printing. Specialized services and materials are available to geologists for varied base-map requirements; to the Cartography Section for preliminary, intermediate, and final reproductions; to all members of the Survey for limited production runs.

The Unit is equipped with two process cameras, three vacuum print frames, an automatic film processor, whirler, whiteprinter, proof-press, sensitometric and other related equipment, to make colour separations, halftone, line, and continuous-tone negatives and positives by camera or contact; to produce peelcoats, scribetches, colour proofs, and a variety of colour keys on plastics.

ELECTRICAL ROCK PROPERTY LABORATORY

Location: 589-591

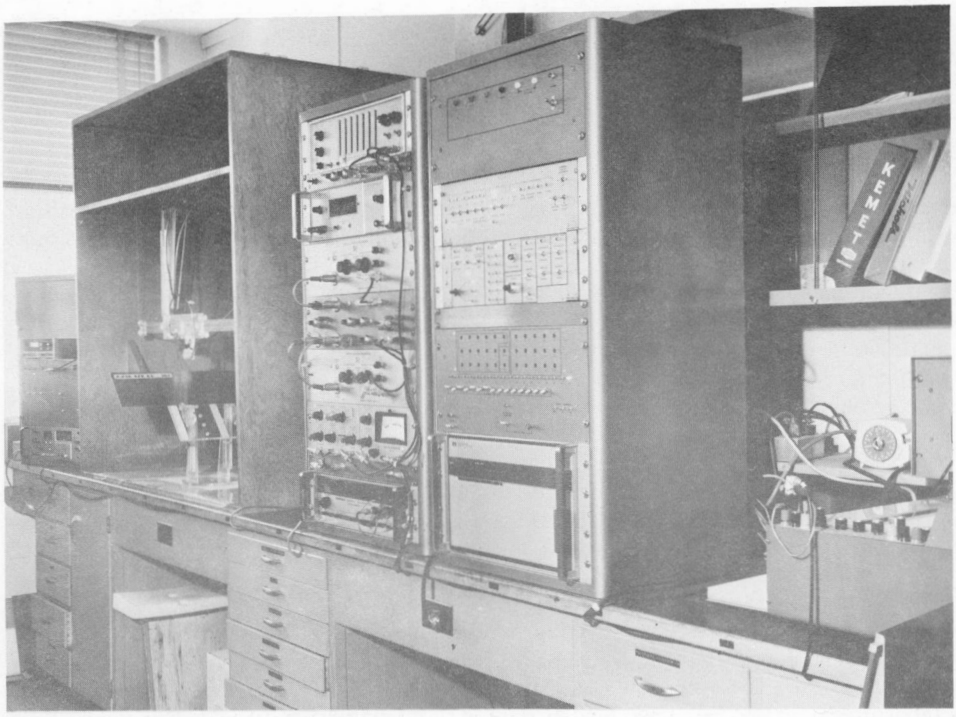
Division: Resource Geophysics & Geochemistry

Section: Electrical Methods

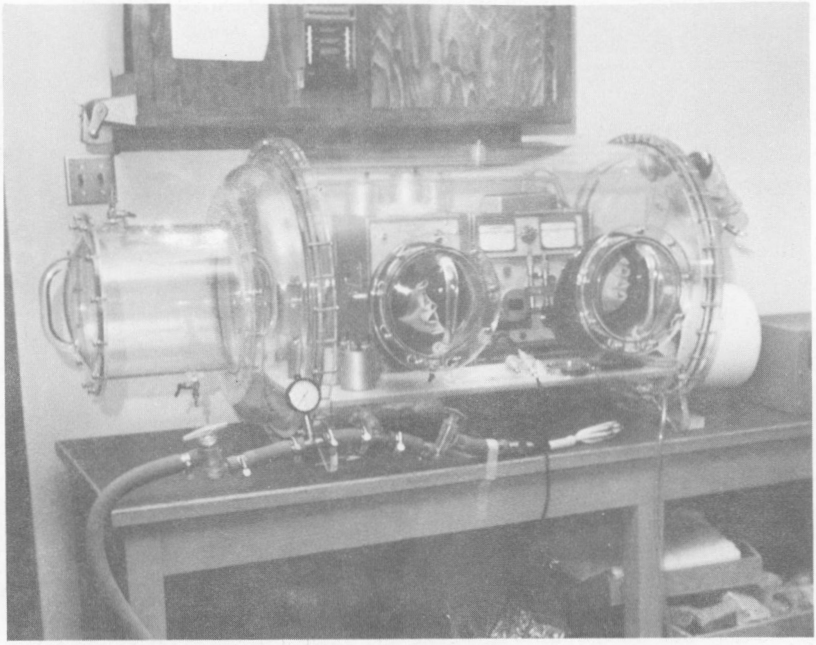
Staff: T. J. Katsube
J. Frechette

Equipment: Standard dielectric measuring system (10^2 to 3×10^7 Hz) - Capacitance Bridges and Q-meters. Impedance measuring system (10^{-2} to 10^7 Hz) - generators, voltmeters, phasemeters, oscilloscopes, XY recorders, filters amplifiers.

Function: Measurements on the general electrical characteristics of rock samples can be made (Impedance measuring system) in order to obtain preliminary data for determining equipment, techniques and measurement conditions necessary for the desired measurements.
Dielectric constant, dissipation factor and conductivity of rocks and other solid earth materials can be measured on a production line basis, within the frequency range from 10^2 to 3×10^7 Hz, by a standard measuring system which has an accuracy of $\pm$ 1.0% for international standards. It is required that the shape of the rock specimens are 20 to 254. mm (0.79 to 1.0 inch) in diameter and 4 to 6 mm in thickness. Rectangular shaped specimens with dimensions of 13 x 13 x (4 to 6) mm are also acceptable.



Experimental scale model of induced pulsed transient method for electromagnetic prospecting. (597)



Controlled atmosphere chamber in electrical rock properties laboratory for measurements on electrical properties of rocks. (591)

Facilities are also available to study the electrical characteristics, electrical conduction mechanism and measurement problems in general, by the laboratory staff. This requires special arrangements with the supervisor of the laboratory.

The electrical properties of rocks and earth material in general vary to a great extent, according to their type. At one extreme there exist rocks that exhibit characteristics similar to good insulating materials. At the other extreme they exhibit characteristics similar to conductive materials. Some rocks exhibit both characteristics depending on the applied frequency. And some rocks exhibit electrical non-linear characteristics which usually make electrical measurements impossible by ordinary measuring techniques. Therefore, the impedance measuring system is in use for determining the general characteristics of dry and moist rocks, in order to determine the optimum measurement methods and conditions. Based on such information, measuring equipment and techniques are selected.

Data of electrical parameters of rocks (dielectric constant, dissipation factor and conductivity) are of importance in development and improvement of electrical exploration techniques in geophysics. This data is also useful in characterizing some rocks.

Not much work has been done in the past on the development of electrical rock property measuring systems. This is because many problems are involved, and the results were generally of low accuracy. However, recent work on development of measuring systems and techniques has resulted in solving many of these problems and this laboratory can produce good quality data within certain limits. Measurement accuracy is generally low outside the 10^2 to 3×10^7 Hz range, but work is in hand to improve the accuracy and standardize the measurement procedures. Work is also being done to allow measurement under various conditions with rock specimens in dry nitrogen atmosphere. When these techniques and systems are standardized they will be added to the production line.

GEOPHYSICAL ELECTRONICS LABORATORY

Location: 597

Division: Resource Geophysics and Geochemistry

Section: Electrical Methods

Staff: A. V. Dyck
C. G. Gauvreau

The laboratory is responsible for an E/M scale model unit for measuring E/M fields in the time domain; with interfacing test equipment for outputs on XY recorders, punched tape and teleprinters, data in this format can then be handled by computer; for the assembly of data-acquisition systems for general application in airborne electromagnetic applications; and for evaluation of mini-computers for controlling various functions both in airborne and ground based geophysical measurements.

GEOPHYSICAL LABORATORY

Location: 590 and 594

Division: Resource Geophysics and Geochemistry

Section: Electrical Methods

Staff: R. H. Ahrens (in charge)
D. C. Butterfield
W. J. Stauffer

The laboratory is responsible for the design and development and operation in the field of equipment to measure natural E-M fields in the Schumann resonance band (8-40 Hz). Under current development is a station unit for measuring the magnetic components at 8 Hz in order to study the relationship between horizontal and vertical components and also the phase relations between these components. A portable unit is also being constructed for truck mounting in order to compare how these fields react over fault zones and other geological features. The results of these studies will be used to write specifications for an airborne version operating at 8 Hz. This development work has arisen from field investigations with AFMAG type systems. AFMAG is seasonally dependent on field strengths, whereas the 8 Hz systems can be used on a year-round basis.

The staff of the laboratory is also responsible for the control and maintenance of electronic stores for the Division which has a considerable and valuable inventory.

RADIOCARBON DATING LABORATORY

Location: 542, 544, B50

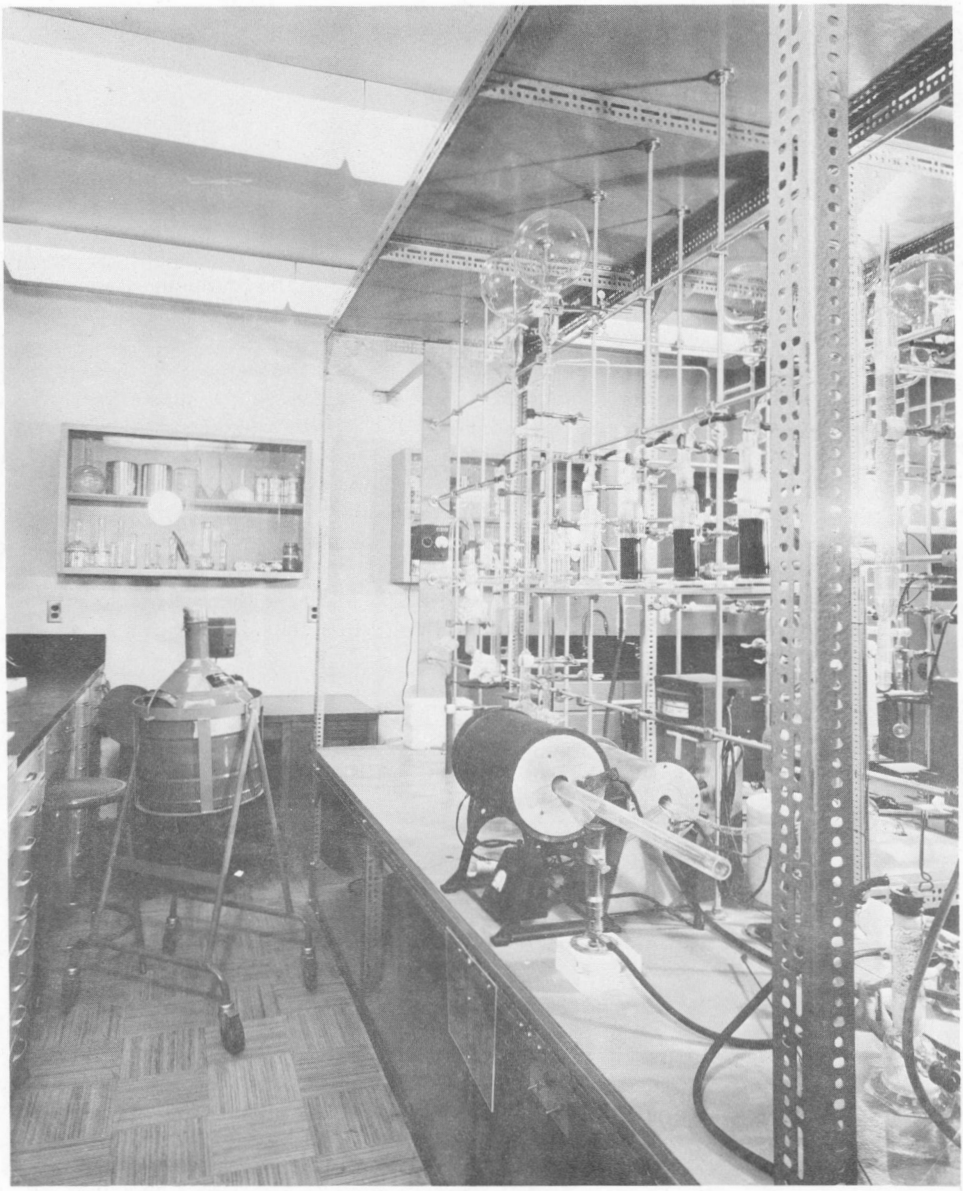
Division: Terrain Sciences

Section: Paleontology and Geochronology

Staff: J. A. Lowdon (in charge)
I. M. Robertson
Suzanne M. O. Chartrand

Equipment: Rooms 542, 544: Sample pretreatment, CO_2 gas preparation and purification system.

Room B50: Low-level C^{14} detection apparatus comprising a 1 litre, a 2 litre, and a 5 litre proportional counter located within a 9 ton shield consisting of a 1" layer of mercury, a ring of cosmic ray detectors, 4" of paraffin, and 8" of iron. The sample counting tubes are operated in conjunction with specially designed, low-noise nuclear radiation amplification and recording equipment. The proportional counters are filled from permanently connected, all-metal, high vacuum systems.



Laboratory for preparation of samples for radiocarbon dating. (544)

Functions: To determine the age of carbonaceous matter (organic and inorganic) using radiocarbon dating techniques and to insure continuing and improving precision of existing techniques. To conduct research on variations in the radiocarbon content of modern organic material and its application to age determinations on fossil material.

The fact that radioactive carbon has been produced in the earth's atmosphere by cosmic rays at a constant rate and for a very long time makes possible the dating of specimens that lived at one time and were in contact with the atmosphere during their life time. Radiocarbon, an isotope of carbon with an atomic weight of 14, decays to N^{14} with the emission of weak beta particles. Its half-life of 5,570 years makes it suitable for age determinations in the time interval from a few hundred years to about 50,000 years. The isotopic abundance of C^{14} in nature is approximately 10^{-10}%, therefore highly efficient detection techniques are required to measure its concentration with accuracy.

Samples submitted are converted to CO_2 gas either by burning in a stream of oxygen (organic materials), or by dissolving in acid (inorganic materials). Types of samples treated include wood, peat, gyttja, charcoal, bone, hair, and shell. After purification of the CO_2 evolved, the sample is introduced into a proportional counter where the C^{14} concentration is determined by counting the beta particles emitted by the C^{14} in the gas. Two, twenty hour counting periods of the unknown gas are generally carried out per age determination. One detector can produce approximately 100 ages per year. At present three counters (1, 2, and 5 litre) are available for routine use, any two of which can be operated at the same time. Using a 95.5% certainty level (2σ criterion), age determinations up to 50,000 years may be carried out. Radiocarbon dates determined in this laboratory are used by Pleistocene geologists, geographers, archeologists, and others involved in the study of carbonaceous materials formed within the last 50,000 years.

TECHNICAL PHOTOGRAPHY

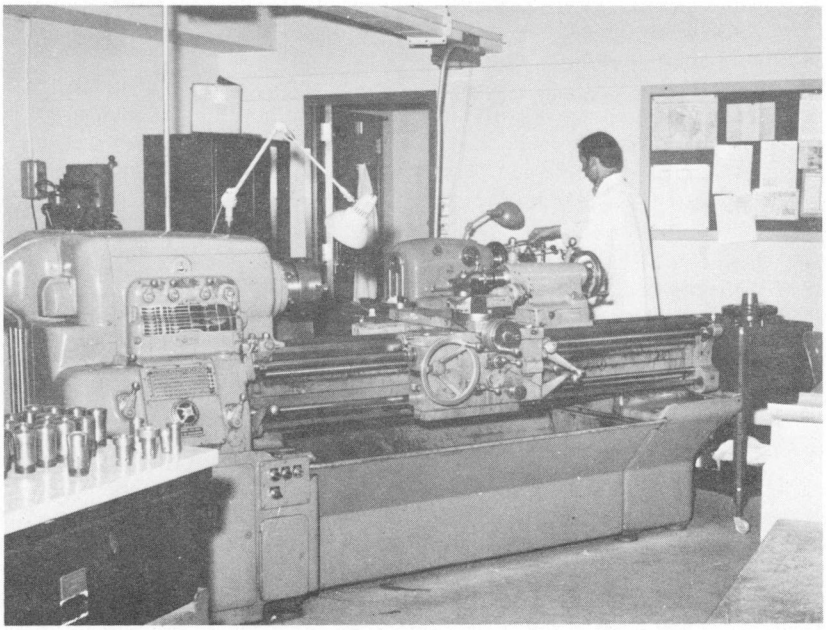
Location: 509-526

Division: Geological Information Processing

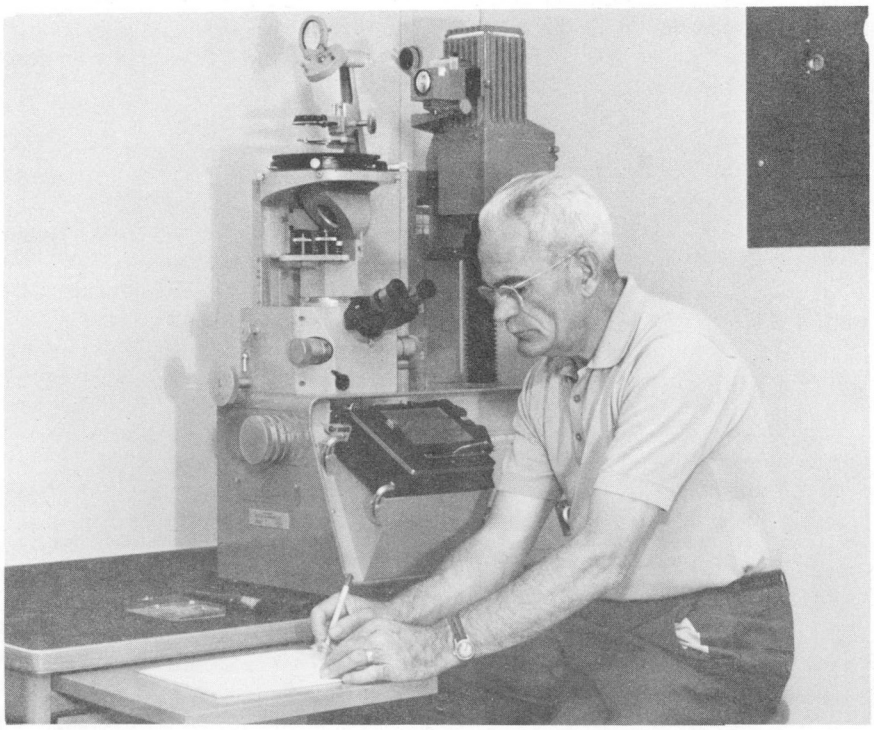
Section: Technical Photography

Staff: F. J. Cook (in charge)
J. W. Kempt
C. A. Skuce
W. T. Stafford
E. Thorpe
Jean I. White
D. C. Beckstead (Photo Librarian)

Many diverse activities are carried out in the photographic laboratories of the Survey. These include some of the more conventional functions of a large photographic unit, such as direct photography of geological specimens, photomicrography, processing of films taken by the field staff, printing, enlarging and retouching, colour photography and the preparation of photographic illustrations for published reports.



Part of machine shop. (B63)



Photomicrography is an important aspect of technical photography in the Survey. (519)

The Geological Survey collection of photographs, commenced in 1862 by J. C. Richardson, is in the care of this section. Aside from the geological importance the collection is a remarkable record of the history of photography.

The laboratories are well equipped and the staff has developed expertise in many specialized types of technical photography, perhaps especially in the photographing of fossils. The logetronic printer provides an almost automated method of printing. It operates on a feed back circuit through a cathode ray tube, and exposures are controlled by a photo-electric cell. It will print film from 35 mm. up to 11 x 14 inches in size. The printer is used in printing fossil and other negatives. An advantage of this machine is that it needs only two grades of paper where five may be required in ordinary hand manipulated printing processes.

PALEOMAGNETIC LABORATORIES

Location: 588, 586, 580, 414, 416
Field laboratory, Blackburn

Division: Regional and Economic Geology

Section: Paleomagnetism

Staff: W. F. Fahrig (Head)
J. H. Foster
R. W. Christie
E. J. Schwarz
G. W. Freda
K. R. Clark

Equipment: The laboratories are equipped with a biostatic magnetometer, designed and built by the Geological Survey which provides an accurate and fast automated means of measuring strongly to moderately magnetised samples. The capacity of the laboratory has been greatly increased by the recent purchase of two spinner magnetometers and an A-C demagnetizing apparatus. Facilities for thermal demagnetization of rocks are being improved. This equipment is essential in the paleomagnetic study of sedimentary rocks and it is expected that the study of these rocks will in future form a higher proportion of the work of the laboratory. Other equipment includes a sensitive thermomagnetic balance, a versatile ballistic magnetometer and equipment for the determination of the anisotropy of magnetic susceptibility. For certain types of rock, a field laboratory in termporary buildings on the outskirts of Ottawa provides a reasonably quiet magnetic environment away from urban interference.

Function: To study the magnetism, particularly the paleomagnetism, of rocks and minerals in order to solve tectonic, chronologic and economic problems encountered in describing and interpreting the geological framework of Canada; to provide paleomagnetic measurements as a service to other units and individuals within the Geological Survey.

GEOCHEMICAL ANALYTICAL LABORATORIES

Location: 606, 614, 618, 733, 735, 737, 738, 739, 742, 852

Division: Resource Geophysics and Geochemistry

Section: Geochemistry

Staff: J. J. Lynch (in charge)
P. J. Lavergne (Sample Preparation Laboratory)
G. Gauthier (Trace Element Laboratory)
W. Alexander
P. Belanger
A. Mac Laurin
L. Trip
R. Horton (Direct Reading Spectrochemical Laboratory)
W. Nelson

Sample Preparation Laboratory (Room 852)

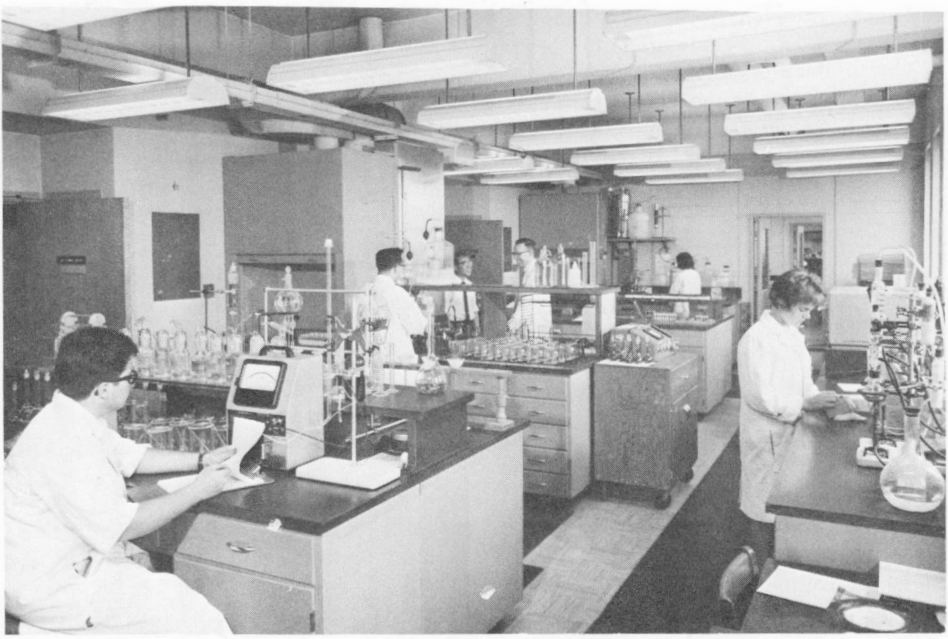
Equipment: Two Chipmunk Jaw Crushers, two Braun pulverizers, four "plant shaker" ball mills, Rotap sieve shaker and a complete set of stainless steel sieves, Superpanner, Frantiz isodynamic separator, Sly dust collector.

Function: Soil sediment and rock samples collected by members of the geochemistry section are prepared for analysis. Mineral separations using a variety of techniques are also performed. Since most of the samples prepared in this laboratory are analyzed for trace elements, special precautions must be taken to avoid contamination. All of the operations carried out in this laboratory can be performed in field laboratories.

Trace Element Laboratory (Rooms 733, 735, 737, 738, 739, 742)

Equipment: Two Perkin-Elmer Atomic absorption spectrophotometers. Ancillary equipment includes a recorder, lamp warmup power supply, digital read-out systems, deuterium arc background correctors, a teletype, and an automatic sampler: one techtron AA-5 atomic absorption spectrophometer modified for cold vapour atomic absorption measurements: Ancillary equipment includes a recorder and a Manostat peristaltic pump; two Eberbach shaking machines are used for solvent extraction work. Cahn Electrobalancer, used for rapid weighing of samples at the rate of two per minute; other equipment includes colorimeters, top-loading balances, distilling apparatus, hot plates, water baths, ovens, furnaces, magnetic stirrers, an oscillating hot plate and a large centrifuge.

Function: The analyses of soils, rocks, sediments, minerals, plant-ash and waters are performed in this laboratory using colorimetric, fluorimetric and atomic absorption spectrophotometric methods. The elements determined include Li, Na, K, Rb, Mg, Cu, Sr, Mo, W, Mn, Fe, Co, Ni, Cu, Ag, Zn, Cd, Hg, Sn, Pb, As, Sb, Bi and U. A wide variety of sample decompostiion methods are used depending on the elements being determined. The methods employed in this laboratory are rapid and permit a high throughput of



Analytical chemistry laboratory. (720)

Direct reading optical emission spectrometer. (783)

samples; over 50,000 single element determinations can be made in a year. Nearly all of the operations carried out in this laboratory have also been performed in field laboratories using trailers or rented laboratory space in the field area. Field laboratories have operated in British Columbia, Northern Ontario, Northern Quebec, New Brunswick and Nova Scotia.

Direct Reading Spectrochemical Laboratory

Equipment: Applied Research Laboratories production control quantometer, 39 channels, computer controlled with a wavelength range 2000-7000Å. Applied Research Laboratories quantograph, 18 channels with a wavelength range 2000-4000Å. Jarrel-Ash 1.5 meter spectrograph with a Wadsworth mounting and a wavelength range 2500-4500Å. Applied Research Laboratories Densitometer-Comparator. Two Spex Industries Shatterbox grinders. Leco-Furnace. Arrestal dust collector. Small laboratory apparatus includes, analytical balances, mixer-mills, dark-room equipment and ovens.

Function: Quantitative and semi-quantitative analyses of rocks, soils and sediments are performed in this laboratory using emission spectrochemical methods. The major elements determined are Si, Al, Fe, Mg, Ca, Ti, Mn and Ba. The trace elements which can be determined include Sr, Zr, Sc, Be, Ni, Co, Y, V, Cr, Mo, La, B, Sn, Zn, Pb and Cu.

A fusion technique is used for the measurement of major elements. The sample is fused at 1000° C. with twenty times its weight of a borate buffer. This procedure permits the analyses of rocks, soils and sediments with widely divergent compositions and physical properties. The fused bead is cooled, ground to a very fine powder and introduced to the spark of the direct reading spectrometer by means of a moving cellulose tape. All the major elements except Na and K are determined simultaneously on the Spectrometer. If Na and K are required they can be determined quite readily by atomic absorption spectrophotometry.

The quantitative determination of trace metals is based on a D. C. arc technique. The samples are diluted with a suitable buffer and arced on the spectrometer. A small, on-line computer selectively reads each element over the most advantageous portion of the arcing time, applies background and matrix corrections and prints out the result on a teletype.

The semi-quantitative determination of trace metals is also based on a D. C. arc technique and has been in use for many years both in Ottawa and in mobile field laboratory. The sample is diluted with graphite powder, arced on a spectrograph and the line spectrum of the sample is recorded on film. A visual comparison method is used to match the analytical line intensities of samples and standards.

GAS CHROMATOGRAPHY AND HIGH RESOLUTION MASS SPECTROMETRY

Location: 612

Division: Resource Geophysics and Geochemistry

Section: Geochemistry

Staff: I. R. Jonasson

Equipment: One single beam MS-30, high resolution mass spectrometer integrated with one gas chromatograph, model PYE 104. Related high vacuum lines and equipment for gas handling.

Functions: The facility is designed and equipped to enable characterization and identification of soil gas constituents such as sulphur and carbon oxides; hydrides of sulphur, the halogens and certain metals; and volatile organo metals. These gases and vapours are considered to have high potential as pathfinders to deeply buried ore bodies. The instruments have the capability to detect and measure sub-nonogram quantities of these gases.

METALLOGENIC LABORATORY

Location: 620-625, 626

Division: Regional and Economic Geology

Section: Geology of Mineral Deposits

Staff: C. R. McLeod
R. D. Burke

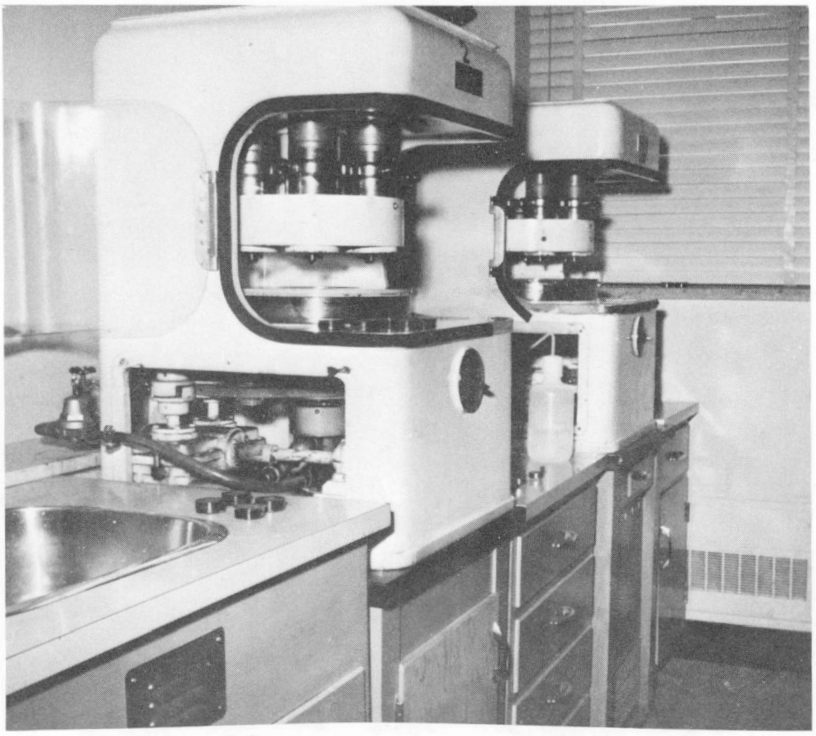
The metallogenic laboratory provides facilities for the investigation of ores and related rocks which are available for use by all staff geologists whose projects are connected with metallogenic studies.

The laboratory comprises sample preparation and ore polishing rooms equipped with two Durener ore-polishes each capable of handling 6 specimens at one time, a main instrument room, and a room for making limited mineral separations and chemical tests related to metallogenic studies. Instruments and equipment on hand include a top quality research microscope with accessories for measuring microhardness and reflectivity of polished ore sections as well as a 3 1/4"x 4 1/4" photomicrographic unit for use with transmitted or reflected light. A heating stage is available for geothermometry studies.

Equipment for making mineral separations includes an electromagnetic separator, and glassware and vacuum pumps for work with heavy liquids.

A reference collection of polished sections of ore specimens is maintained in the laboratory.

Part of production line for mineral and rock sets for sale to the public. (G53)



Ore polishing machines in metallogenic laboratory. (625)

PALEOPALYNOLOGY LABORATORY

Location: 613-617

Division: Regional and Economic Geology

Section: Eastern Paleontology

Staff: D. C. McGregor
Martha Camfield

The laboratory is equipped to extract and prepare for scientific study all forms of minute plant fossils such as spores, pollen and microplankton. The staff is mainly concerned with material from Paleozoic rocks and although administered by the Eastern Paleontology Section, a service is provided for Geological Survey activities in all parts of Canada.

The work carried out in this laboratory provides a basis on which the scientific staff can make precise identification and correlation in a field which is rapidly assuming a new importance with the present emphasis on hydrocarbon-bearing rocks and structures.

In addition to the facilities normally associated with the work, the staff are responsible for the National Type Collection of Palynofossils, undertakes all recommended photomicrography and illustrative work, together with appropriate record-keeping.

PALEONTOLOGICAL PREPARATION LABORATORIES

Location: 625, 650, 629, 611, 500

Division: Regional and Economic Geology

Section: Eastern Paleontology

Staff: B. J. Botte (in charge)
J. J. Callahan
Dawn K. Nash
E. S. Corey

The paleontological preparation laboratories perform two separate functions. The first of these concerns all Survey personnel. All collections of fossils made by field officers of the Geological Survey are turned in to the preparation laboratory together with as detailed geological and geographical field data as possible. Each collection in unpacked, catalogued in the permanent catalogue of the Paleontology Section, and assigned a number which is marked on each specimen. The collections are then divided according to the type of fossils they contain, or according to their stratigraphic horizon, and assigned to the appropriate paleontologist for study and report. Following identification, the collections are re-labelled if necessary and stored permanently in the sub-basement, their whereabouts being recorded in the Section files.

The second function of the laboratories is to supply the necessary help and equipment required by individual paleontologists. These services include: cutting, grinding, and polishing rock and fossil specimens; cutting and mounting thin sections of fossils; production of latex rubber peels and moulds of specimens, and casting replicas to record material about to be cut up or for distribution to research institutions; preparation of collodion peels of fossil plant material; acid etching of rock containing

silicified or pyritized fossils; mechanical preparation and cleaning of specimens in rock; mechanical preparation and cleaning of specimens in rock; separation of microfossils from matrix by chemical and mechanical means, and subsequent picking and preliminary sorting of such specimens.

The laboratories consist of the following units:

(1) Packing and unpacking room, heavy rock cutting (in basement)
(2) Catalogue room (652)
(3) General preparation laboratory with saw and grinding room attached (629)
(4) Micropaleontological laboratory (611)
(5) Acid etching laboratory (500)

PALEONTOLOGICAL TYPE AND INDEX COLLECTIONS

Location: 690, 692, 698

Staff: T. E. Bolton, Curator and
Members of the Eastern Paleontology Section

The paleontological type collection contains about 15,000 specimens of plant and animal fossils on which description of new or revision of old genera and species are based. The collection constitutes by far the largest type collection of Canadian fossils in existence, and has been designated as the National Type Collection of Invertebrate and Plant Fossils.

The palentological index collection houses specimens extracted from the normal collections which are stored in the basement, together with collections which are currently being studied by individual paleontologists. With the National Type Collection it serves as a reference collection to assist in identifying fossils. The stratigraphic or taxonomic importance of individual species or genera is established by incorporating specimens from every new occurrence of a form. Arrangement may be stratigraphic, geographic or biologic, depending on the particular needs of the paleontologist responsible.

The type and index collections are available to any Survey member who wishes to familiarize himself with the main faunas he may expect to encounter before beginning work in a new field area. The collections are also available to accredited paleontological research workers by prior arrangement with the Curator.

ELECTRONIC SERVICES

Location: 661

Division: Central Laboratories and Technical Services

Section: Electronic Services and Instrument Development

Staff: F. W. Jones

Equipment: Precision electronic measurement instruments suitable for testing, calibration and adjustment of laboratory equipment and systems.
A Nova model 1200 Mini-computer with Teletype access and additional High Speed punched tape reader.
Hardware, components and test assemblies to permit design and construction of logic interface boards, etc., as required.

Function: To maintain and service scientific laboratory equipment in the Branch, to re-develop and up-date laboratory instrumentation, to provide computer interface services and advice on new on-line laboratory systems and to advise on electrical and electronic specifications for new equipment as required.

General service facilities include provision for the preliminary inspection of systems or instruments under guarantee, or subject to servicing by local manufactuers, to minimize the need to bring in expensive service staff to repair minor defects; advice on types of available commercial services; assistance with the modification (i.e. up-grading) of existing instrumentation; advice on the selection and adaptation of new types of "read-out" instrumentation.

COAL RESEARCH LABORATORIES

Location: 632-644

Division: Institute of Sedimentary and Petroleum Geology

Section: Coal Research

Staff: P. A. Hacquebard (in charge)
A. R. Cameron
J. R. Donaldson
T. F. Birmingham
C. Gange-Harris

Coal petrological and spore studies are carried out for geological and coal utilization purposes, and provide information on: (1) correlation of coal seams; (2) origin, sedimentation and lateral variations in composition, quality and thickness of coal seams; (3) stratigraphy of the Carboniferous and age determinations by means of fossil spores on terrestrial deposits of Upper Paleozoic age; (4) coal preparation, coal cleaning and coal carbonization; and (5) aspects of coal research for which microscopic studies are required. For the coal petrological investigations the following facilities are available: (1) general preparation room (639), equipped to carry out chemical and physical preparations for coal petrology, as well as the spore investigations, such as gravity separations, etching techniques, preparation of specimens for thin section analyses, spore macerations. Equipment here includes two fume hoods, balance, hot plates, and mounting presses to make lucite pellets of crushed coal; (2) coal cutting and coal grinding room (642), with coal saw, grinder and hammer-mill; (3) polishing room (64) with four lapidary wheels for grinding and polishing, hones and plates for making thin sections; (4) microscope room (636), equipped with microscopes for transmitted and reflected light studies, and (5) dark room (638) for photomicrography connected with microscopic coal research.

For the spore investigations a separate laboratory is provided, because a special technique is required to isolate the spores from coal and sediments. The facilities provided consist of: (1) preparation room (635) with fume-hood, oven, centrifuge and balance; (2) microscope room (637) with transmitted light microscopes; and (3) dark room (637A) for the paleobotanical and spore studies.

Apart from the rooms listed above, the section has at its disposal two separate office rooms (632) and (644), and a small microscope room (633) which also houses the large files of coal samples and polished sections, to which ready access is required.

As regards the service of age determinations by means of fossil spores, it may be worth while to point out that in coal a tremendous number of spores are often present. The collection, by field geologists, of coal samples or samples of carbonaceous shale, even of very thin layers (up to 1/4 inch thick) is therefore recommended, particularly in strata that are otherwise difficult to date. When sampling thicker layers of coal, care should be taken to obtain representative samples over the full thickness of the bed. Besides coal, fine grained sediments, that were deposited in sluggish and stagnant water, often contain spores, as do sandstones with carbonaceous specks. No spores are present in so-called bark vitrain that coalified layers of stems and trunks), but the surrounding material is often worth while collecting.

ENGINEERING-SEDIMENTOLOGY LABORATORIES

Location: 602, 604, 630
45 Spencer Street, Ottawa and at the
Institute of Sedimentary and Petroleum Geology, Calgary

Division: Terrain Sciences

Section: Engineering Geology and Geodynamics

Staff: D. E. Lawrence
D. E. Field
R. Kelly
A. Vilonyay (Calgary)
D. M. Campbell
C. McFarlane
B. A. Revoire

Equipment: Analytical balances, sample splitters, freeze drying apparatus, various types of sieves and sieve shakers, hydrometer and pipette equipment for grain size analysis, convection and vacuum ovens, combustion over, constant temperature baths, Benthos rapid sediment analyser, photo-sedimentometer, subsieve sizer, Chittick carbonate analysis apparatus, various Atterberg liquid limit devices, permeameter, Ph meters, Schmidt rebound hammer, Franklin point load apparatus, Slake durability apparatus.

Proctor compaction apparatus, unconfined compression apparatus (soil), microscopes, microseismic timer, special glassware, distillation equipment, vacuum and air pressure lines, in addition to standard laboratory equipment and supplies. Eighteen-foot mobile field laboratory trailer.

Function: To perform a wide range of sedimentological and engineering classification tests on rock and soil. The majority of samples are of glacial or modified glacial deposits, but analyses are made on all types of geological material. The majority of tests provide physical data but relevant chemical tests are also provided. New procedures, techniques and equipment are developed as required, to assist in special problems and to increase the efficiency of existing test procedures.

The principal laboratory at 45 Spencer Street, Ottawa carries out most service work while laboratories at 601 Booth Street, Ottawa (Rms 602, 604 and 630) and at the Institute of Sedimentary and Petroleum Geology in Calgary are mainly for non-service work; they are developmental and special use facilities.

Mechanical Analysis: This test is done in various ways depending upon the ultimate use of the results; i.e., sand-silt-clay ratios, complete analysis by sieve and pipette or hydrometer, fall velocity (rapid sediment analyser). In the majority of cases raw data from lab. measurements can be computed and plotted by computer.

General Classification Tests: The following basic physical and chemical tests are carried out regularly: bulk density, Sp. Gr. grains, moisture contents Ph, organic content, carbonate analysis.

Engineering Classification: (1) Soils: Atterberg limits, permeability, porosity unconfined compression, Proctor compaction. (ii) Rock: Petrographic analysis, Schmidt rebound classification, Franklin point load compression test, Slake durability or soundness test. Engineering design tests are not carried out but if more extensive testing is required eg., unconfined compression of rock, it is usually done in cooperation with another government department.

Sedimentological: Further treatment of samples after the mechanical properties have been revealed are usually compositional; point counting of heavy mineral separates, staining and X-ray identifications are carried out in cooperation with other branch laboratories (see X-ray mineralogy and petrology).

Developmental techniques: At present the following are the major developmental concerns: Setting up of mobile and portable field laboratory facilities. To develop short methods or more convenient methods of grain size analysis. To devise a battery of classification tests for engineering properties of rock and rock masses as is current practice with engineering soils classification. Recently much energy has been directed toward the computation and plotting of grain size data by computer which has vastly streamlined day to day operations.

QUATERNARY PALEOECOLOGY LABORATORY

Location: 605-609

Division: Terrain Sciences

Section: Geochronology and Paleontology

Staff: R. J. Mott (in charge)
Sigrid J. Federovich
M. Kuc
Leanne D. Wilson

Functions: The main function of the laboratory is to conduct palynological analyses on various types of Quaternary sediments and provide a paleoecological interpretation, stratigraphic correlation or age estimate where applicable. The palynological results are sometimes augmented by studies of other microfossils (diatoms etc.) plant macrofossils (seeds, needles, cones etc.) and identifications of fossil woods.

Many types of sediments and especially organic sediments of lakes and bogs contain pollen grains and spores and various plant and animal microfossils. Some of the pollen and spores released from plants in the region surrounding a lake, bog or other type of sedimentary basin are deposited with the sediment and if the proper conditions prevail, usually a reducing environment, they are preserved. Remains of microorganisms such as diatoms, other algae and plankton that lived in the lake are also incorporated into the sediment. Seeds, cones, needles, wood fragments and various other macroscopic plant remains may fall or be washed into the basin from the surrounding area. Subsequent sedimentation or other geological process may bury the deposit. If not exposed again by erosion, allowing direct sampling, the deposit may be sampled by drilling or excavating. Lake and bog deposits not buried can be sampled using hand operated devices, but because of the special equipment required the laboratory staff usually carries out the program. Samples for radiocarbon dating can be obtained at the same time.

Palynomorphs in the sediments are concentrated in the laboratory using physical and chemical procedures which essentially remove unwanted fractions. Residues are mounted on microscope slides and examined using the research microscope. A reference collection exceeding 1500 slides has been assembled to aid in identification of pollen grains and spores. Results are compiled in the form of pollen diagrams which graphically illustrate the pollen spectral changes that occur throughout the deposit. Standard pollen diagrams from various parts of Canada and modern pollen spectra from diverse vegetation zones aid in the paleoecological interpretation. Deposits can be correlated stratigraphically by their pollen content and the pollen assemblages often allow age estimates to be made.

Identification of fossil woods is another service provided by the laboratory. Samples are sectioned using the sliding microtome and transverse, radial and tangential sections are examined under the microscope. A wood reference collection is maintained to aid in identification and a program to collect samples from throughout the range of various species is followed.

Plant macrofossils such as seeds, needles, leaves and cones are extracted from the sediments using mild chemical disaggregation techniques and sieving. Sectioning using the rotary microtome may be required for some remains but most can be identified under the stereoscopic microscope without further treatment. Reference collections of seeds and needles aid in identification. Seed analyses can be compiled in diagrams and paleoecological interpretations can be made.

Bryophytes can be recovered from sediments using similar techniques of chemical disaggregation and sieving. Remains identifiable under the stereoscopic and research microscopes yield valuable information on paleocology.

In addition to the chemicals and standard laboratory equipment needed for chemical treatments, the laboratory is equipped with a sliding microtome, a rotary microtome, 2 binocular stereoscopic microscopes, 2 Leitz research microscopes with accessories and darkroom equipment for processing photographs taken through the microscope.

FLUME LABORATORY

Location: 299 Carling Avenue (adjacent to GSC Building)

Division: Terrain Sciences

Section: Engineering Geology and Geodynamics

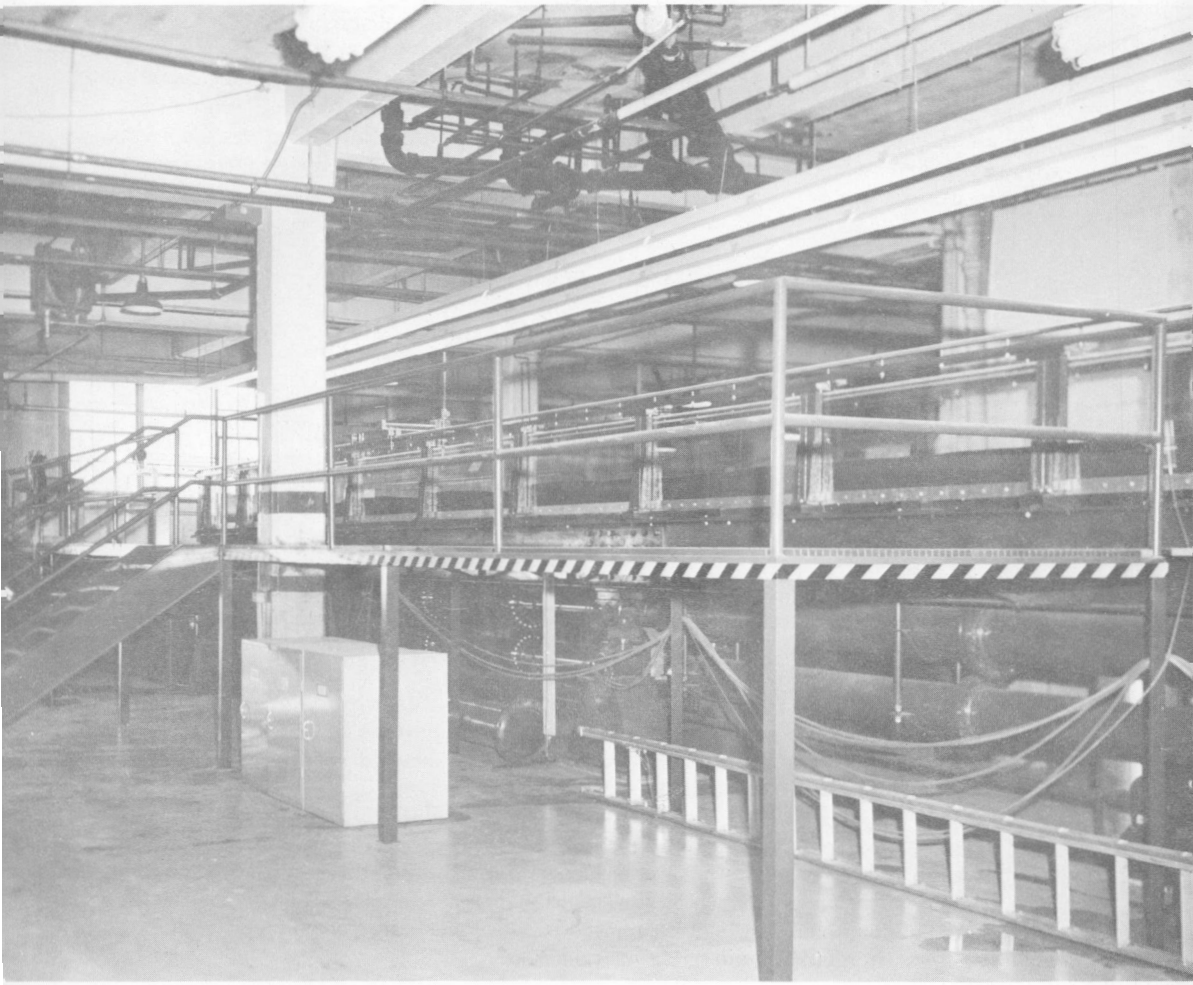
Staff: B. C. McDonald (in charge)
D. M. Morel

Equipment: One tilting recirculating glass-walled sedimentation flume 18.2 metres long x 0.76 metres wide x 0.6 metres deep, ancillary equipment such as discharge manometers, conveyor belts, and point gauges.

Function: To carry out research into sedimentary processes as revealed by variations in sedimentary structures and textures. The flume is primarily designed for study of river processes, although it can be adapted readily to study of certain lacustrine and beach phenomena.

The purpose of the apparatus is to provide a controlled environment where various natural processes can be studied in detail and where the relevant hydraulic parameters can be measured with accuracy. Additional understanding of sedimentation processes thus obtained can then be applied to more accurate reconstruction of paleo-environments attempted on the basis of field data.

The flume can be tilted, by electrically powered jacks, to a slope of 3 feet in 60 to vary the amount of energy available in the system. Water discharge can be varied between 0 and 345 litres/second. Sediment particles finer than 4 mm diameter can be recirculated in the system; coarser particles manually fed into the channel are generally caught in a screen at the downstream end. Transparent sections in each of the 24.8 and 29.9 cm. diameter return pipes permit study of transportation of sediment in pipes.



Experimental studies on river processes and sedimentation are carried out in the flume laboratory.

Stainless steel rails, mounted above the full length of the channel walls guide and support an instrument carriage from which measurements can be taken of either water or sediment bed features, including water depth, at any location along or across the channel.

A total-load samples at the downstream end of the channel permits monitoring of the total discharge of water plus sediment in transport. Suspended sediment samples are obtained with a siphon in the channel.

Discharge is measured at differential mercury - water manometers that record pressure differences across side-contracted orifice plates mounted in the two return pipes.

LASER MICROPROBE LABORATORY

Location: 767

Division: Central Laboratories and Technical Services

Section: Mineralogy

Staff: R. J. Traill

Equipment: Neodymium laser manufactured by the American Optical Company complete with power supply and energy control system. American Optical microscope for specimen viewing in transmitted and reflected light, specially designed for laser use. Jarrell-Ash 75-152 Czerny-Turner 0.75m Spectrograph with photographic recording and exchangeable photo-electric recording head.

Function: The laser microprobe is used to provide in situ spectrochemical analyses of minerals. By focusing the output of a high-power laser onto a specimen by means of microscope, sample can be vapourized and measurable spectral intensities obtained by means of a spark discharge occurring in the vapour cloud produced by the laser. Sample areas as small as 10 microns in diameter can be analyzed by this method.

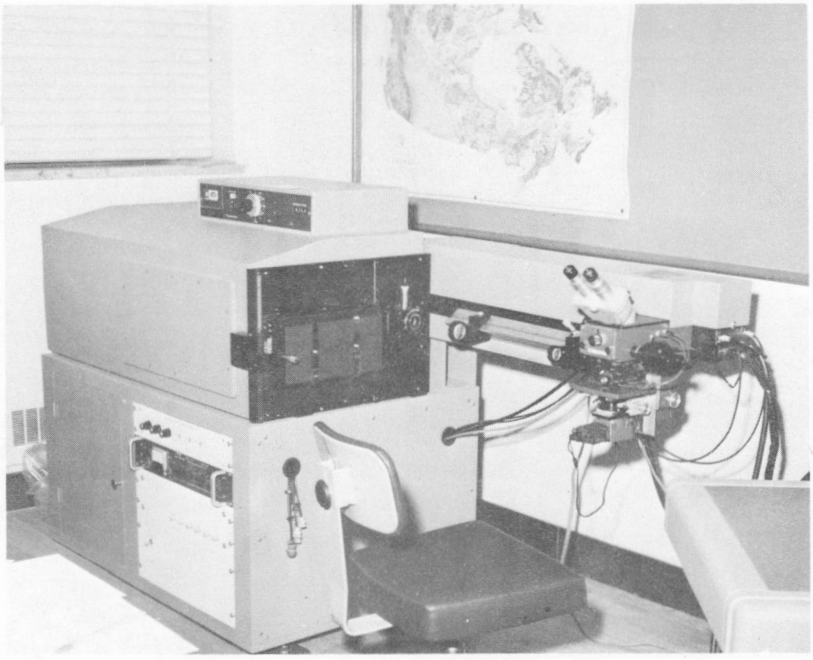
ELECTRON MICROPROBE LABORATORY

Location: 771A

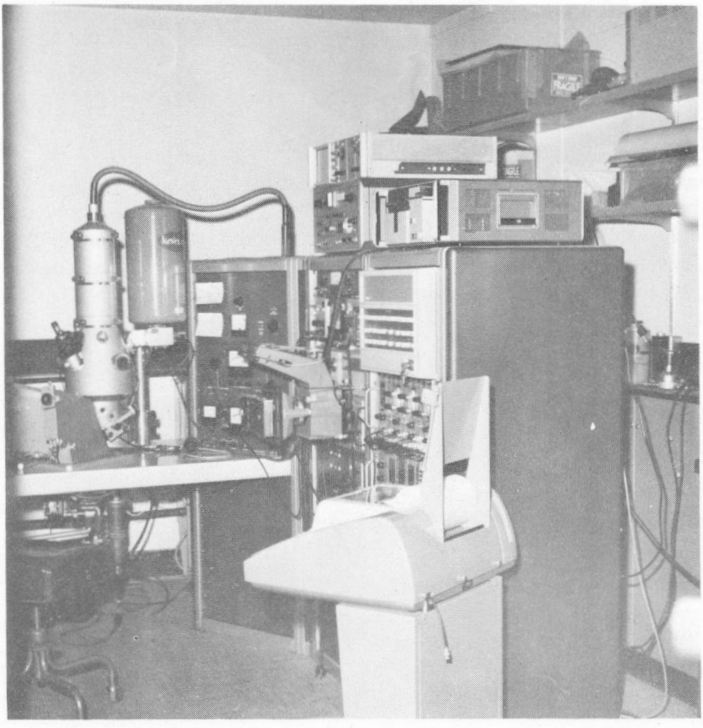
Division: Central Laboratories and Technical Services

Section: Mineralogy

Staff: A. G. Plant (in charge)
G. R. Lachance
R. N. Delabio



Laser microprobe for spectrochemical analyses of minerals. (767)



Electron probe microanalyser. (771A)

Equipment: Two Materials Analysis Company electron probe microanalyzers, each with the full complement of three spectrometers and associated electronic instrumentation for X-ray signal analysis and data acquisition. One instrument is equipped with an electron beam deflection system; an on-line mini-computer for data acquisition and data reduction; and an energy disperse analysis system. Additionally, the laboratory is equipped with petrographic microscopes for sample examination, and with polishing equipment and a carbon evaporator for sample preparation.

Function: The laboratory provides the Branch with the facilities and expertise to obtain compositional data on all types of material - silicates, non-silicates, alloys - and to apply the techniques of electron microprobe analysis to problems in earth science.

The electron microprobe is one of the newest scientific tools applied to the study of minerals, and is capable of providing the research investigator with data heretofore unobtainable. The principles of operation of the instrument are as follows: In the electron optical column, an electron beam produced in the electron gun is demagnified and focused to as small as one micron in diameter by two electromagnetic lenses onto the well-polished, conducting surface of the mineral to be analyzed. The interaction of the incident electrons with the mineral sample produces an X-ray spectrum that contains characteristic lines from all the elements present in the irradiated volume. With the aid of X-ray spectrometers, the spectra are dispersed and intensities measured as a function of wavelength, and to a first approximation the intensity of a characteristic X-ray line is proportional to the concentration of the element at the analyzed spot. Computer programs are then used to process these initial data and to correct for inter-element effects. A sensitivity of 0.1% can be obtained for the majority of elements of atomic number 11 and above, and under particular conditions 0.05% can be achieved.

For the requirements of the earth scientist some attractive features of the electron microprobe are:

(1) individual mineral grains can be analyzed <u>in situ</u> in polished or thin sections. This is important because it presents the mineral with the textural and morphological features of the assemblage undisturbed, and it means that time-consuming and frequently difficult mineral separations are unnecessary.

(2) The electron microprobe incorporates a simplified optical microscope in the electron optical column which enables the specimen to be viewed during analysis. This allows correlation of chemical composition with grain boundaries, inclusions, and exsolution lamellae, and also enables the cathodoluminescence produced by certain minerals (i.e. feldspars, silica minerals, some carbonates) under electron bombardment to be observed and this affords rapid mineral identification.

(3) The technique can, for most purposes, be considered non-destructive, although caution must be observed with some materials, i.e. water-bearing minerals and alkali-rich glasses.

(4) Qualitative and quantitative analyses can be obtained of mineral grains as small as a few microns in diameter, and with the attachment of a motor driven control to the sample holder, elemental profiles may be measured along traverses up to 3 mm. in length. In addition, qualitative and semi-quantitative information of the areal distribution of an element in a mineral assemblage can be obtained with the aid of an electron beam deflection system. The electron beam is scanned over the sample surface to cover an area up to 350 microns square, and the X-ray intensity used to modulate the brightness of a cathode-ray tube oscilloscope which scans in synchronism with the electron beam. The image on the oscilloscope may be photographed to provide a permanent record of the distribution of the element in the scanned area of the sample.

CHEMICAL, X-RAY FLUORESCENCE AND SPECTROGRAPHIC LABORATORIES

Location: 707, 708, 711, 712, 714, 717, 720, 724, 726 (chemical)
704 (X-ray fluorescence) 783, 784 (spectrographic)

Division: Central Laboratories and Technical Services

Section: Analytical Chemistry

Staff: Sydney Abbey (Section Head, also analytical method development)
W. H. Champ (in charge, spectrographic laboratories, also on analytical method development)
G. P. Bender (development and special analyses)
K. A. Church (production analysis)
D. A. Brown
J. G. Sen Gupta (specialized analyses, development, noble metals, rare earths, etc.)
Serge Courville (in charge, chemical and X-ray laboratories)
J. L. Bouvier (precise and general analyses)
Giselle C. Bélanger
Gary Vickers
Linda J. Seymour (rapid analyses)
Veronica E. W. Grushman
Fernande J. Watson

Function: To provide compositional data on geological materials in support of geological projects; to collaborate in world-wide analytical studies on international reference samples; to develop and publish methods for such analyses; to train staff of other institutions in analytical techniques for geological materials; to provide consultation service on chemical and analytical matters for the benefit of officers of the Geological Survey of Canada and of other geological groups in Canada and abroad.

Chemical and X-Ray Laboratories

Equipment: In addition to the usual array of hardware found in most chemical laboratories, there are also: an A. R. L. multi-channel X-ray fluorescene spectrometer, together with the high-temperature furnace for fusions, the grinding mill and pellet press, all required for sample preparation; Varian-Techtron modular atomic-absorption spectrophotometer (embodying components of several models, and used for atomic absorption, flame emission and colorimetric spectrophotometry); a Varian-Techtron model 1000 compact atomic-absorption and flame-emission spectrophotometer; a LECO two-channel induction-heating furnace, together with automatic titrators and other associated equipment.

Services: These laboratories determine all of the usual major and minor components of silicate rocks and minerals (i. e. down to 0. 01 per cent); work is also done on other types of sample and on some less usual components (often in the "trace" range), such as Li, Rb, Cs, Sr, Ba, Cr, Ni, Ag, Au, the platinum metals, the rare earths, and others, as required.

Ordinary rock and mineral analyses can be provided in three broad categories, involving varying degrees of precision, speed and versatility.

(1) "Precise" analyses are performed by a combination of conventional and atomic-absorption techniques. The extent to which the different techniques are utilized varies with individual samples. Results from such analyses should be suitable for research in petrology, mineralogy and geochemistry.

(2) "Rapid" analyses are performed by a combination of X-ray flourescence and supporting "wet" techniques. Depending on the required output rate, X-ray analyses may be done with or without preliminary fusion of the sample. Some of the chemical techniques used (atomic absorption, automatic titration, etc.) are similar to those used in "precise" analyses. Results should be suitable for regionald and reconnaissance studies, comparison of rock types, etc.

(3) Many analyses do not fall within either of the above categories, covering diverse areas, ranging from such simple tasks as the determination of sulphur alone on hundreds of samples (using induction heating and automatic titration), through more difficult operations such as determining traces of lithium, rubidium and cesium in varying rock types, to the highly complex determination of the noble metals (as major, minor and trace constituents) in their minerals and in meteorites.

Spectrographic Laboratories

Equipment: In addition to the usual array of hardware found in most spectrographic laboratories, there are also: (1) a Jarrell-Ash 3.4-metre Wadsworth grating spectrograph, together with the usual sample-preparation and dark-room facilities; (2) two Jarrell-Ash projection comparator-densitometers, together with calculating boards and other computational aids; (3) a Jarrell-Ash 1.5-metre Atom Counter direct-reading emission spectrometer.

Services: Generally, these laboratories utilize various optical emission spectrochemical techniques for the determination of minor and trace elements in aluminosilicate- and iron-base materials. Semi-quantitative and qualitative analyses are also available on almost any non-metallic inorganic materials.

Regular analyses can be provided in the following categories:

(1) Qualitative (photographic), reporting some 50-odd elements in ranges (e.g. major, minor, strong trace, etc.), applicable to samples down to less than 1 mg in weight.

(2) Semi-quantitative (photographic), reporting some 40 elements, with results within a factor of two of the probably correct values.

(3) Quantitative (photographic) for silicate samples, reporting 37 (mainly trace-) elements, probably within 15 per cent (relative) of the true values.

(4) Quantitative (photoelectric direct-reading) for silicate samples, reporting 20 (mainly trace-) elements, over a two-decade range, probably within 15 per cent (relative) of the true values. Designed for similar applications to those of the preceding method, this method is less flexible but much more rapid than any of the others.

(5) Quantitative (photographic) for iron-base samples, reporting 36 (mainly trace-) elements, similar in scope and accuracy to that of (3) above.

(6) Quantitative (photographic), a fractional distillation method for 15 of the more volatile trace elements down to fractional ppm levels in silicates.

All of the above methods (in both suites of laboratories) are continually being modified, improved and extended. Invidual staff members are frequently shifted from one work area to another, within the same suite of laboratories. There is one small chemical laboratory (room 726) used for analytical work on special samples, including lunar and meteorite material, by the Division Chief.

X-RAY LABORATORY

Location: 771

Division: Central Laboratories and Technical Services

Section: Mineralogy

Staff: R. J. Traill (in charge)
G. R. Lachance
M. Bonardi
R. N. Delabio
R. J. Gravel

Equipment: Four X-ray generators and power supplies, with accessory single crystal and powder cameras, devoted to X-ray diffraction studies using film techniques; two X-ray diffractometers; one Norelco vacuum X-ray spectrometer; and a computer controlled microdensitometer.

Function: The laboratory provides the Branch with the facilities and expertise required to apply X-ray techniques to geological problems, such as mineral identification and classification and the analysis of minerals and rocks.

Most crystalline minerals can be positively identified by means of their X-ray diffraction patterns alone, but additional chemical or physical data may be required to confirm an identification. X-ray diffraction techniques may be used to determine the chemical composition of minerals of certain groups such as olivines, spinels, garnets, carbonates and feldspars. These techniques may involve relatively simple powder diffraction methods or more complex single-crystal studies.

Identifications of the silicate constituents of clays and shales are made using an X-ray diffractometer and specially prepared oriented specimen mounts. In some cases X-rays provide the only means of identifying such fine-grained constituents. Variations in the relative abundances of the clay silicates in a suite of samples may be used for correlation and genetic studies of clay sediments. An X-ray diffractometer is also used to check for purity all mica concentrates that are separated in our laboratories for dating by the K-A method. When only a few mineral components are present in a mixture, the X-ray diffractometer may be used to obtain quantitative estimates of their abundances. The determination of the dolomite content of limestones is one example of this type of work.

In addition to X-ray diffraction, which provides a method of identifying and investigating mineral structures, the laboratory is also equipped for X-ray spectrography. This is a rapid non-destructive method of chemical analysis which is applicable to all elements heavier than Na in the periodic table. The sensitivity for many elements extends to 0.01 percent and in favourable circumstances sensitivities of 10 to 50 parts per million have been obtained. Semi-quantitative analyses can be made rapidly for most elements present in more than trace amounts in a wide variety of mixtures. Quantitative analyses, accurate to better than 5 percent of the amount of element present may be made for many elements in specific types of samples.

PETROLOGY LABORATORY

Location: 794 and 741

Division: Regional and Economic Geology

Section: Petrology

Staff: Mariette Turay

Equipment: Petrographic and binocular microscopes, U-stages heating stage, point counters, refracto-meters, monochromator, Na lamp, ultraviolet lamp, immersion oils, vacuum picker for use under microscope, X-ray diffractometer.

Room 741 has equipment for wet chemistry, staining of samples and thin sections, determination of specific gravity and specialized mineral separations.

Function: The petrography laboratory provides equipment and an optical darkroom for use of all officers of the Survey. Special determinations of optical properties, specific gravity as well as staining of rock slabs, thin sections and carbonates are carried out on request.

Special petrographic examinations can be made by special arrangement. The newly acquired X-ray diffractometer may be used personally by prearrangement and under supervision, by scientists who wish to do their own determinations.

GEOCHRONOLOGY LABORATORY

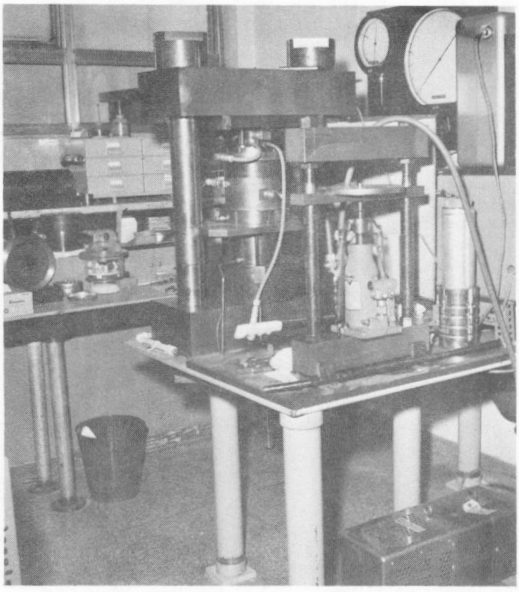
Location: 789-799, 790 and 723

Division: Regional and Economic Geology

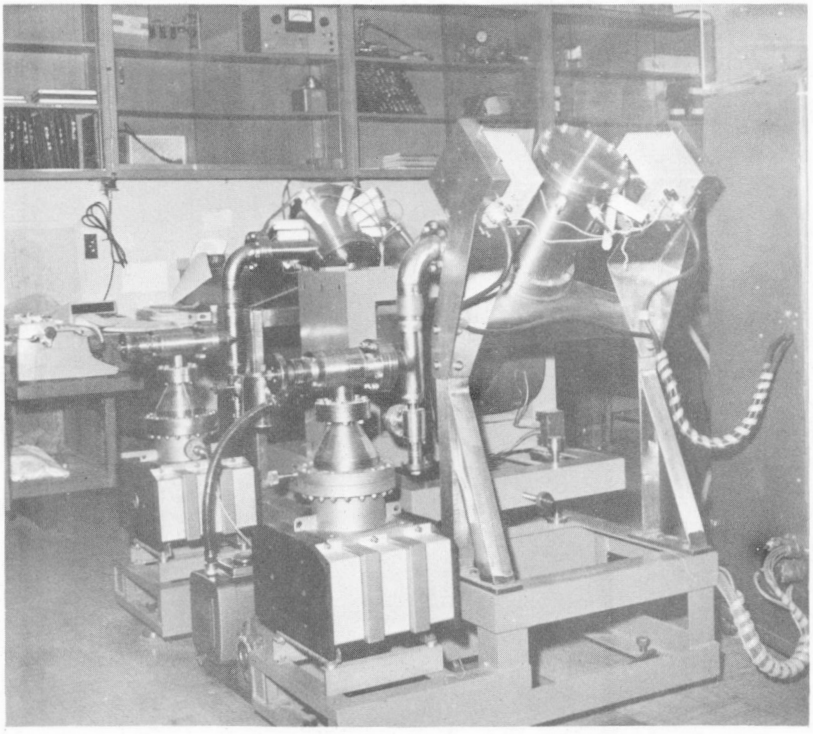
Section: Geochronology

Staff: R. K. Wanless (Head)
R. D. Stevens - Isotopic analysis - K-Ar Age Determinations
W. D. Loveridge - Isotopic analysis - Rb-Sr and U-Th-Pb Age Determinations
R. W. Sullivan - Isotope chemistry
J. C. Bisson
J. L. MacRae
M. Neidy
F. B. Quigg
K. Santowski
R. J. Seguin

Equipment: 6-mass spectrometers, 3 of which are designed to analyse gaseous samples while the other three are used for solid sample isotopic analyses.
4-Hi-vacuum argon gas extraction and purification lines.



Apparatus for high pressure reaction studies on rocks and minerals. (862)



Solid source mass-spectrometer for lead isotope analysis. (790)

1-minicomputer interfaced to process data from three mass spectrometers simultaneously.
1-sulphur dioxide conversion and purification apparatus.

Function: 1. The determination of the age of rocks, minerals and geological events.
2. The study of stable isotopic variations in geological processes.

A few elements (parents) found in rock forming minerals are radioactive and hence transform naturally to other elements (daughters) at rates which are comparable to the age of the earth. By precisely determining the isotopic abundances of these parent-daughter pairs (using mass spectrometers) it is possible to calculate the geological age of the mineral and/or rock being studied. Five parent-daughter systems are currently being exploited in our laboratories - these are - ^{40}K - ^{40}Ar; ^{87}Rb - ^{87}Sr; ^{238}U - ^{206}Pb; ^{235}U - ^{207}Pb; and ^{232}Th - ^{208}Pb.

While the various systems find application over the whole span of geological time they are especially valuable for the study of older (Precambrian) rocks in which no fossil age indicators occur.

It has been observed that under certain natural conditions mineral forming processes tend to fractionate the isotopes of some elements. This is due to the fact the various isotopic species respond differently to the controlling chemical and physical processes. Hence, a record of natural conditions at the time of formation and/or alteration of the rock is to be found in the relative abundance distribution of specific isotopes. Studies based on the distribution of the isotopes of sulphur, carbon and lead are currently being undertaken.

ISOTOPE GEOCHEMISTRY LABORATORY

Location: 730-736

Division: Resource Geophysics and Geochemistry Division

Section: Geochemistry

Staff: W. Dyck
J. C. Pelchat

The Isotope Geochemistry Laboratory has facilities to carry out research using radioactive isotopes and make routine determinations of naturally radioactive substances. Instruments on hand permit the determination of natural concentrations of radon in surface waters, soils and atmospheric air. For β emitting substances a flow type end-window proportional counter is available. Gamma rays are measured with a 3" well type Na I (T1 activated) crystal connected to a 512 channel pulse height analyser.

The recent addition of a small mass spectrometer will make possible isotope analyses of simple gases in the mass range 2 to 312.

GEOCHEMICAL TRAILER LABORATORIES

Location: Winter quarters-322 Catherine Street, Ottawa

Division: Resource Geophysics and Geochemistry

Section: Geochemistry

Staff: Party Chief (in charge) + seasonal employees

Trailers: There are five trailers: two spectrographic units, two wet chemical units and one sample preparation unit

The spectrographic units have: a 1.5m Jarrell-Ash spectrograph with a Wadsworth grating, dark room, comparator-densitometer facilities and the necessary cupboard and bench space for weighing, electrode preparation and data recording activities.

The wet chemical units are designed with sufficient shelf bench and services to carry out routine colorimetric methods.

The sample preparation trailer is equipped with drying cupboards and ovens, weighing facilities, bench space for sample preparation and an office for drafting and data compilation activities.

Trailers are hauled by commercial or G.S.C. vehicles to field sites where power, water and sewage facilities are available. Trailers have been blocked on flat cars for rail shipment. In either case no significant damage is sustrained.

Field trailer laboratory units are capable of providing sample preparation and analytical services similar to that obtained from headquarters laboratories in Ottawa.

GEOCHEMISTRY INSTRUMENTATION LABORATORY

Location: 719

Division: Resource Geophysics and Geochemistry

Staff: Q. Bristow (in charge)
G. Gaumont

This laboratory has been set up to develop state of the art electronic and electrooptical instruments to enable field geochemists to make even more precise and reliable analytical measurements of the concentrations of certain elements, compounds and ionic species in vapours, soils, lake and stream sediments and waters as applicable. Heavy emphasis is laid on the development of small, portable, rugged instruments suitable for use in a field environment and on the application of the most advanced device technology in their implementation.

Facilities include printed circuit and photo engraved front panel fabrication, all stages from artwork layout to finished products. Model shope equipment, including

a jeweller's lathe and hand operated sheet metal shear and punch press. Test equipment; 50 mH_z oscilloscope, pulse and function generators, 50 MH_z combined counter -1 Digital volt meter, and a two channel strip chart recorder.

Examples of instruments which have either been developed or are under development are a mercury vapour sensor based on the frequency shift of a quartz crystal plated with gold electrodes, a miniature pH-meter, and a nephelometer using solid state light emitting diodes and a silicon photodiode detector.

HIGH PRESSURE GEOCHEMICAL LABORATORY

Location: 862

Division: Regional and Economic Geology

Section: Petrology

Staff: R. F. Emslie

The laboratory is equipped for the investigation of high pressure reactions of rocks and minerals over pressure ranges up to 50 kilobars and to temperatures up to 2000° C by means of a single stage piston and cylinder apparatus. There are also facilities for the preparation of synthetic materials for rock and mineral reaction studies.

At present time, most of the work in the laboratory is concerned with experimental studies on anorthositic and related rocks.

MINERAL SEPARATING LABORATORIES

Location: 850, 855, 857, 859 and 863

Division: Central Laboratories and Technical Services

Staff: J. C. Paris (in charge)
B. D. Machin
R. Charbonneau
A. G. Brown
J. M. Huot

The laboratories are designed to handle the requirements of the Geological Survey for rock crushing, grinding, sizing, sample-splitting, and mineral separating.

Room 863 is a general purpose laboratory for crushing and pulverizing rocks, splitting crushed rocks into representative smaller portions, and separating the crushed products into sized fractions. The equipment used for this work includes two jaw crushers for primary crushing of rock from 3" x 4" size down to less than 1/2"; a disc-type pulverizer to further reduce the products from the crushers to whatever finer size is required; sampling devices to permit a large crushed sample to be divided into smaller representative portions; a grader, or shaking-screen device, to divide the

crushed product into several carefully sized fractions; and a mechanical mortar grinder for pulverizing small samples.

Each piece of equipment is housed separately in a glazed-tile cubicle from which an exhaust fan removes rock dust resulting from the operation. The cubicles are designed to minimize health hazards due to rock dust in the air, to permit efficient cleaning of the equipment, and to minimize cross-contamination of samples when several operations are conducted at the same time. A Carpco magnetic separator is installed in one of the cubicles. This apparatus is very useful for making rapid separations between minerals of relatively high magnetic susceptibility such as biotite, hornblende, and pyroxene, and non-magnetic minerals such as quartz and feldspar.

Room 857 is reserved for crushing, pulverizing, sample-splitting, and sizing rocks samples which require special care to avoid contamination with metallic elements. A jaw crusher is used for coarse crushing, and a pulverizer equipped with ceramic grinding plates is used for the fine grinding. Ceramic ball mills agitated by means of paint shaker are used for contamination-free grinding of rocks for chemical analysis.

The exhaust fans and dust collecting units which remove and collect rock dust from the cubicles in rooms 857 and 863 are installed in room 859.

Room 855 is used mainly for mineral-separating. It contains a laboratory model Wilfley table and two Superpanners. The Wilfley table is used for preparing concentrates of heavy minerals from large samples of rock. The Superpanner is a wet separator which is very useful for concentrating heavy minerals, particularly non-magnetic minerals which are too heavy for heavy-liquid separations.

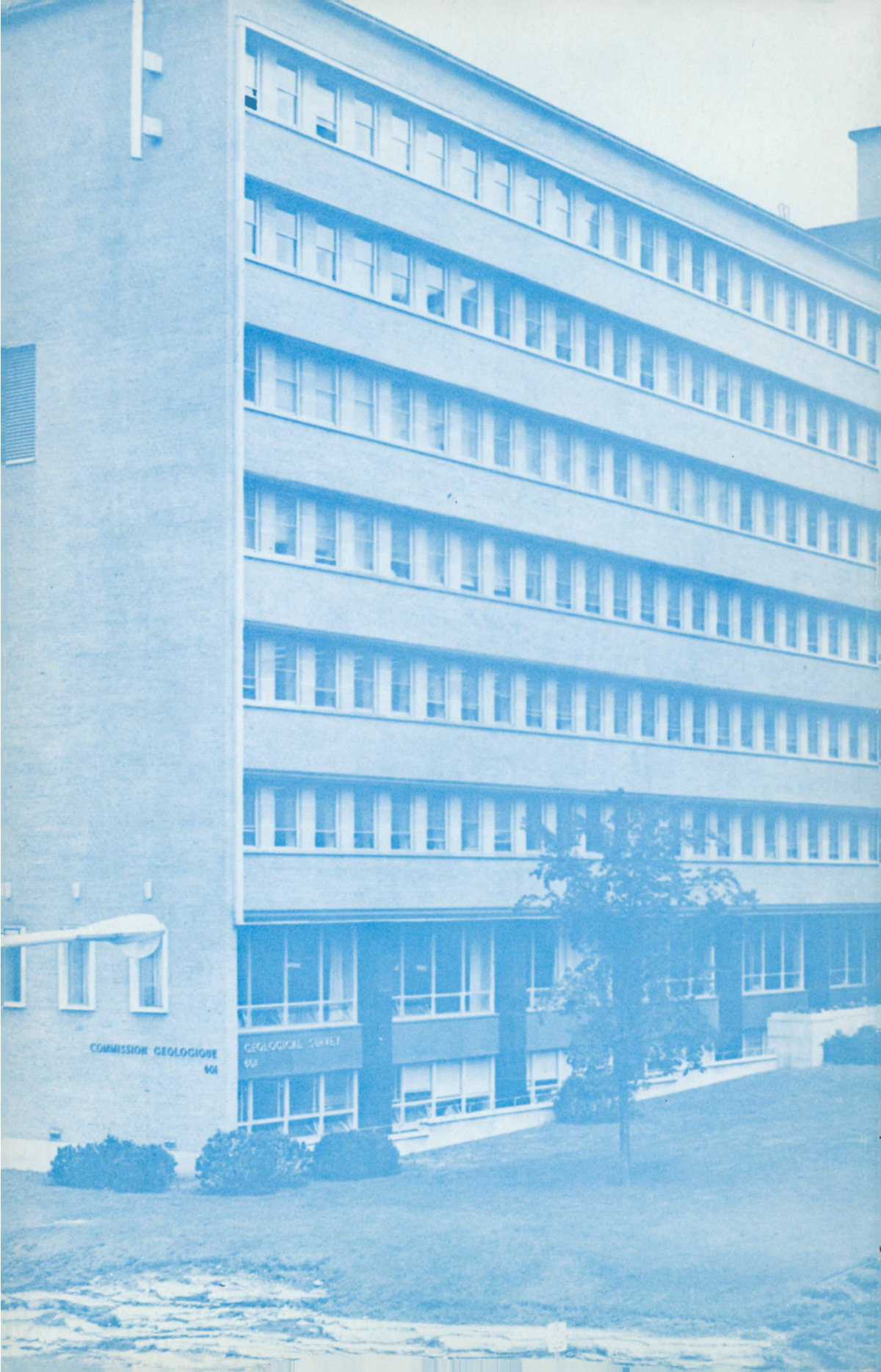
Room 850 includes several Frantz Isodynamic Separators which are used to separate minerals on the basis of their magnetic susceptibilities, and an array of fume hoods containing apparatus for making heavy-liquid gravity separations. Other major pieces of equipment include a Stearns magnetic separator and a Carpco electrostatic separator.

ILLUSTRATIONS

Layout - Carol T. Wilson

OFFICES OF THE GEOLOGICAL SURVEY OF CANADA

Geological Survey of Canada, 601 Booth Street, Ottawa K1A OE8, Ontario		Telephone
Director:	Dr. Y. O. Fortier	(613) 994-5187
Chief Geologist:	Dr. C. S. Lord	" 994-9207
Central Laboratories and Technical Services Division, Chief:	Dr. J. A. Maxwell	" 994-9269
Geological Information Processing Division, Chief:	Dr. P. Harker	" 994-5712
Regional and Economic Geology Division, Chief:	Dr. J. O. Wheeler	" 994-9224
Resource Geophysics and Geochemistry Division, Chief:	Dr. A. G. Darnley	" 994-5789
Terrain Sciences Division, Chief:	Dr. J. G. Fyles	" 994-5116
Geological Enquiries		" 994-5712
Geological Publications		" 994-5004
Geological Library		" 994-5257
Geological Survey of Canada, Cordilleran Section, 100 West Pender Street, Vancouver 3, British Columbia.		
Head:	Dr. H. Gabrielse	(604) 666-1529
Geological Survey of Canada, Institute of Sedimentary and Petroleum Geology, 3303 - 33rd St. N. W., Calgary T2L 2A7, Alberta.		
Director:	Dr. D. J. McLaren	(403) 284-0110
Geological Survey of Canada, Atlantic Geoscience Centre, Bedford Institute, Dartmouth, Nova Scotia.		
Director:	Dr. B. D. Loncarevic	(902) 162-2367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