Thomas Fitch

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GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

SUMMARY OF RESEARCH: FIELD, 1962

Compiled by S. E. Jenness

Price, 25 cents

1963

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Illustration

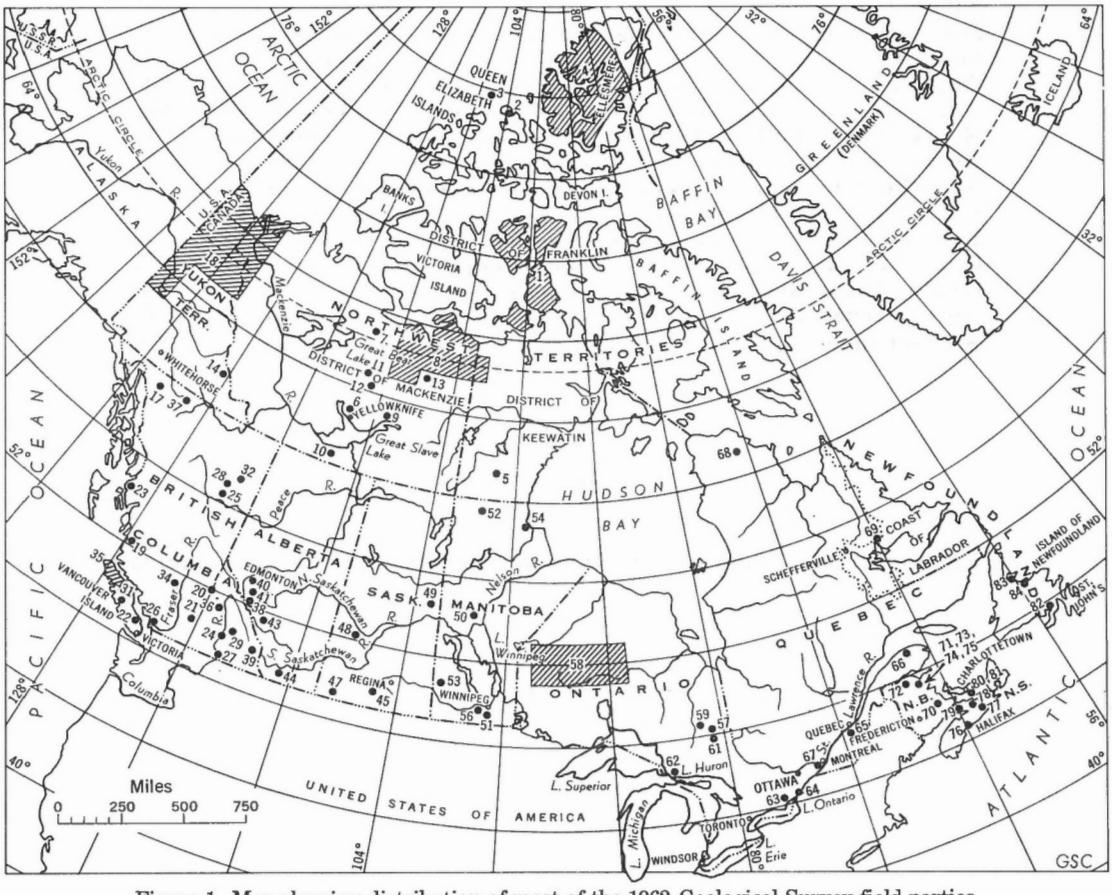

Figure 1. Map showing distribution of most of the 1962 Geological Survey field parties. Numbers correspond with numbered abstracts in text.

SUMMARY OF RESEARCH: FIELD, 1962

INTRODUCTION

In January 1958 the Geological Survey issued a 23-page report (Information Circular No. 1) summarizing the field work undertaken by its officers in 1957. This was followed in succeeding years by four other Information Circulars, each one thicker than the last. All met with considerable public interest and were soon out of print. This year for the first time, such information is being published in the Survey's 'Paper' series. Each statement has been obtained, in abstract form, from the field officer or officers concerned, and has received only cursory editing. The locations of most of the field parties are shown on Figure 1.

The following reports describe briefly, by province, territory, or district, field projects undertaken during 1962, and summarize some of the results. All statements concerning the results of field work are subject to confirmation by office and laboratory studies. The main purpose of most Geological Survey field work is to obtain basic data on the geology of Canada. When assembled, interpreted, and published as appropriate maps and reports, this information may help to guide those engaged in the search for and development of metallic and non-metallic mineral deposits, fuels, water supplies, and construction materials.

Unless otherwise specified, the scale of geological maps resulting from the field projects can be inferred from the size of the map-areas. Areas involving 1 degree of latitude, and 1 or 2 degrees of longitude (for instance, 32 A E 1/2 or 32 A) are generally mapped for publication on the scale of 1 inch to 4 miles, whereas areas involving 15 minutes of latitude and 15 or 30 minutes of longitude (for instance, 32 A/1 E 1/2 or 32 A/1) are generally mapped for publication on the scale of 1 inch to 1 mile. Map-areas are designated according to the National Topographic System as revised in 1960.

Generally, preliminary maps and/or reports incorporating the results of the 1962 field work will be released during 1963. The release dates of preliminary reports and maps, and all other Geological Survey publications are announced from time to time by postcards mailed free of charge to all persons or organizations requesting this service. Requests for announcement cards, geological reports and maps, or information on specific areas or topics, should be addressed to: The Director, Geological Survey of Canada, Department of Mines and Technical Surveys, Ottawa.

DISTRICT OF FRANKLIN

1. OPERATION PRINCE OF WALES

R.G. Blackadar

This helicopter-supported operation completed the reconnaissance geological mapping of Boothia Peninsula, and King William, Somerset, and Prince of Wales Islands (57 NE, NW, SW; 67 NE, SE, SW; 58 SE, SW; 68 SE, SW). R.G. Blackadar was in charge and was assisted in the mapping of the Precambrian areas by F.C. Taylor. R.L. Christie carried out stratigraphic studies in the Palaeozoic strata and was assisted by W.W. Nassichuk, a graduate student. B.G. Craig examined the surficial deposits.

The map-area is dominated by the Boothia Arch, a structural and topographic high, composed of Precambrian igneous and metamorphic rocks. Gneisses predominate, but here and there granitic rocks are abundant. On the east side of the arch lit-par-lit gneiss and extensive areas of granite are present. In the central and western parts of the Precambrian area well-banded gneiss is predominant. A broad division into mainly felsic and mafic gneisses can be made, but any such division embraces a wide diversity of rock types. Rare thin crystalline limestone bands occur near Bellot Strait and Creswell Bay. Extensive gossan zones, derived from pyrite, are present in northern Boothia Peninsula. Many of these rusty zones contain graphite.

Steep dips and a northerly strike characterize the gneissic rocks but narrow elongate basin-like structures occur parallel to this trend. Northeast- and northwest-trending lineaments impart a pronounced rectilinear pattern to Boothia Peninsula. Slickensides and mylonite occur in some of these. Such features are less common on Somerset Island or on the western margin of the arch on extreme eastern Prince of Wales Island and the islands in Peel Sound.

The presence of unfossiliferous sedimentary rocks of presumed Precambrian age south of Aston Bay, northwest Somerset Island, was confirmed. Two formations are probably present. The older, the Aston Formation, is of more limited extent than previously mapped.

All the preceding rocks are cut by dykes of gabbro. These are most abundant on northern Boothia Peninsula and on Somerset Island. On Boothia Peninsula the prevailing trend is northwest but on Somerset Island they are diversely oriented and in the Aston Formation take the form of sills rather than dykes.

The Palaeozoic formations range in age from Cambrian to Silurian and/or Devonian. The presumed Cambrian beds are sandstone, sandy dolomite, and dolomite, which carry a trilobite and inarticulate brachiopod fauna. They outcrop in downfaulted outliers in the Precambrian terrane of central Boothia Peninsula.

A light-weathering dolomite formation, tentatively correlated with the Cornwallis and Allen Bay Formations and about 2,000 feet thick, flanks the Boothia Arch on Boothia Peninsula and Somerset Island. Flat-lying Ordovician beds underlie all of King

William Island except for possible Silurian strata near Douglas Bay on the south coast.

The Ordovician beds are conformably overlain by dark grey limestone and siltstone units identified as the Read Bay Formation. The Peel Sound Formation conformably overlies the Read Bay Formation on Prince of Wales and Somerset Islands, but unconformable relationships were noted locally on northern Prince of Wales Island. Along the east coast of Prince of Wales Island this formation comprises at least 1,500 feet of arenaceous and conglomerate beds. The lowermost beds are transitional from the underlying Read Bay Formation and overlying conglomerate beds pass upward from limestone-dolomite-pebble conglomerate into coarse granite-gneiss-boulder conglomerate. The Peel Sound Formation passes into a sandstone and shale facies and then into a shale and limestone facies, the latter being similar in many respects to the Read Bay Formation.

The central and western parts of Prince of Wales Island are underlain by flat-lying fossiliferous limestone beds similar to the Read Bay Formation.

Along the eastern margin of the Boothia Arch the contact between Precambrian and Palaeozoic rocks is marked by numerous block faults whereas along the western margin the Palaeozoic beds are upended and juxtaposed against the Precambrian rocks apparently by steeply dipping thrust faults.

1a SURFICIAL GEOLOGY, OPERATION PRINCE OF WALES

B.G. Craig

Evidence of glacial activity was found throughout the area mapped (57 NE, NW; 58 SE, SW; 67 SE; 68 SE, SW). Boothia Peninsula, King William Island, and most of Prince of Wales Island display a variety of glacial landforms and materials, ice-marginal channels, and rock-inscribed features. Most of Somerset Island shows little evidence of glaciation, although granite boulders are common on the limestone uplands, the till has a ground moraine surface pattern in many places, and ice-marginal channels occur along many of the valleys.

Ice-movement was toward the northeast of Boothia Peninsula and the east side of King William Island, to the east on the west side of Somerset Island, and to the northwest on the west side of King William Island. The north and east part of Somerset Island is almost devoid of diagnostic glacial landforms except for a few drumlins suggesting northward movement in the central part. A complicated pattern of flow features is exhibited on Prince of Wales Island. Over most of the southern part a broad scale pattern of drumlins and associated features indicates ice-movement toward the north and northwest. Later outward movements toward the coast are indicated by local drumlin fields.

King William Island, much of Prince of Wales Island except for the northern and eastern parts, the coastal areas and southern part of Boothia Peninsula, and the southeast and central parts

of Somerset Island were inundated by the sea following the retreat of the ice. The upper limit of submergence could be deduced in only a few places. Strandlines are not common above 400 feet elevation, although marine pelecypod shells were collected at elevations up to 650 feet on Boothia Peninsula, 500 feet on Somerset Island, and 850 feet on Prince of Wales Island. The highest shells may not represent deposition during the last marine invasion, however.

2. MARINE GEOLOGY PROGRAM, POLAR CONTINENTAL SHELF PROJECT

J.I. Marlowe and G. Vilks

An investigation of sedimentation in Prince Gustaf Adolf Sea and Maclean Strait, in the western Queen Elizabeth Islands, was carried out by Geological Survey personnel attached to the Polar Continental Shelf Project and based at Isachsen, Ellef Ringnes Island, N.W.T. The purpose of the project was to provide information on the total sedimentary environment. To do this samples were collected from outcrops and stream beds, as well as from the near-shore and offshore bottom zones.

Preliminary examination of samples taken from detailed traverses across the sublittoral zone of the west coast of Ellef Ringnes Island indicates that the sediments of that area are texturally complex, a characteristic which suggests that ice has the dominant role in sublittoral transport and erosion. A distinctive, extremely cold-water fauna is present in the near-shore samples so far examined.

Core samples taken from the channels west and south of Ellef Ringnes Island are lutite with frequent pebbles. A light-coloured upper layer overlies a darker layer in most of the cores and probably represents a drastic change in conditions of sedimentation. Analysis may relate this change to climatological events in the Pleistocene.

Bathymetric data indicate strongly that the channels occupy a drowned area of terrestrial drainage. Submarine valleys, with a local relief of 200-300 metres, trend along the axes of the channels, and some shoal features appear to be seaward extensions of presently emerged islands.

3. SEDIMENTATION AND SUBMARINE TOPOGRAPHY OF THE CONTINENTAL SHELF, WESTERN QUEEN ELIZABETH ISLANDS

B.R. Pelletier

This is a continuing study begun in 1960; this year reconnaissance traverses were made across parts of the continental shelf between Ellef Ringnes and Borden Islands, and extended to the upper continental slope. Bottom grab samples and, in some cases, short cores were obtained from pre-selected sites over the Arctic Ocean. Laboratory examinations of these samples are presently being carried out by the Geological Survey.

A preliminary study of the field observations indicates the following:

1. The continental shelf is fairly uniform in relief, except for small local knolls and depressions, and extends about 100 miles off shore in this area. The depth of the shelf varies from 400 metres some 30 to 40 kilometres off shore to over 600 metres where the continental slope begins. Shallower depths near shore are the result of submergence of old land features.

2. The sediments consist generally of light brown mud and silt with a mixture of sand varying from 10 to 25 per cent, although in the drowned areas, the sand content exceeds 75 per cent. Much of the fine material appears to be derived directly from the adjacent islands to the east by means of normal sedimentary processes, for the layers increase in thickness in that direction, and there are no slump structures evident in the cores. Pebbles and cobbles are presumably ice-rafted in origin, and occur over all areas of the continental shelf and slope that were investigated.

Field work was carried out during April and May from the Polar Continental Shelf Project Base at Isachsen, Ellef Ringnes Island.

4. AXEL HEIBERG AND ELLESMERE ISLANDS

R. Thorsteinsson, E.T. Tozer, H.P. Trettin, and J.W. Kerr

A two-year program of reconnaissance mapping of Axel Heiberg and Ellesmere Islands started in 1961, was completed in 1962. Transportation was provided by one G2A Bell helicopter, provided by Atlantic Helicopters, Montreal, and one Piper Super Cub aircraft (PA 18A) under contract with Bradley Air Services, Carp, Ontario. The Super Cub was equipped with low pressure tires for landing on unprepared terrain. The party was based at Eureka from June 14 to September 3.

Reconnaissance mapping, in part suitable for publication at a scale of 1 inch to 8 miles, and in part 1 inch to 4 miles, was completed for Axel Heiberg Island and for much of central Ellesmere Island. The southern limit of mapping on Ellesmere Island is approximately a line joining the head of Baumann Fiord and the tip of Bache Peninsula. The northern boundary is from upper Yelverton Bay to the Head of Archer Fiord.

As in 1961 Trettin was responsible for the early Palaeozoic eugeosynclinal rocks, Kerr the early Palaeozoic miogeosynclinal rocks, Thorsteinsson the Pennsylvanian and Permian formations, and Tozer the Mesozoic and Tertiary beds.

In northern Axel Heiberg Island an angular unconformity between Middle Silurian siltstone-lithic arenite and overlying Lower or Middle Devonian red beds has been observed. This area thus experienced early Palaeozoic tectonism. Ludlovian volcanic rocks, associated with graptolite-bearing rocks, occur in adjacent northwestern Ellesmere Island. In northern Axel Heiberg Island quartz diorite was found to have intruded Middle (?) Devonian strata. This intrusion has a K-Ar age of 360 m.y. The field relations and

radiogenic age both corroborate the suggestion that a major orogeny took place in Upper Devonian time[1].

In northwestern Ellesmere Island a nearly complete Silurian section of the Franklinian eugeosyncline has been studied and 4 major map-units have been established. High grade metamorphic rocks, comparable to the Cape Columbia Complex, have been recognized in northwestern Ellesmere Island, east of Henson Bay. A large dunite-serpentinite dyke, occupying a Tertiary fault on Kleybolte Peninsula, northwestern Ellesmere Island, is considered to be a "cold" intrusion. Traces of copper minerals occur in several localities in northwestern Ellesmere Island.

Generally in the Queen Elizabeth Islands the miogeosynclinal late Ordovician and Silurian rocks are of two contrasting facies: carbonates in the south and southeast, and graptolitic shales in the north and northwest. It was found in 1962 that the facies boundary is sinuous between Baumann and Canyon Fiords, Ellesmere Island, and that there may be isolated carbonate banks within the shale belt in this area. North of Canyon Fiord a thick siltstone sequence is interbedded with Silurian graptolitic shale and chert (Cape Phillips Formation). At Ella Bay a comparable thick siltstone formation rests directly upon the Ordovician Cornwallis Formation. The siltstone unit evidently represents the southeastern extension of the Cape Rawson beds, which are widely distributed in northeastern Ellesmere Island. In the section north of Canyon Fiord the Cape Phillips and Cape Rawson Formations are apparently interfingering. Marine Middle (?) Devonian rocks are now known to be widely distributed between Baumann Fiord and Copes Bay. These Devonian rocks are the youngest in a structurally conformable sequence that extends down to the late Precambrian Thule Group. The Palaeozoic folding of central Ellesmere Island is thus dated as later than Middle (?) Devonian.

Sections of Pennsylvanian and Permian rocks were measured between Baumann and Tanquary Fiords Ellesmere Island, and on eastern Axel Heiberg Island. The facies relationships are complex. In general wedges of sandstone and conglomerate, with interbedded carbonate, characterize the eastern sections, exposed on the eastern edge of the Sverdrup Basin. A shale-siltstone sequence, locally underlain by early Pennsylvanian reefs, spans much of Pennsylvanian and Permian time and extends from the Stolz Range of eastern Axel Heiberg Island, northeast to the country around Hare Fiord. In other areas, the sections are dominated by carbonate, with reefs in both the Pennsylvanian and the Permian. As noted elsewhere[2], there are two units of gypsum and anhydrite in the section. The lower unit is now known to be of early Pennsylvanian, or possibly late Mississippian age; the upper unit is early Permian. The lower unit appears to the source of the material in the diapirs and and domes of the Sverdrup Basin.

A substantial Mesozoic section is now known to occur in northern Ellesmere Island. These rocks are preserved in synclines in the country between Hare and Tanquary Fiords, and also between the head of Hare Fiord and the Tanquary-Yelverton Pass. The section ranges as high as the Hassel Formation. One thin basalt flow occurs in the Isachsen Formation (Lower Cretaceous) but in lithology most of the formations resemble those of Fosheim Peninsula and eastern Axel

Heiberg Island. Some units become progressively thinner to the northeast; this change is most pronounced in the Middle and early Upper Triassic deposits and on the shores of Tanquary Fiord the Middle Triassic is cut out completely. No Mesozoic rocks younger than Triassic are known in the part of northwest Ellesmere Island that lies north of Otto Fiord; in this area faulted outliers of Tertiary rocks rest upon the Triassic, and perhaps also older beds. It would appear that Tertiary overstep prevails in northwestern Ellesmere Island, as on eastern Axel Heiberg Island[2]. On eastern Fosheim Peninsula and in the country south of Bay Fiord the Isachsen Formation is transgressive and rests directly upon various older Mesozoic and Palaeozoic Formations. A sub-Isachsen unconformity has already been recognized on the south and southwest margins of the Sverdrup Basin (southern Melville Island and Banks Island), and the present discovery reveals that the east margin experienced a comparable geological history.

Note

Mr. Alan Spector, a seasonal employee with the Gravity Division of Dominion Observatories Branch of the Department of Mines and Technical Surveys, while attached to the Polar Continental Shelf Project, observed bituminous sands or similar material on the north shore of Marie Bay, Melville Island. The observed deposit extends from about latitude 76° 15', longitude 115° 10' to about latitude 76° 15', longitude 115° 30'. Another area, observed from the air, and possibly underlain by similar material, extends about 5 to 17 miles east-southeast of the head of Marie Bay.

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[1] Kerr, J.W. and Trettin, H.P. (1962): Mississippian Rocks and the Mid-Palaeozoic Earth Movements in the Canadian Arctic Archipelago; Jour. Alberta Soc. Petrol. Geol., vol. 10, No. 5, pp. 247-256.

[2] Caley, J.F. et al.: Field Work, 1961; Geol. Surv., Canada, Information Circular No. 5 (1962).

DISTRICT OF KEEWATIN

5. KOGNAK RIVER AREA

K.E. Eade

The stratigraphic section of the unmetamorphosed Early (?) Proterozoic sedimentary rocks in the southwestern quarter of Kognak River (65 G E 1/2, 65 H W 1/2) map-area is as follows, from bottom to top: glassy white orthoquartzite; grey or red argillite and black slate; dolomite with interbedded grey argillite, grading upward into grey argillite and greywacke; impure grey to pink quartzite. Within the black slate and argillite overlying the basal orthoquartzite, sill-like bodies of fresh gabbro are abundant. The sedimentary rocks overlie unconformably either granite varying to granite gneiss, or volcanic rocks, andesite, dacite or tuff, with some interbedded greywacke.

The sedimentary rocks occur in synclinal basins with axial trend northwest, but later folding with axial trends northeast complicate the structural picture. Many faults were observed in the sedimentary rocks.

The general outline of the geology in this area, as published at the scale of 1 inch to 8 miles[1], has proven to be correct, but the present more detailed mapping has refined the stratigraphic and structural data on the area.

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[1] Lord, C.S.: Geological Notes on Southern District of Keewatin, Northwest Territories; Geol. Surv., Canada, Paper 53-22 (1953).

DISTRICT OF MACKENZIE

6. GEOCHEMISTRY AND PETROGRAPHY OF GREENSTONES, YELLOWKNIFE DISTRICT

W.R.A. Baragar

The purpose of the project is to provide reliable chemical data representative of the volcanic belts of the Canadian Shield presented in its proper petrological framework. The present phase of the project is concerned with the Yellowknife Group volcanic rocks in two separate belts; the Yellowknife belt in map-areas 85-J-8 and 9, and the Cameron River belt in map-areas 85-I-14 and 15. Much of the Yellowknife belt had been mapped in detail by Henderson and Brown and their maps were used as guides for sampling. The Cameron River belt was mapped by the writer in sufficient detail to permit a rough subdivision of volcanic types.

The sampling method adopted was as follows. Typical cross-sections were located through each of the volcanic belts and samples were taken at 500-foot intervals. Each sample comprised 2 lb. of fresh rock chips taken from 3 or 4 separate localities within about a 50-foot radius. In the Yellowknife belt the cross-section, broken into several parts so as to cover the full stratigraphic range exposed, spans a thickness of about 25,000 to 30,000 feet. In the Cameron River belt it spans a thickness of about 6,000 to 8,000 feet. A total of 99 samples was taken in the two belts.

It is tentatively proposed to analyse both composite and individual samples as follows. Composite samples will be formed of each of the major petrographic types such as basalts, variolitic basalts, dacites etc., which together with individual samples of each will be submitted for analyses. In the case of the Yellowknife belt the samples of the most common type, the ordinary basalts, will be combined into 3 or 4 composite samples, each representing one-third or one-quarter of the total stratigraphic thickness. Thus, variations in the composition of the lava with height in the lava pile might be recognized. A total of 12 to 15 chemical and spectrographic analyses is anticipated.

7. MUSKOX INTRUSION, COPPERMINE RIVER AREA

D.C. Findlay

Field work on the Muskox Intrusion included geophysical and geological surveys in order to select two diamond drill hole sites for the proposed drilling program to be carried out on the body in 1963. The work included:

(a) A gravity survey over that part of the intrusion lying to the north of Coppermine River. This work was carried out by the Dominion Observatory.

(b) Detail ground magnetometer surveys over the two general drill site areas (Speers Lake and Transition Creek).

(c) Detail ground magnetometer and geologic surveys on a scale of 1 inch to 100 feet over the immediate drill site localities.

A sulphide-sampling program was carried out to obtain material for sulphur isotope studies, and additional rock samples were collected from various localities within the intrusion to fill out the sample coverage for petrographic and chemical studies.

8. OPERATION BATHURST

J.A. Fraser, J.A. Donaldson, H.H. Bostock, and W.H. Poole

The bedrock geology of the Bathurst Inlet region (66 K, L, M; 76 E, F, I, J, K, L, M, N, O, P; 77 A, B, C), an area of about 55,000 square miles, was mapped in one season by 5 geologists using helicopters. Traverses were run east and west at 6-mile intervals. Ground observations were made from 5 to 10 miles apart along these traverses and were supplemented by air observations.

About 70 per cent of the area is underlain by massive and gneissic granitic rocks; 12 per cent is underlain by early Precambrian sediments and volcanic rocks; Proterozoic and younger rocks make up the remainder.

The oldest rocks mapped are intermediate to acid flows and sediments that have been metamorphosed and invaded by granite. They are confined chiefly to that part of the map-area lying west of longitude 106° 00'W. Prominent greenstone belts, each about 10 miles wide, extend southward from Gray's Bay on Coronation Gulf to latitude 66° 30'N, and from Hope Bay on Melville Sound to latitude 67° 30'N. The metasediments are mostly micaceous quartzites and knotted schists. Rocks of this kind are well exposed along the margins of the Proterozoic sediments east and west of Bathurst Inlet. Phyllite and micaceous quartzite with minor amphibolite extend eastward in a belt 20 miles wide across the northern half of Contwoyto Lake to longitude 110° 20'W.

Granitic rocks west of Bathurst Inlet are mainly massive; east of the inlet, except for massive granite south of Melville Sound and Elu Inlet, hornblende-rich gneisses and migmatites predominate. They are derived from volcanic and sedimentary rocks and locally contain layers of amphibolite, garnetiferous granulite, and, rarely, lime-silicate rock. Bodies of anorthosite and anorthositic gabbro up to 8 miles across, intrude the gneisses in the MacAlpine Lake region.

Comparatively unmetamorphosed Proterozoic sediments overlie the basement rocks unconformably. Strata of the Goulburn Group are exposed on Kent Peninsula and along Bathurst Inlet from Arctic Sound to Western River, and along Burnside River southwest to Peacock Hills. They consist of several hundred feet of quartzite, dolomite, and argillite, overlain by thousands of feet of argillite, quartzite, conglomeratic quartzite, and carbonate rock. Strata of the younger Kanuyak and Coppermine Groups, and of the Epworth Group, are found on some of the islands and parts of the coast between Bathurst Inlet and Tree River. Together they comprise a few hundred feet of sediments that include sandstones, shales, and carbonate rocks.

Flows of amygdaloidal basalt outcropping near Arctic Sound and on the west end of Kent Peninsula, overlie Goulburn and Kanuyak strata unconformably. Diabase sills and dykes intrude the flows, the Proterozoic sediments, and the older rocks.

Flat-lying, fossiliferous sandstone, and dolomite, presumably Palaeozoic in age, underlie much of the northern and central parts of Kent Peninsula.

Structural trends in the basement rocks are mainly northerly but in the southwestern part of the map-area deviations from this direction are common. Proterozoic rocks along Bathurst Inlet are preserved in down-faulted blocks between faults that strike northwesterly. Fold axes in these sediments also strike northwesterly. Along Burnside River, fold axes strike northeasterly. The folds, in both cases, are probably related to vertical fault movements.

Zones of sulphide occur in the metasediments and greenstones exposed in the western quarter of the map-area. North of James River scattered sulphide zones in greenstone may carry pyrite, pyrrhotite, arsenopyrite, and chalcopyrite. At Contwoyto Lake, gold has been reported in association with pyrrhotite and arsenopyrite in metasediments. Magnetite-bearing iron formation was observed at the mouth of Perry River, on the west shore of Chester Bay, and just south of James River at longitude 111°00'W.

8a. SURFICIAL GEOLOGY, OPERATION BATHURST

W. Blake, Jr.

Field work was devoted to reconnaissance mapping of the surficial geology of 55,000 square miles centred about Bathurst Inlet (76 E, F, I, J, K, L, M, N, O, P; 77 A; 66 K, L, M). Throughout most of the area directions of ice motion were easily determined by the presence of drumlins, crag-and-tail hills, striae, and other minor glacial features.

East of Contwoyto Lake a "discontinuity" in the ice flow pattern is well developed. This has been mapped elsewhere in the north by Craig[1], Fyles[2], and others. In part of the area studied this "discontinuity" is delineated by a prominent north-south oriented end moraine, formed by ice retreating eastward and northeastward after the ice-sheet had separated into two lobes.

Throughout most of the rest of the area ice flow was toward the northwest and north-northwest, although local variations occurred. To the east, north, and west of MacAlpine Lake a more extensive and northeast-southwest oriented end moraine belt extends discontinuously for 200 miles. Presumably this marks a significant pause in the general recession of the ice between the Arctic coast and eastern Keewatin.

Raised beaches are well developed near the coast, and they, together with other features, indicate that at Bathurst Inlet more than 700 feet of uplift of the land relative to present sea-level has occurred since deglaciation. To the east and west the level of

submergence decreases slightly, suggesting that at Bathurst Inlet a re-entrant developed in the receding ice-sheet, allowing marine waters to enter before they inundated the adjacent plateau areas. Marine shells are common in many localities; the highest found were about 650 feet above present sea-level.

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[1]Craig, B.G. and Fyles, J.G.: Pleistocene Geology of Arctic Canada; Geol. Surv., Canada, Paper 60-10 (1960).

Craig, B.G.: Surficial Geology of North-central District of Mackenzie, Northwest Territories; Geol. Surv., Canada, Paper 60-18 (1960).

[2]Fyles, J.G.: Pleistocene Features; in Geological Notes on Central District of Keewatin, Northwest Territories, by G.M. Wright; Geol. Surv., Canada, Paper 55-17, pp. 3-4 (1955).

9.

BENJAMIN LAKE MAP-AREA

W.W. Heywood

Metamorphosed sedimentary and volcanic rocks form a north-trending belt bounded by biotite granite in Benjamin Lake (75 M/2) map-area. The oldest rocks consist of greenstones and amphibolites derived from extrusive basic volcanic rocks and related dykes and sills. Rhyolite and dacite and derived quartz-sericite schist overlie the basic volcanic rocks. Cherty crystalline limestone appears to be conformable with the acid volcanic rocks and probably forms a continuous unit ranging from 10 feet thick in the west, to 300 feet or more on the east side. Slate and phyllite overlie the crystalline limestone in the north-western part of the map-area. Andalusite and cordierite knotted schists derived from greywacke and subgreywacke are widespread in the central and southern parts of the map-area. Primary sedimentary structures are preserved locally.

Granitic rocks of two distinct ages are present in the area. The older is a medium-grained, massive to foliated, biotite granite with few to abundant large orthoclase porphyroblasts. The younger granite forms plugs and sills in the metamorphosed greywacke and subgreywacke. Inclusions of metasediments are present in the younger granite.

Mineral occurrences have been known in the area for several years, and a number of mineral claims are held in and near the area underlain by volcanic rocks. No new mineral discoveries of importance were found, although pyrite and a minor amount of chalcopyrite occur near the small granite plug on the southwestern side of Benjamin Lake, and in a shear zone at 63°05'N, 110°44'W. No evidence of mineralization was noted in the crystalline limestone in the area mapped. Pegmatite dykes are common northeast of Benjamin Lake and near Waldron River in the southeastern part of the area.

10. STRATIGRAPHY AND PETROLOGY OF UPPER DEVONIAN ROCKS, HAY RIVER AREA

E.R. Jamieson

Extensive petrologic collections of Upper Devonian rocks were made in the Hay River area (85 C). Collections along Hay River were from the Alexandra Member of the Twin Falls Formation, and from the underlying Hay River Formation. These formations were traced along a northwest-trending escarpment for 30 miles. Sections were described at 65 stations at approximately half-mile intervals. At each station oriented specimens were collected at 2-foot stratigraphic intervals (and at each lithological change whose units were less than 2 feet thick), in order that the collection would be suitable for statistical treatment.

Outcrops along the Hay River have been described by McLaren[1] from observations made during 'Operation Mackenzie'.

The northwest-trending escarpment (Douglas, 1959[2]— Map-unit 15b) had not previously been studied in detail. It consists of a persistent sequence (20-25 feet thick) of spar-cemented calcarenites, which characteristically contain Amphipora, Stachyodes (?), and stromatoporoids of lamellar and concentric habit with minor small fragments of corals and brachiopods. The calcarenites overlie and drape a massive undulating reefal sequence of stromatoporoid and coral-stromatoporoid rock, which apparently thickens northwest to a maximum thickness of more than 100 feet near Heart Lake. The matrix is dolomitic in places with sporadic lenses of bitumen (?) in this lower sequence.

A discontinuous sequence of medium-bedded light brown argillaceous fine calcarenite containing minor amounts of crinoidal debris and brachiopods outcrops sporadically as lenses between the two sequences described above.

Petrographic examination of this collection is being undertaken to assess the distribution of both skeletal and non-skeletal elements in these rocks and to interpret their depositional environment. It is hoped that this study will provide quantitative data so that comparisons with present-day carbonate basins may be made.

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[1]Belyea, H.R. and McLaren, D.J.: Upper Devonian Formations, Southern Part of Northwest Territories, Northeastern British Columbia, and Northwestern Alberta; Geol. Surv., Canada, Paper 61-29 (1962).

[2]Douglas, R.J.W.: Great Slave and Trout River Map-areas, Northwest Territories; Geol. Surv., Canada, Paper 58-11 (1959).

11. ARSENO LAKE (EAST HALF) MAP-AREA

J.C. McGlynn

Mapping of Arseno Lake east half (86 B/12 E 1/2) map-area was completed during the summer and a small part of the adjoining Norris Lake (86 B/5) map-area was also mapped. The area is underlain by basic volcanic rocks, paraconglomerates, subgreywacke shales, and hornblendic rocks of uncertain origin that are cut by granitic rocks. Sedimentary rocks of the Snare Group consisting of dolomites, quartzites, and finely interbanded silts and shales, overlie the Yellowknife Group rocks unconformably. They are cut by basic dykes or sills and by younger granitic rocks. Diabase dykes are the youngest rocks exposed in the area.

Recognition of the paraconglomerate and its significance, and studies of the stratigraphy of the Snare sediments have made possible a more precise location of the unconformity between the Snare and Yellowknife rocks. Some rocks that were formerly grouped with the Snare sediments are now known to be part of the Yellowknife Group.

The paraconglomerates occur locally between the volcanic rocks and subgreywacke shale. Similar rocks have been recognized in a similar environment in several other areas in the district. It is possible that these various occurrences are at the same stratigraphic level; if this is so it will be useful in regional correlation studies. Work is planned to investigate these possibilities.

Structural information on rocks of the Snare and Yellowknife Groups and on the unconformity between these groups was obtained. The effects of Snare deformation (and possibly metamorphism) on rocks of the Yellowknife Group were established. The ages of some granitic rocks relative to Snare and Yellowknife rocks were determined and samples of these and of granitic rocks of uncertain age were obtained for age determination studies.

12. THE BASLER LAKE GRANITE

P.H. Smith

The Basler Lake granite lies in the southwestern quarter of Indin Lake (86 B) map-area on the western edge of the Archaean-aged Slave structural province. The mass is overlapped on the west by folded shelf-type rocks of the Snare Group.

Regional and local variability in composition and texture within the granite will be tested. A hierarchical sampling plan was used. Three 2-mile wide strips across the mass were sampled on a 1/2-mile grid (approximately 60 samples each). Smaller 200, 350, and 500 foot grids of 36 samples each, were placed within the larger grids.

The Basler Lake granite comprises largely coarse to very coarse crystalline biotite granodiorite. Smaller, and in many cases younger, masses of fine- to medium-crystalline granodiorites are common.

Elongated in a north-south direction, the granite is bounded on its east side by high grade schists and gneisses, and a mixed rock zone ranging from about 1/4 mile to 2 miles in width. On the western side of the granite, adjacent to the Snare unconformity the envelope rocks are similar in composition to those on the east but are of much lower metamorphic grade (argillites and phyllites). The contact between the granite and these rocks is sharp and no mixed rock zone is present. The contact on both eastern and western sides of the mass parallels the foliation in the adjacent envelope rocks. Xenoliths are abundant in the eastern parts of the granite but are rare in its western parts. Foliation is often present in the granite, particularly in areas where xenoliths are common. In contact zones between granite and schist (both xenoliths and envelope rocks) foliation in the granite parallels that in the schist.

Faults, mostly vertical are very common, but displacements, where discernible, appear slight.

13 GEOLOGY OF BEECHEY LAKE MAP-AREA

L.P. Tremblay

A major fault, the Bathurst Fault, was traced for about 30 miles in a north-northwesterly direction in the northeastern corner of Beechey Lake (76 G) map-area. West of the fault the sediments are Yellowknife-type and fairly fresh. East of it are gneisses and granitized rocks. Near the fault and south of Western River the sediments are interlayered with gabbro in the proportion of 60 per cent sediments and 40 per cent gabbro. The amount of gabbro decreases westerly. North of Western River and along Ellice River they are overlain unconformably by gently folded younger rocks (mainly Goulburn Group).

The biotite granite west of the fault is in discrete masses with little metamorphic effects, whereas east of the fault it is in diffuse masses of granitized rocks. Dykes of this granite and related pegmatite cut medium-grained amphibolite masses (probably metamorphosed gabbro) east of the fault whereas west of it the granite is cut by two ages of gabbro dykes. This suggests two ages of granite.

The Goulburn Group, which reaches a thickness of 5,000 feet, was subdivided into seven mappable units. One unit is a gabbro sill, the other six are relatively unmetamorphosed clastic rocks. The group is cut by gabbro dykes, but not by granites, and rests unconformably on gabbro sills, thus implying three ages of gabbro.

Fine-grained banded iron formation was recognized in the sediments west of the fault. The iron content (mainly as magnetite) was estimated at less than 40 per cent. Chalcopyrite, mainly as discrete grains but also as masses up to 3 inches wide, and a few grains of arsenopyrite (?) were noted in the oldest gabbro near the Bathurst Fault.

YUKON

14. STRATIGRAPHIC AND STRUCTURAL STUDIES NEAR THE CANADA TUNGSTEN PROPERTY

S.L. Blusson

A well-exposed section of Precambrian and Palaeozoic rocks, some 30 miles north of the Canada Tungsten camp, was studied and the detailed stratigraphic information obtained supplied to the area in the vicinity of the orebody.

Detailed information was obtained on the stratigraphy in the vicinity of the orebody, the regional structure of the valley of the Flat River, and the more complex structure associated with the granitic intrusions.

Both facies changes and unconformities are present in this area, the most important unconformities occurring at the base of both Middle Cambrian and Ordovician strata. The regional structure is a complex syncline involving Lower Cambrian to Ordovician rocks and flanked by Precambrian rocks on either side.

The Lower Cambrian rocks in which the deposit occurs appear to be the most favourable hosts for tungsten mineralization. The areas where these rocks have been intruded by granitic rocks would appear to be good prospecting terrain.

15. HEAVY MINERAL INVESTIGATIONS, PROJECT KLONDIKE

C.F. Gleeson

Heavy mineral sampling of the gravels and soils in the Klondike area (115 O; 115 N E 1/2; 116 B; 116 C E 1/2) was continued. Detailed soil sampling and geological mapping was done over and near several lode gold deposits. Reconnaissance sampling was done on the gravel bars of Sixty Mile and Indian Rivers. Samples of decomposed bedrock and gravel were taken over various rock types in order to determine the suite of heavy minerals each rock unit has contributed to the gravels of the area. Geological mapping was also done in the area of Bonanza, Eldorado, and Hunker Creeks.

Topaz, tourmaline, and fluorite were found in the soils over a rhyolite porphyry near the mouth of Hunker Creek. It is possible that this rock was the source of the "wood" tin (cassiterite) that occurs in the gravels of Hunker Creek and Klondike River.

Micro-meteorites were found in several soil samples from Bonanza Creek. It is thought that these small globules might be derived from the dust trail of a meteorite.

Geochemical studies on some magnetites from tributaries on the right limit of the North Klondike were high in zinc (550 to 1,300 ppm). Several of these samples were also anomalous in copper and nickel. Trace element work on magnetites is continuing.

The preliminary geological mapping completed to date suggests that some of the lode gold deposits of the Klondike could be associated with strong shear zones that occur in the Klondike schists.

16. PRELIMINARY RECONNAISSANCE STUDIES OF UNMAPPED AREAS IN YUKON AND ADJACENT DISTRICT OF MACKENZIE

L.H. Green

Field work included visits to most of the properties in production or undergoing development in Yukon and southwestern District of Mackenzie.

In addition, a brief airborne reconnaissance was carried out in parts of the following map-areas: Flat River (95 E), Glacier Lake (95 L), Sekwi Mountain (105 P), Niddery Lake (105 O), Bonnet Plume Lake (106 B), Nadaleen River (106 C). This reconnaissance indicated that many of the more important geologic units can be traced along strike throughout this area and that there is a major facies change in rocks of Precambrian age from argillaceous and carbonate rocks in the northeast to impure argillite and gritty quartzite in the southwest. This change has already been mapped in the Nahanni area (Geol. Surv., Canada Map 14-1961) and the Nash Creek area (Geol. Surv., Canada Paper 62-7).

17. COPPER DEPOSITS OF YUKON AND NORTHERN BRITISH COLUMBIA

E.D. Kindle

The writer continued a study of copper deposits of the Yukon and Northern British Columbia. An additional week was spent in the Whitehorse Copper Belt (Yukon) and several days in the Rainy Hollow area of northwestern British Columbia. The Lang Creek property near Cassiar was also visited. Much of the summer was spent in examining some of the properties in areas near the Canadian National railway between Smithers and Burns Lake.

A tungsten prospect with minor copper was visited half a mile southeast of Manson Creek. This prospect was discovered by placer mining operations. The scheelite-bearing quartz veins occur in slate adjoining an altered greenstone dyke.

The Jahoboe mine west of the Haines Road in the Yukon continued to produce high grade copper ore in 1962. The ore consists of veins and lenses of massive bornite and chalcopyrite in andesite.

18. OPERATION PORCUPINE

D.K. Norris

D.K. Norris, E.W. Bamber, E.W. Mountjoy, B.S. Norford, A.W. Norris, R.A. Price, R.M. Procter and G.C. Taylor

completed the bedrock phase of Operation Porcupine, an air-supported, reconnaissance geological survey of that part of the Northwest Territories and Yukon Territory north of latitude 65°N and west of longitude 132°W (106 E, F, K, L, M, N; 107 C, D, E, F; 116 F (E 1/2), G, H, I, J, K (E 1/2), N (E 1/2), O, P; 117 A, B, C (E 1/2), F (E 1/2), G, H). The project area is approximately 80, 000 square miles.

Approximately 140 stratigraphic sections totalling 364, 000 feet were measured. Many stratigraphic units display remarkable facies variations and some are separated by pronounced unconformities.

Maximum measured thicknesses of composite stratigraphic sections in each of the major physiographic subdivisions within the area are as follows: Mackenzie Mountains, 16, 000 feet with about 3, 000 feet of Precambrian strata and the remainder assigned to the Cambrian, Ordovician, Silurian, and Devonian Systems; Wernecke Mountains, 16, 000 feet of which about 8, 000 feet are Precambrian and the remainder Cambrian, Ordovician, Silurian, and Devonian in age; Richardson Mountains, 24, 000 feet with negligible Precambrian and the succession almost wholly in the Cambrian, Ordovician, Silurian, Devonian, Permo-Carboniferous, Jurassic, and Cretaceous Systems. In the Barn Mountains, the bulk of the succession is believed to be Precambrian and because of complex structure and limited outcrop, only partial sections were measured in Silurian, Devonian, and Mississippian Systems. In the British Mountains, 12, 000 feet of Neruokpuk Formation of probable Precambrian age were measured, but the true thickness of the formation is believed to be considerably in excess of this. A minimum thickness of the Mississippian Kyak and Lisburne Formations is 4, 000 feet there. In the Ogilvie Mountains the maximum measured thickness of the sedimentary succession is in the order of 21, 000 feet, including 1, 200 feet of strata of probable Precambrian age. The bulk of the succession is assigned to the Ordovician, Silurian, Devonian, Permo-Carboniferous, Triassic, and Cretaceous Systems.

The structural habits of the mountain systems in the project area compare somewhat with that in southern Mackenzie Mountains and contrast with that in the southeastern Cordillera. For most of the area the fold is the primary structural element. It is commonly modified by later, secondary faults along which the dominant movement has been up the dip. The only major thrust fault known in the area is in western Porcupine Plateau and Keele Range. It is believed to be folded and locally has strata as old as the Precambrian Tindir Group thrust onto Lower Cretaceous rocks. Faults on which the dominant movement has been right lateral are common in Richardson Mountains and they can be traced southeastward into northern Mackenzie and Wernecke Mountains. Domes such as that in White Mountains in northern Richardsons are structurally complex. British Mountains is essentially a southwest dipping homocline in the Neruokpuk Formation. Where examined, its north flank appeared to be faulted so that the northern limit of outcrop of the Neruokpuk may be structural rather than depositional.

Wolframite and molybdenite occur in the vicinity of Mount Fitton on the east flank of Barn Mountains. Brilliantly coloured sediments similar to those around the Mount Fitton intrusive body were noted at several points in Barn Mountains and around Mount

Sedgwick in British Mountains. The iron formation in the upper reaches of Snake and Cranswick Rivers occurs in the lower part of a thick conglomeratic mudstone succession, which rests unconformably on beds of probable Cambrian age. The succession is overlain by carbonate rocks of Cambro-Ordovician age. The iron occurs as hematite in banded jasper in stratigraphic intervals up to 200 feet thick over an area of about 200 square miles. It would appear to average less than 40 per cent hematite at the outcrop. Float from this occurrence was reported by Camsell[1] (1907) in the Peel River basin. It has been prospected over the years by residents of the Yukon and was recently staked by Crest Explorations Ltd., a wholly owned subsidiary of The California Standard Company.

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[1]Camsell, C.: Report on the Peel River and Tributaries, Yukon and Mackenzie; Geol. Surv., Canada, Ann. Report 1904, vol. 16, pt. CC (1907).

18a. SURFICIAL GEOLOGY, OPERATION PORCUPINE

O.L. Hughes

Field work was directed mainly toward ground checking of photo-interpretation maps prepared in advance of field work, and in studying stratigraphy along major streams and coastal shorelines. Such field work was devoted mainly to the region west of Snake and Peel Rivers, with only widely scattered observations in the area to the east. In addition, heavy mineral samples were collected from several streams in the northwest part of the area, which drains igneous and/or metamorphic terrains.

Continental ice moving from the southeast reached the junction of Peel and Hort Rivers in Peel Plateau, as indicated by Shield rocks in the drift, and by ice-marginal features. The former limit of Shield ice lies somewhat above the 3,000-foot contour on the east flank of Richardson Mountains, and continues along the Arctic slope to the west side of Firth River, essentially as shown in the Glacial Map of Canada. Two, and locally three, tills are exposed in superposition along Snake River, but without intervening deposits of interglacial rank.

Three valley glaciations inferred in Southern Ogilvie Ranges (Vernon, P. and Hughes, O.L., in press) are recognized in Central and Northern Ogilvie Ranges; limited valley glaciation is also recognized in Richardson and British Mountains.

Deposits representing possible continuous deposition through late Tertiary into Quaternary time are exposed along Old Crow and Porcupine Rivers, which drain the extensive unglaciated southwestern and west-central parts of the area.

BRITISH COLUMBIA

19. BELLA COOLA MAP-AREA

A.J. Baer

The rocks in a zone extending roughly from Ocean Falls to Bella Coola, in Bella Coola (93 D) map-area, consist of a highly metamorphosed complex of foliated diorite, hornblende gneisses, and schists with local zones of biotite schists, garnet-biotite schists, or kyanite-biotite schists. The whole complex shows a consistent northwesterly orientation.

East of Bella Coola, the dioritic rocks grade progressively into less metamorphic andesitic lavas, with a few tuffs and zones of black slates. All these rocks are cut by intrusive bodies of leucocratic biotite granite.

One of these intrusive bodies is cut itself by the feeder-dykes of a younger volcanic formation that covers most of the northeastern corner of the map-area. These lavas contain a few layers of greywacke in which fossils of probable Jurassic age have been found.

A few intrusive bodies of monzonitic composition cut across these rocks and are overlain by Tertiary basaltic flows. These flows have been tilted by a later set of northeast-trending faults of a horst-and-graben type.

20. QUESNEL LAKE AND ADAMS LAKE MAP-AREAS

R.B. Campbell

In the southern part of Quesnel Lake east half (93 A E 1/2) map-area metamorphic rocks, locally with much pegmatite, lie east of a line extending roughly from lower McKusky Creek to lower Deception Creek. Two serpentized ultrabasic bodies occur in these rocks; one is 5 miles southeast of Deception Mountain, the other is about a mile west of the middle of Crooked Lake. Granodiorite intruded limestone along the south side of East Creek Valley.

Mesozoic volcanic and sedimentary rocks lie west of the metamorphic rocks and are intruded by granitic rocks at Takomkane Mountain and on the southern boundary just east of Hendrix Creek.

In Adams Lake (83 M W 1/2) map-area all the rocks are metamorphic and granitic except for small areas of Tertiary and Recent volcanic rocks in the northwestern part.

North of Raft Mountain and east of a line extending approximately from the Hole-in-the-wall to Adams Lake the rocks are a complex association of gneiss, schist, medium-grained granitic rocks, and pegmatite. West of the line the metamorphic rocks are sericitic quartzite, chloritic schist, greenstone, and limestone.

A batholith of porphyritic quartz monzonite extends from the northern end of Adams Lake to the western boundary of the area. A smaller body extends westward from the ridge just southwest of the Hole-in-the-wall to the southern slopes of Raft Mountain.

21. SURFICIAL GEOLOGY, NICOLA MAP-AREA

R.J. Fulton

Deglaciation of Nicola (92 I E 1/2) map-area was mainly accomplished by downwasting with the ice retreating from the uplands towards valleys. Stagnant tongues of ice remaining in the valleys after the uplands were free of ice played an important role in the late glacial history of the area, for they blocked the normal drainage and controlled the deposition of outwash. A distinctive succession of sub-till material was seen at several places along the valleys of the North and South Thompson Rivers. The succession from the bottom up was: oxidized silt, oxidized gravel, grey gravel, grey to white silt. The oxidized silt contains plant fragments and non-marine fossils and is thought to be an interglacial valley fill; the unoxidized material is considered a pre-glacial outwash. The placer gold operations on Tranquille River appear to have been in the lower gravel.

22. SURFICIAL GEOLOGY, NANAIMO-DUNCAN-GULF ISLANDS

E.C. Halstead

The oldest Pleistocene deposits in the map-areas (92 F/1 E 1/2; G/4; C/16; B/13; B/14) are exposed at the base of sea cliffs and consist of laminated silts and clays that are found at elevations not exceeding 70 feet above the present sea-level. Sands and gravels with plant remains and fossil wood overlie the laminated silts and clays and represent interglacial deposits. In most places glacio-marine deposits of stony clay overlie the sand and gravel, and till in turn overlies the stony clay. The till was deposited by the last major ice advance and older tills are not exposed, but are found in sea cliffs north of the area. Upon retreat of the last major ice-sheet a glacio-marine environment prevailed and a second or younger stony clay was deposited on top of the till. A tongue of ice advanced down the Cowichan River valley and its meltwaters left extensive kame and outwash deposits that are a source of gravel and sand for the Duncan area.

23. PRINCE RUPERT (EAST HALF) AND PORT ESSINGTON (WEST HALF) MAP-AREAS

W.W. Hutchison

One aim of this summer's work was to obtain geological information across a section of the Coast Range in the Prince Rupert area of British Columbia. This was achieved by means of shoreline and road traverses and also by aerial reconnaissance. In addition the large amount of coastline, combined with its amenability to being

easily studied from a small rubber boat (even in very bad flying weather), permitted a relatively large amount of rock to be examined.

Tsimpsean Peninsula, which is largely composed of strongly folded sedimentary rocks (shales, phyllites, greywackes, and minor conglomerates and limestones) displays an increase in grade of metamorphism going from west to east from phyllites, which may be spotted with biotite, to coarse hornblende biotite garnet gneisses and in places granite migmatite.

The well-defined form of Work Channel (NNW - SSE) roughly follows the contact between the Tsimpsean sedimentary rocks and a major quartz diorite (?) mass on the mainland. East of this plutonic mass, the rock is mainly composed of large areas, often distinct phases, of homogeneous but commonly foliated quartz diorite (?), granite (?), well defined bands (100 feet to 2 miles wide) of garnet mica schist (which contains some sillimanite) and a complex of migmatite, granite gneiss, and foliated and massive granites.

Although clean-cut relationships have not yet been found, the evidence suggests that the more acid bodies may be younger than the more basic. The age of the sediments is unknown but it is likely that they were folded and metamorphosed at the time of emplacement of some of the earlier quartz diorite (?) masses.

24. NAKUSP MAP-AREA

D.W. Hyndman

The sedimentary and metamorphic rocks in Nakusp (82 K/4) map-area have been separated into a succession in which the metamorphic isograds appear parallel to the major lithologic units:

	Volcanic rocks
	Slocan Group: shales to phyllites, some argillaceous limestone
	Fine-grained calc-silicate hornfelses and schists
	Medium-grained amphibolites
Shuswap Group	(Biotite-quartz and quartzofeldspathic schists
	(Strongly lineated biotite leucogranite to granite, with interbedded schists
	(Finely vuggy-weathering, white, diopsidic quartzite
	(Sillimanite-garnet-biotite-quartz and quartzofeldspathic schists and gneisses

Dominant in the metamorphic rocks is a strong mineral lineation plunging gently and consistently east, except to the northwest where it plunges gently west. Small isoclinal, recumbent folds are found locally. They commonly have axes parallel the mineral lineation. Schistosity dips gently, both in most parts of the high-grade Shuswap rocks and in the phyllites of the overlying Slocan Group.

The most striking large structure in the high-grade rocks is a fold overturned to the south, with a 5,000-foot, vertical, middle limb. This fold is presumably post-metamorphic, since the foliation, which parallels the axial planes of the minor folds, follow the major fold.

The southwestern corner of the Kuskanax Batholith consists of a fine-grained, massive, epidote-hornblende granite. It intruded rocks of the Slocan Group parallel the foliation of the latter. The contact is knife-sharp and exhibits very little metamorphic effect.

25. HALFWAY RIVER MAP-AREA

E.J.W. Irish

Halfway River (94 B) map-area extends from the Great Plains on the east to the Rocky Mountain Trench on the west and includes all of the Foothills and most of the Rocky Mountain physiographic divisions between latitudes 56 and 57 degrees north. The area is underlain by Cambrian to Lower Cretaceous sedimentary strata that have been folded in a general northwest-southeast direction and broken by southwest-dipping thrust faults, whose strike roughly parallels that of the folds.

The Rocky Mountains in the western part of the map-area, which are composed mainly of carbonate rocks, are formed principally by a series of thrust slices that have repeated Cambrian, Ordovician, Silurian, Devonian, and Lower Mississippian strata. Folding was, in general, subordinate to thrust faulting in the mountain division.

The Foothills division, east of the Mountains, is relatively wide and is underlain mainly by Triassic and Lower Cretaceous strata. Folding was probably more important than faulting in this division. Many southwest-dipping thrust faults occur, but stratigraphic displacement on any single fault is normally measured only in tens or hundreds of feet. The folds consist of a succession of narrow, compressed anticlines separated by broad synclines. Many of the anticlines are faulted near their axes.

Natural gas is obtained from wells drilled in the extreme easterly part of the Foothills and adjacent parts of the Plains. Surface rocks are mainly Lower Cretaceous strata and only moderately deformed.

26. GRAVEL DEPOSITS, STRAIT OF GEORGIA AND VICINITY

S.F. Leaming

A field study of sand and gravel deposits in the lower mainland of British Columbia and part of the east coast of Vancouver Island was completed in 1962. A report describing the distribution and origin of these deposits, the major areas of potential supply, and the pits and operations of most of the producers is now in preparation.

27. ROSSLAND-TRAIL MAP-AREA

H.W. Little

Geological mapping of Rossland-Trail (82 F/4) map-area was completed in 1962, for publication on a scale of 1 inch to 1 mile.

The Pennsylvanian (?) Mount Roberts Formation, which unconformably underlies the Jurassic Rossland Group, is more extensive than previously realized, and underlies much of the northern part of the map-area. The stratigraphy of the Rossland Group has been extended westward, but contains relatively little interbedded sediments, and few fossil localities were found to confirm the interpretations. The volcanic rocks on Old Glory Mountain and extending northward to upper Lamb Creek, were previously mapped as Rossland, but resemble Daly's Midway Group of early Tertiary age, and are cut by Coryell dykes.

Small bodies, resembling 'Rossland monzonite' occur on Mt. Neptune. It has been established that this rock is younger than Nelson granodiorite.

Exploration is currently being done on a few properties in the map-area. There is some indication that the copper ores of Rossland Camp, like those of the Velvet mine, are of Early Tertiary age, but further study of data and specimens is required.

28. TRIASSIC STRATIGRAPHY, TRUTCH AND HALFWAY RIVER MAP-AREAS

B.R. Pelletier

Stratigraphic and sedimentation studies, begun in 1959, of the Triassic formations in the Foothills of northeastern British Columbia were completed. About 100,000 feet of section from more than 60 partial and complete sections have been described. The work also includes the mapping of the Triassic systemic boundaries in certain areas, the gathering of palaeontological collections, and about 2,500 observations on primary current structures.

During 1962 the work was continued in Halfway River (94 B) and Trutch (94 G) map-areas, between Peace River and Kluachesi Creek. All Triassic formations previously described from other areas of northeastern British Columbia were recognized and examined. It is now possible to demonstrate further the correlation of the Triassic units from Peace to Liard Rivers, and to set up a tentative stratigraphic equivalence of beds of the subsurface east of the Foothills and the exposures in the Foothills.

Analyses of stratigraphy and paleocurrents corroborate earlier reports in that clastic sediments were transported in a generally southwesterly direction across a shallow-water platform into a deeper marine basin; also, that these sediments were derived from a source northeast of the present study area. Trends of the major sandstone ledges, thought to be ancient offshore bars, extend slightly obliquely (and more northwesterly) to the main trend of the Foothills. As highly bituminous sands and limestones occur in such trends, it appears that it may be profitable to extend petroleum and natural gas exploration to the southeast where potential producing horizons may occur beneath the plains region.

29. A STUDY OF THE ENVIRONS OF THE EAST CONTACT OF THE KUSKANAX BATHOLITH

P.B. Read

Poplar Creek (82K/6) map-area is underlain by the Lardeau Group in its eastern part, by a thin belt of the Milford and Kaslo Groups in the central section, and the leucogranite Kuskanax batholith with related stocks in the western part. In the Lardeau Group, the lowest rocks exposed are a sequence of green phyllite, limestone, and a dark grey phyllite that grades upwards into a grey phyllitic argillite. A volcanic unit, which may correlate with the Jewett Formation, appears to overlie the limestone-phyllite sequence. These rocks crop out in Lardeau Valley and the lower parts of the creeks to the west where they form gently northwest-plunging isoclinal antiforms overturned to the southwest and separated by vertical- to northeasterly-dipping faults with apparent movements of several hundred to several thousand feet. A thick sequence of grits and phyllites, probably equivalent to the Broadview Formation, lies between the volcanic unit on the east and the Milford Group on the west. Granitic pebbles are present in the volcanic unit and the grit-phyllite unit.

The Permo-Triassic Milford Group has been intruded by at least eleven soda pyroxene-bearing leucogranite stocks. The intrusion of these lense-shaped, semi-concordant stocks has caused at least one phase of refolding of the isoclinally folded Milford Group.

The Kaslo Group is represented by an aphanitic to medium-grained basic and ultrabasic intrusive complex, with a brecciated and partly mylonitized pyroxene gabbro or diorite being the most common rock type. The complex contains sheets of Milford up to several hundred feet thick and is spatially related to the borders of the later leucogranite intrusions.

30. GRANITIC ROCKS, SOUTHERN BRITISH COLUMBIA

J.E. Reesor

Examination of granitic plutons and metamorphic complexes in southern British Columbia was continued for six weeks in July and August. Two granitic bodies (Toby stock and the southern limit at Nelson Batholith) that show clear evidence of intense, penetrative, post-crystalline deformation were examined. Both show a penetrative lineation similar in all respects to that produced in the Shuswap Terrain, except that in both cases the structures trend perpendicular to identical structures in the Shuswap.

A preliminary examination of the Thor-Odin area of the Monashee Group shows a "domal" structure consisting of an extremely deformed veined gneiss in the core, followed by an intensely folded zone of biotite-quartz-feldspar gneiss, all overlain by a succession of metasedimentary gneisses. Rocks have been deformed by an early phase of recumbent flowage folding with amplitudes up to several miles and axes trending west. This succession has then been later refolded by shear folding on roughly similar trending axes. The entire mass has been warped into a broad north-trending anticlinal structure.

Metamorphism is up to upper amphibolite grade (sillimanite-almandine sub-facies). A detailed study of this region is planned.

31. IRON DEPOSITS, SOUTHERN BRITISH COLUMBIA COAST

D.F. Sangster

A study of contact metasomatic magnetite deposits in British Columbia, including ore zones, skarn rocks, and associated igneous intrusions, was started in 1961 as part of a general study of 'Iron in Canada' under the direction of Dr. G.A. Gross, in order to determine the mineralogical and geochemical characteristics of such deposits, the possible origin of the iron, and factors controlling its emplacement.

Five magnetite deposits on Vancouver Island and the Queen Charlotte Islands were mapped in 1962 on a scale of 1 inch to 50 feet.

Field work in 1961 had suggested that limestone was necessary for the deposition of magnetite, but that local structural controls, generally a syncline, were responsible for the ore concentration. The 1962 field work lent further support to this interpretation.

The associated skarn assemblage appears to indicate a high temperature environment, but the magnetite, which in all cases is post-skarn, appears to be a low-temperature mineral. Evidence includes the following features: hair-line fracture fillings in skarn and associated volcanic rocks; colloidal texture in the magnetite; and large bodies of magnetite in contact with unaltered bedded limestone.

Numerous large post-ore dykes, which were noted in almost all deposits, have a general composition, commonly dioritic, similar to that of the main intrusive rock. Field relationships seem to indicate that the deposits were formed after the main batholithic intrusion, but before all igneous activity associated with it had ceased.

32. CRETACEOUS STRATIGRAPHY OF NORTHEASTERN BRITISH COLUMBIA

D.F. Stott

The Lower Cretaceous Bullhead and Fort St. John Groups (and also the Jurassic Fernie Formation) were studied in outcrop between Graham and Buckinghorse Rivers as part of a continuing project. In addition, the general distribution and structures of those rocks were mapped in Trutch (94 G) map-area.

The Bullhead Group, as presently defined, comprises two distinct major units separated by a widespread regional unconformity. The lower one, consisting of the Monteith and Beattie Peaks (and possibly Monach) Formations, gradationally overlies the Jurassic Fernie Formation. The Monteith Formation grades laterally northwestward from massive quartzitic sandstones into interbedded silty sandstones and mudstones. In this region, the Beattie Peaks

Formation consists mainly of interbedded marine mudstones, siltstones, and fine-grained sandstones. A major erosional unconformity separates that succession from the Gething Formation, which lies on successively older beds from south to north and west to east. The youngest dated beds beneath the Gething are Beattie Peaks of Valanginian age which, in the Western Foothills, extend north of Halfway River. In the northern part of Trutch map-area, the Gething Formation lies on Triassic beds of successively older age. The coal-bearing beds of the type Gething Formation on Peace River grade laterally northward into well-sorted sandstones, which, in turn, grade northward into thinly interbedded sandstones and shale and finally into marine shale of the Buckinghorse Formation.

The Fort St. John Group of this area includes the Buckinghorse, Sikanni, and Sully Formations. The Buckinghorse shale underlies a large area between the Alaska Highway and the Foothills. The Sikanni Formation, as presently restricted, includes three units of fine-grained sandstone in Halfway River (94 B) map-area and four sandstone units farther north. These form a prominent west-facing escarpment extending from Graham River to Prophet River. The overlying marine shales are included in the Sully Formation.

The Dunvegan Formation of massive sandstone and conglomerate caps many erosional remnants east of the Alaska Highway.

33. MACDONALD CREEK MAP-AREA

G.C. Taylor

Following the completion of his work on Operation Porcupine, the writer spent a week in MacDonald Creek (94 K/10) map-area in order to complete the geological mapping and to trace two thrust faults through an extensive area of poor exposure. Poor weather prevented the completion of this project.

34. TASEKO LAKES MAP-AREA

H.W. Tipper

The west half and parts of the east half of Taseko Lakes (92 O) map-area were mapped in 1962. In the northern plateau area the oldest rocks were encountered, a belt of sedimentary and volcanic rock along Chilcotin and Fraser Rivers tentatively mapped as Permian; Mesozoic (?) argillites and greywacke overlie the Permian rocks unconformably. A belt of pre-Lower Cretaceous granitic rocks is exposed intermittently from the northwestern corner southeastward to Gaspard Lake and is best exposed on Piltz Peak and the range to the north. The hills between and within these two belts of rocks are mainly early Tertiary volcanic rocks and much of the flat areas between the hills is underlain by late Tertiary basic plateau lavas.

The mountainous area west of 123° longitude is underlain by a succession of Upper Jurassic - Lower Cretaceous, marine and non-marine argillite, greywacke, and conglomerate. This is

overlain, possibly unconformably, by Upper Cretaceous (?) non-marine argillite, greywacke, and conglomerate and a thick section of volcanic breccias and tuffs. In Taseko Mountain - Mount Vic area a younger group of green andesite flows and sills overlies the Upper Cretaceous rocks unconformably and may be Upper Cretaceous or Tertiary. Tertiary volcanic rocks underlie small areas throughout the mountain area; related basaltic to felsitic dykes and sills are large, numerous, and widespread.

The Coast granitic rocks occupy a small area in the southwestern corner and are in part Upper Cretaceous or younger. East of Taseko Mountain, granite, quartz monzonite, diorite, and granodiorite of more than one age have intruded the Upper Cretaceous - Tertiary green volcanic rocks.

The pre-Tertiary rocks are complexly folded, but the main structural features of the mountainous part are steep, southwest-dipping thrust faults. Chilcotin Valley is the site of several major northwest-trending faults.

Mineral occurrences in the southwestern quarter of the map-area have been known for many years and gold, silver, copper, and molybdenum have been reported. No new mineral occurrences were found.

35. AIRBORNE MAGNETOMETER SURVEY, NORTHERN VANCOUVER ISLAND

S. Washkurak

A method has been developed for conducting airborne magnetometer surveys in mountainous terrain. The method was tested over northern Vancouver Island (92 L/2, 3, 4, 5, 6, 11, 12, 13; and 102 I/8, 9, 16).

A Beaver aircraft was used for the low-level contour flying. The magnetic data were transmitted (telemetered) to a base station for magnetic diurnal correction via a repeater station carried in a 180 Cessna cruising at 8,000 feet. This method proved to be quite versatile and satisfactory.

Recovery of the aircrafts' flight path for the compilation of magnetic data still remains a problem in mountainous terrain.

Some 5,054 line miles were completed during the field season.

36. BIG BEND (82 M E 1/2) MAP-AREA

J.O. Wheeler

Selkirk Mountains east of Columbia River between LaForme Creek and Goldstream River are underlain mainly by phyllite, schist, marble, and quartzite of the Lardeau Group and marble of the Badshot Formation, and subordinately by quartzite and greenstone of

the Hamill Group and slate, quartzite, and marble of the Horsethief Creek Group. Structures trend northwest and are characterized by sharply attenuated folds overturned to the southwest, and northeast-dipping thrust faults, some of which appear to have been folded subsequently. The formations are intruded by several porphyritic granite stocks.

Monashee Mountains west of Columbia River and Clachnacudainn Range east of Columbia River and south of LaForme Creek are underlain by crystalline rocks. Those in Monashee Mountains appear to form a large, northwesterly elongated dome broadly centred around Frenchman's Cap. Mixed gneisses and metasediments in the core are overlain successively by sheets of augen gneiss and leucogranite gneiss, light and dark gneiss with numerous bedded pegmatite veins, hybrid gneiss composed of metasediments and granite gneiss, and mixed granite gneiss, which at the northwestern end of the dome contains abundant pegmatite.

Monashee rocks were deformed first into westerly trending, attenuated recumbent folds. Subsequently eastward-inclined folds, which plunge northwestward at the northwest end of the dome and southward in the southern part of the dome, were superimposed on the earlier folds. Lineation associated with the earlier folding was, in some places, warped by the later folding but, in others, it was obliterated by a new lineation parallel to the latter.

37. METAMORPHISM OF THE BLUE RIVER ULTRAMAFIC INTRUSION, CASSIAR DISTRICT

W.J. Wolfe

The Blue River ultramafic intrusion in parts of 104 O and 104 D is an alpine-type body intruded into the volcanic and sedimentary rocks of the lower part of the Sylvester Group. The ultramafic rocks are essentially dunites, peridotites, and serpentinites, and are intruded by the younger Cassiar granite batholith to the northwest.

Dunites and peridotites are serpentinized to varying degrees. Serpentinization was most intense at the margins of the intrusion, whereas the central core is occupied by relatively unserpentinized peridotites and dunite. Primary igneous layering of dunite and peridotite broadly reflects a synclinal shape.

Pronounced development of talc, serpentine, and tremolite in the ultramafic rocks is characteristic of a zone 1,000 to 4,000 feet wide adjacent to the granite contact.

Textures indicating regenerated or secondary olivine are widespread in the intrusion, and a large mass of "regenerated dunite", about one mile in diameter, is located adjacent to the central core. There is evidence that these regenerated rocks were formed as a result of thermal metamorphism of the serpentine by the intrusive granite. Smaller pods of the same rock type are spatially related to diorite dykes intruded into serpentinite along the southwest contact of the ultramafic body.

Basic volcanic rocks of the Sylvester Group have been altered to amphibolites for distances up to 1,000 feet out from their contact with the ultramafic body.

BRITISH COLUMBIA AND ALBERTA

38. PRE-DEVONIAN STUDIES, SOUTHERN ROCKY MOUNTAINS

J.D. Aitken

Thick conglomerates heretofore assigned to the Fort Mountain Formation (Lower Cambrian) in the Lake Louise area were found to be separated from the overlying quartzites by a major unconformity, and therefore are presumably of pre-Cambrian age. The facts support the older concept of a major hiatus at the base of the Cambrian sequence, rather than the minor hiatus that has been suggested.

Important changes of thickness and facies have been studied in the Middle and Upper Cambrian sequences in areas remote from the much-studied Lake Louise and Saskatchewan Crossing areas; nevertheless, little difficulty is encountered in applying a common stratigraphic nomenclature within the polygon, Exshaw-Mt. Assiniboine-Glacier Lake-Sunwapta Pass-Nordegg. Contrary to published statements, the Eldon Formation is not abnormally thin nor absent near Saskatchewan Crossing.

The Ordovician section at Glacier Lake was found to be much thicker (4, 200 feet ±), and more varied than has been suggested in the literature. The Glacier Lake Ordovician succession is easily recognized at Mt. Wilson and Sunwapta Pass.

Further detailed study of the sub-Devonian unconformity and the basal Devonian deposits in the Front Ranges has shown that all relatively thick (over 40 feet) sections of basal Devonian red beds and argillaceous dolomites (Ghost River Formation of some authors) occupy channels in the sub-Devonian surface. Known occurrences of plant and fish remains are confined to these channel deposits. Lithologic and stratigraphic criteria established in 1961 for the recognition of the base of the Devonian System were tested and found valid.

39. STRATIGRAPHY OF THE ETHERINGTON AND TUNNEL MOUNTAIN FORMATIONS IN THE SOUTHERN ROCKY MOUNTAINS

D.L. Scott

Marine strata lying between the Mount Head (Mississippian) and Kananaskis (Pennsylvanian) Formations have been examined from Crowsnest Pass to Bow Valley to establish a lithologic and palaeontologic framework.

The Etherington Formation (Chesteran) is a heterogeneous association of dolomite, limestone, shale, and sandstone, transitional between Mount Head limestones and Tunnel Mountain sandstones. It is readily divisible into an upper, uniform, persistent, dense, sandy dolomite member, which is gradational downwards and passes westward into sandstone, and a lower member,

which consists of two contrasting, cyclic facies. The eastern facies is very thin and composed of dolomite, limestone, siltstone, and maroon and green shale, which may originally have passed eastward into red beds. The western facies, much thicker, is composed of skeletal limestone, oolite, and sandstone, and passes westward into highly sandy, finer textured limestone. In eastern parts of the area the upper and lower contacts of the Etherington Formation are definitely disconformable.

The Tunnel Mountain Formation is mainly uniform, fine-grained, well sorted dolomitic and quartzitic, brown-weathering, partly cross-stratified sandstone. Scattered coarse, highly rounded quartz-chert sand grains are believed significant provenance indicators. The formation is divisible into several units, and is unconformably overlain by the Kananaskis Formation, which appears to gradually truncate an upper quartzitic sandstone northward from Highwood Pass. The Etherington-Tunnel Mountain contact has not yet been chosen.

Many well preserved silicified spirifirid brachiopods have been collected and may provide the basis of a Mississippian-Pennsylvanian standard for Western Canada. Shark teeth have been recovered from the Rocky Mountain Group.

ALBERTA

40. TRIASSIC ROCKS NEAR THE NORTHERN BOUNDARY OF JASPER NATIONAL PARK

D.W. Gibson

Triassic rocks near the northern boundary of Jasper National Park are divided into the Whitehorse and Sulphur Mountain Formations.

The Whitehorse Formation tentatively remains undivided owing to rapid facies changes occurring within relatively short distances in the area investigated. However, with a detailed petrological and palaeontological investigation, subdivision into distinct lithological units may be possible.

The Sulphur Mountain Formation is subdivided into four distinct lithological units: a lower silty shale unit; a blocky, brown siltstone unit; a black silty shale unit; and an upper sandy siltstone unit. These units are readily correlatable throughout the area investigated.

Twenty-five sections were examined and sampled at 5- and 10-foot intervals. The Whitehorse Formation ranges from 177 feet thick near Wild Hay River to 1,084 feet thick near Monoghan Creek. The Sulphur Mountain Formation ranges from 620 feet thick in the Wild Hay River area to 1,161 feet thick in the Glacier Pass region. Thus a marked thickening westward is readily apparent in both formations.

Gypsum was observed at two localities, Monoghan Creek, and Mowitch Creek. The occurrence at Monoghan Creek is very local, lensitic, and appears to be uneconomical. The Mowitch Creek occurrence has been described by Govett[1].

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[1]Govett, G.S.: Occurrence and Stratigraphy of some Gypsum and Anhydrite Deposits in Alberta; Alberta Research Council Bull. 7 (1961).

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41. GEOLOGY OF THE SOUTHESK-CAIRN CARBONATE COMPLEX

W.S. MacKenzie

With a view to more detailed investigation of lithic and biogenic units than is customary in the course of regional reconnaissance, stratigraphic sections of the Upper Devonian Alexo Formation and of the Fairholme Group were measured at accessible outcrops where they have been exposed by a series of sub-parallel northwesterly trending thrust faults.

The study area, comprising five fault blocks, and with its long direction parallel to the principal topographic expression, is contained within a rectangle some 34 by 16 miles and has its approximate centre at the crest of the Southesk-Cairn Pass (117°08'W Long. and 52°43'35"N Lat.).

Particular attention was accorded reef margin relationships. Where the carbonate Cairn and Southesk Formations pass into an off-reef or basinal facies, represented collectively by the Flume, Maligne, Perdrix, and Mt. Hawk Formations, there appears to be an abrupt change from the dark brown Cairn dolomites and dark grey limestones to equivalent Perdrix shales and shaly limestones. On the east side of Deception Creek, for example, Perdrix strata abut on irregularities on the upper surface of the Cairn Formation with no suggestion of interfingering of the two formations. There is no evidence of brecciation along the contact.

In contrast, the Southesk Formation appears to grade progressively into argillaceous limestones and shales of the Mt. Hawk Formation. The Southesk/Mt. Hawk transition was not observed in outcrop. However, closely spaced measured sections show that the Mt. Hawk becomes progressively more calcareous approaching areas of carbonate deposition.

In the neighbourhood of Sawtooth Mountain, the Cairn Formation has increased to some 1,300 feet in thickness at the expense of the Southesk and is overlain by silty Alexo strata.

42. ALEXO EQUIVALENTS IN SUNWAPTA PASS AREA, BANFF NATIONAL PARK

D.J. McLaren

Sections were measured through the interval between the Palliser and Southesk Formations. The interpretation of McLaren and Mountjoy (Geol. Surv., Canada, Paper 62-23) of a solution to the Alexo problem in the Jasper region was found to apply here. Overlying a reef development in the Fairholme Group on, e.g., Cirrus Mountain, 240 feet of "Lower Alexo" (equivalent to the Ronde Member of the Southesk in the Miette Range) are overlain with very sharp contact by the Palliser Formation; "Upper Alexo" (Sassenach equivalent) is absent. East of the Icefields Chalet, overlying an "off-reef" succession of Fairholme strata, 143 feet of "Lower Alexo" are overlain by 55 feet of "Upper Alexo" carrying traces of a Sassenach fauna, and are in turn overlain by Palliser strata.

43. BURNT TIMBER MAP-AREA

N.C. Ollerenshaw

Investigation and mapping of the Burnt Timber (82 O/11) map-area were commenced in 1962.

Efforts were concentrated on the eastern half of the area, with minor reconnaissance into the western half. Mapping of the eastern half was 85 per cent completed.

Preliminary mapping of part of the eastern region had been accomplished by G.S. Hume in 1933 (unpublished information). Some minor revisions of Hume's interpretation have been made.

Two major southwesterly dipping thrust faults occur in the eastern half of the area, imposing superimposed Cretaceous slices onto a pronounced Tertiary (Paskapoo) basin and implying a post-Paskapoo age for the thrusting. The fault planes underlie the Lower Cretaceous Blairmore Group, shearing through the Jurassic Kootenay Formation, more or less eliminating the latter or leaving it intensely sheared and tightly folded and producing a sympathetic increased folding in the lower Blairmore strata.

The Burnt Timber Mississippian gas field is located in the east-central part of the map-area. A new discovery of Mississippian gas occurred in July, 1962, approximately 8 miles south of the established field, at the Texas Gulf Sulphur et al. Hunter Valley site on the southern edge of the area. Further proved gas reserves are known from the Panther gas area in the western half of the map-area. The gas potential of Burnt Timber map-area appears to be good.

44. SURFICIAL GEOLOGY, BLOOD INDIAN RESERVE

A. M. Stalker

More than 75 per cent of the Blood Indian Reserve is covered with quiet-water deposits of lacustrine silt and clay. The inlets for the glacial lakes, however, were north and west of the Reserve and the coarser lake deposits and deltas are in those directions and beyond the Reserve limits. The rest of the Reserve is covered with rather featureless till. As a result there is a singular lack of surface deposits of gravel and sand. Much gravel occurs in buried preglacial valleys that cross the Reserve, but is too deep to be economic. It is, however, important for groundwater supply.

Most of the till is of Laurentian origin, but pure Cordilleran till is present in the south and west. One buried occurrence 7 miles southeast of Fort Macleod is the farthest northeast that Cordilleran till has been found in the region.

SASKATCHEWAN

45. GROUNDWATER STUDY, OLD WIVES LAKE DRAINAGE BASIN

R.A. Freeze

Results of groundwater studies in 1962 in the Old Wives drainage basin, Saskatchewan (parts of 72 F, G, and H), although preliminary in nature, are as follows:

1. Streamflow records in intermittent streams are inadequate for baseflow analysis, owing to extensive use of river water for irrigation and the influence of storage dams.

2. Piezometric installations indicate:
   a) there is groundwater contribution to small intermittent prairie streams, but it is local in nature (probably less than a 1-mile zone of influence along Notuken Creek);
   b) there is considerable upward groundwater flow into the saline flats and alkaline lakes occupying large preglacial (or glacial spillway) valleys.

3. Hydrochemical and piezometric data offer good correlation in outlining flow patterns in bedrock aquifers. However, flow through the non-homogeneous glacial till appears to be more complex.

4. Initial results of an experiment to find out what length of time and distance of travel is necessary before groundwater acquires the characteristic chemical qualities of the various geological formations suggest that chemical modification of groundwater by the materials is rapid.

46. GROUNDWATER IN THE HEADWATER REGION OF QU'APPELLE RIVER

P. Meyboom

Fieldwork was directed toward the evaluation of a groundwater flow system in a typical prairie drainage basin. Knowledge of the prairie vegetation proved to be indispensable in distinguishing between areas of recharge and areas of discharge. Measurements revealed that some of the phreatophytic communities (e.g. Elaeagnus commutata, Symphoricarpos occidentalis, and Rosa sp.) in a discharge area consumed as much as 0.20 foot of groundwater per day.

Particular attention was paid to the hydrological behaviour of depressions in hummocky moraine, which are characteristic of many recharge areas. Piezometer measurements showed that such depressions are areas of groundwater discharge rather than recharge for at least part of the summer.

Playas, saline soils, and a high salinity of surface waters are distinct features of many discharge areas. These

characteristics could be used successfully in the mapping of various parts of the flow system.

It was apparent that artesian conditions can be explained better by Hubbert's tangent law than by the classical geological concept of an exposed inlet, leading to a confined aquifer.

47. ENGINEERING GEOLOGY AND GROUNDWATER STUDIES, FRENCHMAN RIVER BASIN

J.S. Scott

Field work in the Frenchman River Basin was aimed at using a drainage basin approach to groundwater studies and to determine geological and hydrologic factors involved in slope stabilities.

Inadequacy of existing hydrologic and climatic data precluded a water balance study of the basin, but sufficient data were available to give a qualitative assessment of potential aquifers. Aquifers occur at the base of the drift and within Cypress Hills, Ravenscrag, and Frenchman Formations. Yield from these aquifers generally does not exceed 5 gpm.

Shallow piezometers were installed adjacent to farm stock ponds to determine the interrelation of groundwater and surface water influx to these ponds. Sufficient readings of the piezometers are not yet available for analysis.

Landslides have occurred in the upper reaches of Frenchman River valley where downcutting through Tertiary formations has exposed clay shale of the Cretaceous Bearpaw Formation. Near Val Marie, Saskatchewan, landslides also occur in the Bearpaw Formation, but are manifested mainly by creep phenomena rather than by slumping. Groundwater movement within, and clay mineralogy of, the Bearpaw Formation are thought to be more important factors contributing to slope instability than the stress history of the formation.

Potential aquifers exist on the Blood Indian Reserve as indicated by the presence of sand and gravel within buried valleys revealed by seismic drilling.

Quantitative well data for the Reserve are not available, thus only a qualitative assessment of the groundwater potential can be made.

48. HYDROGEOLOGY, EAGLEHILL CREEK DRAINAGE BASIN

A.M. Toth

Studies of the flow system and chemistry of groundwater were commenced in the lower part of the Eaglehill Creek drainage basin between Asquith and the North Saskatchewan River. The groundwater table was defined and piezometers installed to provide data for studies of the flow system near some intermittent streams. Chemistry of Eaglehill Creek was also studied.

49. REPORT ON THE CORONATION MINE COMPREHENSIVE STUDY

D.E. Whitmore

On behalf of the National Advisory Committee on Geological Research in Canada, coordination and technical direction of a comprehensive cooperative study of the Coronation Mine of Hudson Bay Mining and Smelting Co. were continued.

Field work on a surface map of the Coronation-Birch Lake area, which is the principal direct commitment of the Geological Survey to the project, was completed. The map covers an area of 32 square miles extending from latitude 54°34' to 54°42' and from longitude 101°57' to 102°03'.

Additional studies begun in previous years were continued.

MANITOBA

50. WEKUSKO LAKE MAP-AREA

C.K. Bell

The map-area (63 J) straddles the Superior-Churchill structural provinces. A suite of age samples have been taken across the contact zone to help establish its approximate location.

Within the Superior province, Cross Lake Group sediments become granitized and disappear under lake clay deposits as they strike southwest from Cross Lake into the Drunken Lake area. Anorthosite, charnockite, with related granulites and porphyritic granite outcrop in the Kiskitto Lake-Nelson River area. Most of the surrounding rock is northeast-striking granite, granodiorite, or tonalite gneiss. Lake diabase dykes intrude all these rocks.

Amisk and Missi Group (Churchill province) sedimentary, volcanic, and associated metamorphic rocks continue eastward in repetitious folded structures from the Crowduck Bay area[1] until they are concealed under drift east of Saw Lake.

Northeast-striking sedimentary and volcanic rocks and their granitized equivalents outcrop in and along Setting, Kiski, and Pakwa Lakes.

A large mass of hornblende granodiorite outcrops southwest of Wabowden. Late leucogranite dykes, sills, and stock-like intrusive rocks are omnipresent in both structural provinces.

Ordovician dolomite overlaps the Precambrian in a line that strikes east from the south end of Wekusko Lake to just west of Button, then south-southeast through Hill Lake to just west of Kiskitto and Kiskittogisu Lakes. Silurian limestone and dolomite may overlie the Ordovician rocks in the extreme southwestern corner of the map-area.

Three copper-zinc-lead-gold-silver deposits are being brought into production northwest of Herb Bay. Nickel showings have been drilled in the Wabowden area.

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[1]Frarey, M.J.: Crowduck Bay (West of Principal Meridian), Manitoba; Geol. Surv., Canada, Map 987A (1950).

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51. HYDROGEOLOGICAL STUDY OF THE RED RIVER VALLEY — WINNIPEG AREA

J.E. Charron

The area mapped covers Ranges 1E to 5E and Township 7 to 12. The study shows that potable groundwater is available at various depths throughout the northern part and eastern half of the area. Only the area south of Assiniboine River and west of Red River lacks potable groundwater.

Ice crack features in the form of minor ridges were mapped on the ground and from aerial photographs. This work—a by-product of the hydrogeological study—reveals the origin of these features and may also help to derive the thickness of the ice at that time.

A pump test carried on in the Winkler region (SE-36-3-5W), having a yield of 416 gpm, confirmed the writer's belief that the area around Winkler had great potential groundwater resources[1]. The water is hard, 700 ppm, potable, and classified B for irrigation.

Another pump test, in the vicinity of St. Pierre (lot 43, Rat River Settlement), yielded 100 gpm. The water is soft, 85 ppm, and potable.

A few miles south of the area, in 6-6-3E and 35-5-3E, the chemical analyses of two groundwater samples show abnormally high sulphate contents, which if interpreted on the basis of the geochemistry of the groundwater in the surrounding region, would suggest a possible gypsum horizon at depth.

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[1]Charron, J.E.: Ground-water Resources of Plum Coulee Area, Manitoba; Geol. Surv., Canada, Paper 60-22, p. 39, (1961).

52.

MONROE LAKE MAP-AREA

W.L. Davison

The central part of Monroe Lake (64 O) map-area is occupied by remnants of a broad easterly trending belt of metasediments. Grey to pink quartzite is characteristic; less abundant, associated rocks include biotite schist, garnet-biotite gneiss, impure dolomite, and locally micaceous greywacke and silty sandstone. The metasediments are cut off and partly disrupted by bodies of gneissic granite; extensive zones of mixed metasediments and granite occur throughout the area.

Homogeneous granite occurs in a few places, and is generally porphyritic. A fluorite-bearing granite south of Hearne Bay is probably equivalent to a similar, dated granite reported from the Kasmere Lake area to the west[1]. Some muscovite-tourmaline pegmatites occur in the same part of the area.

Concordant bodies of amphibolite and hornblende-rich gneiss are associated with granite-gneiss.

Several aeromagnetic anomalies were investigated. At least one, in the vicinity of Nueltin Lake, reflects the presence of a small ultrabasic body, and drift in several other areas contains blocks of rusted gneiss. No occurrences of definite economic interest have been found in this area.

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[1]Fraser, J.A.: Kasmere Lake Map-area, Manitoba, Geol. Surv., Canada, Map 31-1962 (1962).

53. SURFICIAL GEOLOGY, RIDING MOUNTAIN AREA

R.W. Klassen

The study of surficial deposits in the Manitoba part of the Riding Mountain area (62 K), begun in 1961, was continued.

Deglaciation, under stagnant ice conditions, appears to have proceeded from the Riding Mountain highland towards the Assiniboine River valley. A readvance of the last glacier in this area probably took place along the Assiniboine River valley when the highland to the northeast was either ice free or covered by dead ice.

The most common type of drift mapped is a recessional type moraine. Southwest of Assiniboine River this type of moraine exhibits a marked pattern of depressions and ridges aligned in a northeast to southwest direction. Relatively small areas of drift adjacent to the Assiniboine River valley were mapped as ground moraine. The ground moraine is marked by fluting, drumlins, and drumlinized hills indicating ice movement to the southeast. Two prominent lateral moraines were mapped; one is about 18 miles long, 2 to 5 miles wide, and parallels the Assiniboine River valley between Cracknel and a point 4 miles east of Binscarth; another is 4 miles to less than 1 mile wide, and extends from the hamlet of Arrow River to a point about 11 miles to the southeast. Lake deposits of considerable extent in the Virden area (62 F), extend for several miles into the map-area near Alloway.

54. MARINE GEOLOGY OF THE CHURCHILL ESTUARY AND ADJACENT AREA OF HUDSON BAY

R.J. Leslie

Sedimentation studies in Hudson Bay were commenced in 1961 in cooperation with the Division of Oceanographic Research. This project involved the sampling of geological and other pertinent material, underlying and associated with the entire bay, on a reconnaissance basis. The program that commenced in 1962 is a detailed study of the Churchill area, and is part of an overall investigation along the shoreline, as well as near-shore and estuarine areas, of the factors contributing to the sedimentation patterns within Hudson Bay.

To carry out this investigation a sampling program was conducted in the estuary of Churchill River, and along the western shore of Hudson Bay from Churchill River south to Owl River. Samples of sediments in cores and bottom grabs, water from the depositional interface, and bottom microfauna were obtained; also, shoreline processes were investigated.

The samples are presently undergoing laboratory analyses at the University of Southern California, and results of these studies will be integrated with the observations made in the field.

55. GREATER WINNIPEG FLOODWAY

J.E. Murray and G.D. Hobson

A hammer refraction seismic survey was conducted along the centre line of the Greater Winnipeg Floodway to study Pleistocene materials as detected by seismic velocities and to produce a profile of the bedrock surface underlying the floodway. The seismic data agrees favourably with the sparse drill-hole information at hand, leading to the conclusion that a reliable survey has been conducted. Bedrock in one location may approach surface sufficiently closely to affect earth-removal methods and even to require rock removal.

The seismic method was also used in the Winnipeg area in an attempt to correlate localized Garson clay deposits with bedrock topography. The Garson clays correspond with topographic 'highs' and may correspond with bedrock 'highs'.

56. GROUNDWATER RESISTIVITY INVESTIGATIONS

J.E. Wyder

The resistivity crew in cooperation with J.E. Charron of the Geological Survey's Groundwater Section outlined and drilled a major fresh-water aquifer in the Plum Coulee area (62 H/SW) in southern Manitoba.

The aquifer, which is an accumulation of glacial outwash material, occurs in an environment of lake clays and till. It is oriented in a northwest-southeast direction, has a strike length of approximately 15 miles, and varies in width from 1/8 mile to 2 miles. The aquifer material grades from coarse boulder gravel at its northern end to silty clay at its southern extremity.

The resistivity results showed the aquifer to be a high resistance zone of from 30 ohm-feet to 10,000 ohm-feet in an environment of 20 ohm-feet to 25 ohm-feet material.

A one-week drilling program, using a continuous flight power auger capable of penetrating 50 feet in clay, substantiated the resistivity interpretations.

A small offshore sand bar south of the above-mentioned aquifer was also successfully outlined by the resistivity technique.

An excellent set of type-resistivity field curves were obtained from the summer's work.

It is thought that in the Red River Plains area resistivity can accurately locate fresh-water aquifers, and it may also be capable of delineating boundaries between various soil-types that occur in the area.

ONTARIO

57. GEOCHEMICAL SURVEY, KIRKLAND LAKE

R.H.C. Holman

A geochemical study of the Kirkland Lake mineralized belt and surrounding region was initiated to appraise the possibilities of applying geochemical techniques to mineral exploration and to the elucidation of the geology of the district. After considering the different media such as vegetation, soils, and overburden, the study has been orientated, in the first place, to an examination of the common rocks underlying the district, and in particular to the Algoman intrusive bodies.

A total of 450 rock samples was collected from underground at three operating gold mines, from outcrops on the surface within the mineralized belt, and from the surrounding region. The samples were prepared by crushing and fine-grinding in the field and analysed in a newly-constructed mobile spectrographic laboratory mounted in a trailer. Trace amounts of the 13 elements, Ti, Mn, V, Cr, Cu, Co, Ni, Pb, Sn, Ag, B, Mo, and Zr, were estimated by emission spectrography using a semi-quantitative technique.

A provisional examination of the results for the elements listed has not revealed any geochemical peculiarities of the rocks that might provide direct or indirect criteria of the proximity of gold veins or their host rocks, but further analytical work for other trace, minor, and major elements is contemplated.

58. FURTHER GEOLOGICAL OBSERVATIONS, "ROADS TO RESOURCES" PROJECT

G.D. Jackson

Several regions within "Roads to Resources" map-areas (42 M; 43 D; 52 N, O, P; 53 A, B, C) were examined to obtain geological information to supplement that obtained in 1959, 1960, and 1961.

Conglomerate beds were studied at several widely scattered localities and Rosiwal-type analyses made.

Iron formation at the east end of North Spirit Lake (53 C) is more extensive than shown previously. Iron formation near Greenmantle Lake (52 P), not shown previously, has been intruded by granite in lit-par-lit fashion.

Ultrabasic sills and flows about Hornby Lake (53 C) are more extensive than shown previously. Granite, not basic flows, is the main rock type underlying a circular area northwest of Juniper Lake (52 P).

The gabbro area shown about Boy Lake (52 N) is underlain mainly by porphyritic granodiorite with minor scattered zones of mixed rocks. Two circular areas in the northwestern part of Wunnummin Lake (53 A) map-area are underlain mainly by

magnetite-bearing basic to ultrabasic rocks and by apparently younger carbonate rock (carbonatite?). Considerable pyrrhotite and traces of chalcopyrite are present in the more northerly area.

Remarkably uniform fine-grained sheared quartz porphyry of granitic composition comprises most of the bedrock between Slate Falls and Bamaji Lake (52 O), and apparently includes extrusive and intrusive varieties. Much of the apparent interfingering of this rock unit with the basic lavas is due to folding.

Interesting gold prospects near Opapimiskan Lake (53 B) are being investigated by Kenogamisis Gold Mines Ltd. and others. Several small gold showings occur north of Bamaji Lake (52 O). Uranium occurs between Moosetegon and Bamaji Lakes (52 O) and on the south side of Bearhead Lake (53 C).

59. APPLICATIONS OF PLEISTOCENE GEOLOGY TO MINERAL EXPLORATION, KIRKLAND LAKE - LARDER LAKE GOLD BELT

H.A. Lee

Reconnaissance study of the Pleistocene geology of the Kirkland Lake - Larder Lake gold belt was commenced in mid-July to see how this branch of geology could be used to further mineral and industrial development in this region. Although insufficient mapping was done to warrant publication, early results show several extensive areas of clay, which represent potential farmland, in McElroy township. Outlining abandoned drainage channels on high-level air photographs has resulted in the identification of some old valleys, but these are as yet untested as to origin or placer content.

This year's studies have suggested to the writer a new technique that seems promising to mineral exploration in the region. This technique can be used to test both the approximately 85 per cent covered bedrock and the 15 per cent exposed bedrock. The writer sees the glacial grooves and striations and the depressions around roches moutonnées as the scars on the bedrock surface of chipped samples taken about 10,000 years ago by the glacier in a manner similar to the "channel sample" of the modern prospector. He further recognizes that sample existing today as a semi-consolidated rock called "basal till".

Concentrates of heavy metals and minerals from the basal till can be systematically made in the field, and modern methods of examination can be carried out for counts on mineralization using x-ray fluoroscope, assay, and other techniques, as well as specially trained microscope operators.

The line that the glacier sampled can be determined by the specialist in the field for each sample, and the position of mineral prospects could be isolated and "homed in on the target" by first testing with wide intercepts along this line, and then with closely spaced intercepts in the promising zones.

60. SEISMIC REFRACTION SURVEYS OVER THE OAK RIDGE MORAINE, SOUTHERN ONTARIO

H.A. MacAulay and G.D. Hobson

Seismic refraction surveys were conducted along 8 selected lines of control over the Oak Ridge Moraine of southern Ontario. Continuous reversed control was obtained except in locations where habitation prevented such control. Large velocity contrasts between drift and bedrock created a favourable model for depth determinations to bedrock under the moraine. Buried channels and escarpments can be delineated. The combination of short and long detector spreads permits a correlation between seismic velocities and Pleistocene stratigraphy. The easterly limit of the moraine can be extrapolated from seismic and geologic data.

Long offset refraction spreads were shot at the ends of each control line to prove the base of the sedimentary section. The velocity contrast between Palaeozoic sediments and Precambrian basement rocks is small but generally leads to a reasonable interpretation. One reversed refraction profile was shot on Long Point in Prince Edward county indicating a depth of approximately 1,680 feet to the Precambrian surface.

61. SEISMIC REFRACTION SURVEYS, KIRKLAND LAKE AREA

H.A. MacAulay and G.D. Hobson

Seismic refraction profiles were conducted over an extensive area of the Kirkland Lake - Larder Lake gold camps. Velocity determinations were made on outcrops of different rock types in an effort to establish velocities for each type. Reversed profiles were shot, but it is indicated that no definite velocity can be associated with each rock type. The range of velocities recorded within each rock type is comparable to that expected for the entire suite of Precambrian rocks.

The contact between the Cobalt Series and the Temiskaming can be determined by reflection techniques if the Cobalt Series is thick enough to allow the application of the method.

The most useful contribution, at this stage of the interpretation, of the seismic method may be the determination of overburden thickness. This information is extremely useful in a drilling program.

62. REPORT ON HURONIAN METAZOAN OCCURRENCE

D.J. McLaren and M.J. Frarey

Well-preserved traces of Huronian Metazoans occur in the Lorrain Formation in Johnson township, District of Algoma, approximately 25 miles southeast of Sault Ste. Marie, Ontario. The geology and palaeontology will be described and illustrated in a forthcoming Geological Survey of Canada publication.

63. SURFICIAL GEOLOGY, SYDENHAM, BATH, AND WELLINGTON MAP-AREAS

E. Mirynech

The surficial deposits of the map-areas (31 C/2, 31 C/6, and 30 N/14) are thin, commonly less than 3 feet thick and locally less than 1 foot. This is particularly evident in Prince Edward county, an area that was glaciated then submerged beneath glacial Lake Iroquois in late Wisconsin time. Clays and silts border the Lake Ontario basin, for the most part, but they also extend up the creek and river valleys to the Shield margin. In addition to these lacustrine deposits post-Iroquois beach deposits were mapped eastward from Belleville (31 C/3) map-area. Many well-developed gravel bars were discovered and surveyed.

Drumlins within the present map-area are less abundant than in the Belleville-Tweed (31 C/3, 31 C/6) area and quite different in form. They are distinctly longer, narrower, and lower, yet the till does not appear to be markedly different in texture.

The Dummer moraine was traced eastward to around Centreville and Enterprise, where it grades imperceptibly into thin ground moraine. This recessional moraine is exceptionally well-developed east and northeast of Tamworth.

64. PRECAMBRIAN GEOLOGY OF THE FRONTENAC AXIS, SOUTHEASTERN ONTARIO

H.R. Wynne-Edwards

The Frontenac Axis is a narrow belt of Precambrian rocks that connects the Canadian Shield to the Adirondack Mountains of New York State. The rocks of the Axis are well exposed and readily accessible, and are ideal for the study of structure in high grade metamorphic rocks. Geologically they belong to the Grenville structural province. The principal types are layered (stratiform) gneisses, marbles, granulites, and quartzites, with associated gabbro, diorite, syenite, and granite. The metasedimentary rocks are metamorphosed to granulite and upper amphibolite facies; cordierite, hypersthene, garnet, biotite, and sillimanite are common in the aluminous gneisses. Detailed stratigraphic and structural mapping of these rocks has revealed 3 stages of a single continuous deformation: (1) pervasive deformation by flow, which produced both upright and refolded folds, all with parallel axes; (2) a stage of 'plastic shear' when linear zones of marble continued to flow between more rigid gneiss units; and (3) faulting and cataclasis along narrow zones with the same sense of movement as (1) and (2).

There are two main types of granitic rock. The first is coarse grained, perthitic, and varies from quartz monzonite to syenodiorite (Frontenac type). It has a constant stratigraphic relationship to the metasedimentary rocks over much of its extent and may represent the basement upon which the latter was deposited. In some places, however, it was remobilized and forms intrusive

masses. The other granitic rock is a fine grained, quartz-rich, two feldspar granite (Rockport type), which forms a large migmatic mass along the St. Lawrence River, and also appears as sharp-walled dykes cutting both the metasedimentary rocks and the coarse-grained Frontenac-type syenites. The latter also contain inclusions of the Rockport-type granite, so that both granitic rocks were at least locally mobile at the same time.

QUEBEC

65. SURFICIAL GEOLOGY, QUEBEC-THETFORD-BEAUCEVILLE DISTRICT

N.R. Gadd

Three types of topography occur within the area mapped (21 L/2, 5, 6, 7, 11, 12): a glaciated hill or mountain topography in the south; a flat, central area where marine sand plains dominate; and an "exhumed" bedrock topography near the St. Lawrence River.

The Beauceville region occurs in the glaciated hill region, where hilltops are mainly bare rock and where valleys are filled with glacial and fluvial sediments. The system of valleys that existed prior to the last glaciation carries the main alluvial gold deposits of the Beauceville region.

The central marine plains are underlain chiefly by poorly drained sands. Stony ridges of till and of bedrock rise above the general plain and trend northeasterly. These ridges are barriers to drainage southward to the St. Lawrence and thus produce extensive bogs.

Along the south shore of the St. Lawrence, nearly vertical beds of sandstone and conglomerate produce northeasterly trending ridges that rise tens of feet above the intervening less resistant shale-bearing valleys. Soils here are thin and heavy where developed on glacial till or shale, lighter where developed on abandoned terrace gravels and sands; these also are poorly drained.

Regions studied to date have shown evidence of only a single glacial advance that moved from the Laurentian highlands southward across the St. Lawrence valley towards the southern, or Appalachian, highlands. Glaciation was followed by marine submergence and subsequent uplift and erosion.

Extensive glacial-lake clay deposits, important to the brick industry at Deschaillons, appear to terminate in the area at Leclercville, and are not found along the south shore of the St. Lawrence in Portneuf (21 L/12) and Chaudière (21 L/11) map-areas. They do occur, however, in unmapped areas north of the St. Lawrence River near Donnacona.

66. DEEP DRILL SITE SELECTION - MOUNT ALBERT ULTRAMAFIC INTRUSION, GASPÉ

C.H. Smith

Preparatory work was completed to choose a site for a 10,000-foot diamond drill-hole in the Mount Albert intrusion, as part of the International Upper Mantle Project study.

The Mount Albert intrusion was chosen from among many possible sites in Canada for the following reasons: a) good surface outcrops; b) low degree of serpentinization; c) presence of a

contact metamorphic aureole indicating unfaulted margins on three sides; d) availability of gravity data indicating a gravity high; e) availability of aeromagnetic data indicating a magnetic low (i.e. little serpentinization); and f) availability of petrographic data indicating variations in olivine, pyroxene, and spinel compositions, possibly related to changes in oxidation state in the magma.

Site selections consisted of the following surveys: a) location of route of 3 1/2-mile access road from Trans-Gaspesian highway to drill site; b) cutting, surveying, and levelling of 35,000 feet of base line and picket line in the valley of Riviere Diable in the centre of the intrusion; c) magnetometer survey of the picket lines to locate possible shear zones in the peridotite, which should be avoided in drilling; none were found; and d) a hammer seismic survey to determine the depth of overburden in the valley of Riviere Diable.

In addition surface sampling of the intrusion was continued so as to provide samples, where possible on 1,000-foot centres, for statistical analyses of chemical trends.

67. SURFICIAL DEPOSITS, VAUDREUIL MAP-AREA

J.J.L. Tremblay

Work in Vaudreuil east half (31 G/8 E 1/2) map-area consisted of mapping the geology and stratigraphy of the surficial deposits.

A striking geological feature is a large delta formed in the Champlain Sea by the Ottawa River extending between the Oka Mountains and Rigaud Mountain. The deposits found in this delta consist mainly of sand. Their thickness is unknown, but in some areas borings were made to a depth of 75 feet and presumably the formation was sand.

A smaller deltaic deposit is also present near Rigaud. The material in this deposit, although varied, is much coarser and probably much younger in age, although it could be contemporary to the Champlain Sea deposits, because clay pebbles are present in it.

In general the stratigraphy consists of bedrock overlain by the following units:

1. Till
2. Glacial-fluvial gravel
3. Clays
4. Deltaic sands and gravels
5. Alluvial sands
6. Wind-blown sand
7. Peat and muck.

NEW QUEBEC AND LABRADOR

68. NEW QUEBEC CRATER

K.L. Currie

The New Quebec Crater, in northernmost Quebec (35 H/5), is a circular depression 2 miles in diameter in the acid Archaean gneisses common to this region. The depression is completely encircled by a bedrock rim rising about 300 feet above the surrounding barrens. No unusual rocks were found as outcrop. Possible impactite was recovered from one cobble in glacial drift. Sheeting in the rim is deformed into a crude bilaterally symmetrical structure, dipping away from the crater with steep dips to the northwest, and gentle dips to the southeast. Structures in the foliation, and the steeply dipping fracture systems are significantly radial to the crater in the rim, but not elsewhere. Widespread development of splendid green crystals of epidote occurs inside the crater. Two directions of glacial striae were found in the hinterland, but none could be found on the rim. U-shaped valleys and perched boulders of material from the Cape Smith belt show the rim has been glaciated. The presence of felsenmeer makes the identification of any throwout, which may be present, impossible. No new evidence of impact origin was found. Structures in the foliation, and the presence of hydrothermal alteration do not agree with the impact hypothesis. The origin of the crater is considered to be still uncertain.

69. MICHIKAMAU LAKE AREA

R.F. Emslie

The map-area (23 I E/2, 13 L W/2) is underlain chiefly by granitic rocks, gneisses, minor metasedimentary rocks, and anorthosite. Glaciation and deglaciation features trend southeasterly across the area.

The largest rock unit exposed is the western part of the Michikamau anorthosite, which outcrops on the western and eastern shores of the lake and extends some 20 miles to the east. Particular emphasis was placed on examining this intrusion. Three primary phases—plagioclase, pyroxene, and iron oxide—have been recognized in the field. Variations in amounts of these minerals, textural variations, and igneous laminations formed by planar orientation of feldspar laths were used to map the structure of the intrusion, which is interpreted as being lopolithic. Tilting and rotation of several segments of the intrusion have been recognized. Preliminary calculations indicate a 'stratigraphic' thickness of at least 30,000 feet of exposed rock.

Quantitative investigation of the compositions of coexisting mineral phases is expected to provide progress toward understanding the crystallization histories of large anorthosite intrusions.

NEW BRUNSWICK

70. HYDROGEOLOGICAL STUDIES, MONCTON AREA

P.A. Carr

Four well sites were drilled this summer to evaluate the group water potential of the Moncton (21 I/2) area. No areas having high values of transmissibility and no areas yielding large quantities of water were found. The maximum value of transmissibility found to date is around 25,000 gallons/day/foot, but most values are below 10,000 gallons/day/foot. Thus the possibility of finding wells yielding large quantities of water near the city of Moncton has been greatly reduced.

The geological mapping was continued this summer and now is near completion.

71. GEOLOGY OF THE ROCKY BROOK - MILLSTREAM AREA

J.L. Davies

Several small deposits of zinc, lead, silver, and copper sulphides occur in the area immediately surrounding the so-called Rocky Brook - Millstream "Break" within Bathurst (21 P/12). Two of the larger deposits—Nigadoo mines, and Sturgeon River mines—were mapped in detail (1 inch to 200 feet) by R.W. Boyle (in 1959), the writer (in 1961), and W.M. Tupper (in 1962). The writer spent the 1962 field season mapping an area covering the Rocky Brook - Millstream "Break" within Bathurst map-area (scale 1 inch to 2,000 feet), logging drill cores, and compiling information derived from Provincial Government files and company reports and maps. A geological map now in preparation will provide a clearer picture of the environment of the Nigadoo and Sturgeon River deposits, as well as the numerous smaller deposits. It will also serve as a better guide in future prospecting.

The area mapped lies on the south limb of a broad synclinorium involving Middle Silurian greywackes, argillites, and calcareous slates and phyllites, and limestone, and Middle Ordovician rocks consisting of grey, green, and black phyllites, slates, argillites, and subgreywacke. The rocks are intruded by sills and dykes of diabase, gabbro, diorite, and quartz and feldspar porphyries, and by small plugs of quartz-feldspar porphyry and a granite stock. The Rocky Brook - Millstream "Break" is a major lineament trending east-northeast. It consists, along most of its length, of a system of en echelon wrench (?) faults associated with a zone of tight folding in the lower part of the Middle Silurian rocks and the upper part of the Middle Ordovician sequence. The exact nature of the fault is not clear. The so-called "Main Break" appears to be a fault developed along the crest of an anticline that has been overturned to the northwest. A system of northwest-southeast trending faults appears to be a significant feature of the geology. Two of these faults form the boundaries of a structural block that contains most of the known mineral deposits, the Nicholas Denys granite stock, and most of the

quartz and feldspar porphyry and aplite dykes. The Nigadoo deposit, though it lies outside this block, occurs in one of these northwest-trending fractures.

72. UPSALQUITCH MAP-AREA

R.R. Potter

Rocks of probable Ordovician age, consisting of dark grey, green, and maroon argillite, diabase, quartzite, and their metamorphosed equivalents, outcrop in the southeastern part of Upsalquitch (21 O/10) map-area. They appear to be overlain unconformably by an upper Middle Silurian lithic greywacke succession, consisting of green and red conglomerate, sandstone, siltstone, and grey argillites and calcareous argillites. Silurian sedimentary and volcanic rocks occur near McCormack fire tower. Maroon, green, and grey grits and argillites of unknown age also occur in the southern part of the map-area.

Lower Middle Silurian sedimentary rocks, including argillites, limestones, and conglomerates, occur near Little Popelocan Brook and Gordon Brook. They are overlain by several thousand feet of basaltic, trachytic, and rhyolitic volcanic rocks, which are in turn overlain by Lower Devonian argillites and basalts. An east-west fault, parallel to Oxbow Brook and Mulligan Gulch, is the southern boundary of the latter. Gently dipping Middle Devonian sandstones were noted near the mouth of England Brook.

A small stock of diabasic gabbro occurs near Ramsay Brook bridge. Small amounts of pyrite and chalcopyrite were observed near the contact. A small fine-grained granitic stock occurs within calcareous sedimentary rocks of Silurian age, approximately 4 miles southwest of The Forks. Minor sulphides were noted. Large feldspar-porphyry dykes intrude Silurian sedimentary and volcanic rocks north of Norton Gulch on Red Brook. Similar dykes intrude Devonian rocks near Flying Eddy bridge. The New Jersey Zinc Exploration Co. (Canada) Ltd. massive sulphide deposit occurs within rocks of probable Ordovician age, 3 1/2 miles east of Third Portage Lake.

73. GEOCHEMICAL STUDIES OF STREAM SEDIMENTS AND WATERS, BATHURST - NEWCASTLE AREA

A.Y. Smith

Under the direction of R.W. Boyle, preliminary work was begun on the stream sediment and water survey of the Bathurst - Newcastle area. The Millstream River system was selected for a pilot study of methods of sampling and sample treatment prior to beginning the main survey. The Millstream River system drains several small deposits representing concentrations of Cu, Pb, Zn, Ag, As, Sb, and Au, all of which should be present in the drainage system. A total of 42 stream sediment samples was collected in order to

determine which of these elements would serve as useful indicator elements, and to determine what sampling frequency is required in order to detect the presences of deposits of the Bathurst type.

In addition some time was spent in the mobile laboratory examining additional methods of trace element analysis that would be applicable to the stream sediment project. Methods will be required for some or all of the following elements: Cu, Pb, Zn, As, Sb, Ag, Mo, Sn, W, V, Ni, Co, and Mn. From the pilot study of the Millstream River, it will be decided which elements should be done in the field laboratory by wet chemical methods, and which should be done in Ottawa by spectroscopy.

74. GEOCHEMISTRY OF MOLYBDENUM, BATHURST - NEWCASTLE DISTRICT

M. Tauchid

Under the direction of R.W. Boyle, the writer began work on the geochemistry of molybdenum in the rocks, soils, and waters of the Bathurst - Newcastle district. These materials were sampled throughout the district and analysed colorimetrically for molybdenum. The main part of the work entailed selecting suitable procedures for analysing the diverse materials, and improving the sensitivity of the analytical methods. One part per million molybdenum could be determined by the best method.

75. GEOLOGY AND GEOCHEMISTRY OF THE NIGADOO, ORVAN BROOK, AND CAPTAIN YELLOWKNIFE SULPHIDE DEPOSITS OF THE BATHURST AREA

W.M. Tupper

The Nigadoo, Orvan Brook, and Captain Yellowknife deposits were mapped on a scale of 1 inch to 100 feet. The subsurface geology was mapped where drill core was available. All three deposits were sampled for sulphur isotope analysis, trace element analysis, and for petrographic studies.

The three deposits each contain unique features. The Nigadoo deposit is a telescoped, epigenetic, hypothermal vein-type deposit, which cuts Silurian sedimentary rocks and a quartz-feldspar porphyry plug. The Orvan Brook deposit has a strike length of 8,000 feet, with an average width of approximately 4 feet. The sulphides are confined to a thin band of sericite schist. Gross features suggest the deposit is conformable, whereas detailed features indicate an epigenetic origin. The Captain Yellowknife deposit is geologically similar to the other massive sulphide deposits in the Bathurst area, but contains appreciable quantities of cobalt and traces of tin.

Granite masses in the Northwest Miramichi River area were sampled for trace element analysis.

Several Eh-pH-temperature determinations were made in local sedimentary environments where iron-bearing minerals are currently being precipitated.

NOVA SCOTIA

76. MARINE GEOLOGY, MARGARET'S AND MAHONE BAYS

G.A. Bartlett

Detailed study of bottom sediments and microfauna in St. Margaret's and Mahone Bays, Nova Scotia was commenced in 1962. This area was selected as it provided an opportunity to undertake such studies in different environments of high and low salinity, shallow and deeper water, and inshore and offshore localities where variations in ocean currents exist. The nature of bottom sediments provided considerable variety in that boulder till, gravel, and coarse sand are abundant along the shoreline, and that these coarser sediments grade rapidly into a rich sour-smelling black ooze in the less turbulent areas that characterize the bays.

To undertake these studies bottom samples were collected by means of SCUBA diving and standard oceanographic sampling equipment. The use of SCUBA diving equipment greatly increased the number of bottom samples obtained, particularly in compacted sands, and permitted visual examination of the bottom to depths of 100 feet. Preliminary studies indicate that only a secondary relationship exists between sediments and the contained fauna, and that probably such oceanographic factors as currents, geography, salinity, bathymetry, physiography, as well as nutrients, play the more important role.

Laboratory analyses of the samples, and the compilation of the field data are proceeding.

77. LOCHABER MAP-AREA

D.G. Benson

Meguma (Ordovician) quartzite and phyllite underlie a highland along the southern extent of Lochaber west half (11 E/8 W 1/2) map-area. These rocks were intruded by bodies of Devonian granite. Traces of gold were seen around some of the old prospecting pits and shafts near the margins of the granite bodies.

The northern third of the map-area is underlain by a volcanic and sedimentary complex. The volcanic rocks, thought to belong to the Ordovician James River Formation, vary in composition from rhyolite to andesite and in type from flows to pyroclastics. Interbedded argillite was probably originally fine ash beds. The volcanic rocks are overlain in several places by sparsely fossiliferous siltstone, wacke, and shale, tentatively assigned to the Silurian Arisaig Group. The entire complex is highly folded and metamorphosed so that structural interpretation is difficult. A small granite body intruded basic volcanic rocks east of Eden Lake.

A generally east-west trending belt of folded sedimentary rocks of the Mississippian Horton Group occupy the central half of the area. Light grey coarse-grained arenite and dark grey siltstone predominate. Lesser amounts of greywacke, and

maroon and green shale and mudstone are found. Plant fragments are common, but identifiable megafossils are scarce. Horton rocks unconformably overlie Meguma rocks and the Ordovician-Silurian complex.

A short narrow trough of calcareous Windsor (Mississippian) rocks lies between the Horton and Arisaig rocks near the western boundary.

Most outcrops are found in stream valleys, as glacial sand and gravel up to 70 feet thick cover most of the area.

78. NEW GLASGOW MAP-AREA

J.W. Gillis

The Ordovician Browns Mountain Group and the Silurian Arisaig Group outcrop in the southeastern corner of New Glasgow (11 E/10) map-area[1]. Fossils were collected from the Arisaig Group.

Intermixed metasedimentary, metavolcanic, and granitic rocks of the pre-Carboniferous Cobequid Complex are exposed in the southwestern part of the map-area.

The River John Group, found in the west-central part of the map-area, is tentatively correlated with the Mississippian Horton Group[2, 3]. The unroofing of plutonic igneous source areas is suggested by the abrupt lithologic change between the conglomerates of the River John Group and the overlying Pennsylvanian Riversdale Group. Sedimentary and metasedimentary fragments make up the conglomerates of the River John Group, whereas granitic fragments are abundant in the conglomerates of the Riversdale Group. Material for spore analysis was collected from the River John Group.

The Mississippian Windsor and Canso Groups are exposed in the southwestern and south-central parts of the map-area[4]. Canso strata also occur in the east-central part.

Pennsylvanian rocks belonging to the Riverdale, Cumberland, and Pictou Groups underlie the northwestern, central, and northeastern parts of the area[3, 4]. The coal seams of Pictou county belong to the Stellarton Group[4] of Pictou age. Spore and other fossil material was collected from the Stellarton Group to aid in correlation of the coal measures.

Copper minerals are found at scattered localities in the Browns Mountain and Arisaig Groups, the Cobequid Complex, and the Canso and Riversdale Groups. Specular hematite occurs in a number of places in the Browns Mountain and Arisaig Groups of the Canso Group. Barite is found at several localities in the Pictou Group.

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[1]Maehl, R.H.: The Older Palaeozoic of Pictou County, Nova Scotia; N.S. Dept. Mines, Mem. 4 (1961).

Benson, D.G.: Hopewell, Nova Scotia; Geol. Surv., Canada, Map 3-1962 (1962).

[2]Bell, W.A.: Carboniferous Formations of the Northumberland Strait, Nova Scotia; Geol. Surv., Canada, Summ. Rept. 1924, pt. C, pp. 142-180 (1926).

[3]Bell, W.A.: Carboniferous Rocks and Fossil Flora of Northern Nova Scotia; Geol. Surv., Canada, Mem. 238 (1944).

[4]Bell, W.A.: The Pictou Coalfield, Nova Scotia; Geol. Surv., Canada, Mem. 255 (1940).

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79. COBEQUID MOUNTAINS

D.G. Kelley

Field work during the past summer consisted mainly of widely spaced detailed traverses mostly in areas underlain by sedimentary rocks.

Sedimentary and volcanic rocks underlie a larger part of the Cobequids than was previously known. Fossiliferous Silurian and Devonian rocks were known from five areas within the Cobequids; four new localities were found during the past field season. Early Devonian fossils were found in one area previously considered as underlain by granitic rocks.

The Cobequids include fossiliferous Devonian and Silurian rocks which are, in part at least, similar to those of the Arisaig section in Antigonish county. There is every reason to expect more fossiliferous rocks will be found, and because of the detailed work that has been done on the Arisaig section, each new fossiliferous zone can probably be definitely related to the Arisaig section. The stratigraphic units in the two areas appear to be similar, but not enough work has been done to know how great a formational breakdown can be made in the Cobequids.

PRINCE EDWARD ISLAND

80. GLACIAL GEOLOGY OF RUSTICO (WEST HALF) MAP-AREA

G.H. Crowl

The northern and eastern parts of the map-area (11 L/6 W 1/2) have been completed; the southwestern part is as yet unmapped.

The low area of gentle relief to the north and east has a relatively thick drift cover (5 feet to 20 feet); drift is thin or absent on the high hilltops in the southwestern part of the area but is present in the valleys.

The predominant till is a clayey sand till derived from sandy bedrock; areas of clayey till are apparently related to areas of clay-rich bedrock.

All major valleys and many minor valleys are floored with a variety of glacio-fluvial deposits. The deposits are non-descript; they range from kames to ice-sloughed debris and generally lack good sorting and good topographic form. These deposits were laid down during the stagnation and downmelting of the ice-sheet on the island.

Striae and till fabrics indicate that the ice moved generally eastward from a centre of glaciation in New Brunswick.

81. BEDROCK GEOLOGY OF MONTAGUE (11 L/2) AND PARTS OF CHARLOTTETOWN EAST (11 L E/2) MAP-AREAS

L. Frankel

Study of the southeastern part of Prince Edward Island has indicated that three major stratigraphic units are exposed. On the basis of palaeobotanical and vertebrate fossil evidence the oldest unit, exposed around Charlottetown Harbour, Cape Bear, and Cardigan River, is of Permian age (Wolfcamp and/or Leonard).

Overlying this unit, perhaps unconformably, is the most widespread unit, a greywacke-arkose, whose facies vary from a slightly pebbly sandstone to a conglomerate. Its age is unknown.

The youngest unit is a sandstone with numerous conglomerate facies, which probably represent stream channel fillings. This unit is regionally unconformable with the underlying unit; its age is unknown.

NEWFOUNDLAND

82. BELLEORAM MAP-AREA

F.D. Anderson

Late Precambrian (?) Random Formation was recognized in strata on the western tip of Burin Peninsula, and on the north shore of Fortune Bay. The upper contact appears conformable with the Lower Cambrian Brigus Formation on Burin Peninsula and disconformable with the Middle Cambrian Youngs Cove Formation on the north shore of Fortune Bay.

Chapel Island and Doten Cove Formations on the north shore of Fortune Bay, which were previously mapped as Lower Cambrian, are now believed to be Precambrian and probably equivalent to part of the Musgravetown Group.

In the northwestern part of the map-area four ages of granitic intrusion are recognized. The youngest is either Late Devonian or early Carboniferous in age, the remaining three of post-Ordovician to pre-Late Devonian age.

Clay, in deposits about 10 feet thick and a few hundred feet long, was found in two new localities. The first lies a few feet above high water on the shore of Parsons Cove, East Bay, near the mouth of Northeast Brook (1 M/11). The second is exposed best at low water along the west side of the head of Bay d'Espoir about 1/4 mile south of Long Point (1 M/13).

83. KINGS POINT AND BAIE VERTE MAP-AREAS

E.R.W. Neale

Approximately 2 1/2 weeks were spent in Kings Point (12 H/9) and Baie Verte (12 H/16) map-areas to up-date information on mineral deposits and to examine new data, first noted at the close of the 1961 field season, that bears on the relationships of rock units immediately east of the Baie Verte road.

It is now established that the sediments and silicic to basic volcanic rocks (unit 5, Map 35-1960)[1], form an elongated outcrop belt south of Flatwater Pond, rest unconformably on greenish grey granitic rocks (unit 10a, Map 35-1960; unit 7, Map 10-1958). Previously the granitic rocks were interpreted as intrusive into this sedimentary-volcanic unit[1]. It is also probable that silicic volcanic rocks farther east (unit 7, Map 35-1960) also unconformably overlie these granitic rocks. As the granitic rocks are known to intrude the Ordovician (?) Baie Verte Group[2], the unconformity could be related to the Taconic orogeny, which affected certain parts of the Appalachian System in Ordovician time. A radiometric Devonian age obtained on mica from these greenish grey granitic rocks[3] probably dates recrystallization of the mica during the intrusion of later red syenite and granite.

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[1]Neale, E.R.W., Nash, W.A., and Innes, G.M.: Kings Point, Newfoundland; Geol. Surv., Canada, Map 35-1960 (1960).

[2]Neale, E.R.W.: Baie Verte, Newfoundland; Geol. Surv., Canada, Map 10-1958 (1958).

[3]Lowdon, J.A.: Age Determinations by the Geological Survey of Canada, Report 3; Geol. Surv., Canada, Paper 62-17 (1962).

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84. BOTWOOD MAP-AREA

H. Williams

Rocks of Botwood west half (2E W/2) map-area are chiefly Ordovician and Silurian sedimentary and volcanic rocks, which are cut by younger intrusive rocks. The layered rocks are closely folded and stand at high angles. Northeast-trending faults are a prominent structural feature.

The results of earlier 1-mile mapping have been integrated into a more regional pattern and the many rock groups of the area have been generally correlated across the western part of Notre Dame Bay. The discovery of approximately 50 new fossil localities has aided considerably in outlining the extent of Ordovician and Silurian strata. Three new graptolite localities within the Badger Bay Series confirm its earlier lithologic correlation with the Exploits Series.

The controversial Botwood Group[1] is of definite Silurian age and is much more extensive and of more varied lithology than previously considered. The general Silurian sequence has been interpreted to include several thousand feet of volcanic rocks, and fossiliferous Silurian limestone, previously known only through its occurrence as boulders in Botwood conglomerates, has been found in place near the base of the Botwood Group. Silurian Botwood Group rocks can be traced beyond the shores of Horwood Bay to the east of the map-area and their continuation southwestward from Bishops Falls is to be measured in several tens of miles. Thus a heretofore unrecognized northeast-trending continuous belt of Silurian rocks crosses the northern half of Newfoundland.

The structural relations between the Ordovician and Silurian strata show no evidence of deformation at the close of the Ordovician Period. Silurian rocks of the Botwood Group south of Exploits River are intruded by a large mass of granitic and dioritic rocks. The presence of pyrite and arsenopyrite at several places near the intrusive contact suggests that the Silurian rocks should not be overlooked as favourable prospecting ground.

In Twillingate (2 E/10) map-area, which was mapped on a scale of 1 inch to 1 mile, the extent of Ordovician and Silurian rocks has been outlined and the general stratigraphic sequences interpreted. Rocks of the controversial Farewell Group outcropping on Port Albert Peninsula contain fossiliferous limestone blocks and are considered to be of Silurian age.

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[1]Williams, H.: Botwood Map-area, Newfoundland; Geol. Surv., Canada, Paper 62-9 (in press).

GENERAL

85. GEOLOGY OF THE NATIONAL PARKS

D.M. Baird

Field observations for the preparation of geological guide books were made in the following National Parks: Riding Mountain (Manitoba); Prince Albert (Saskatchewan); Elk Island (Alberta); and Mount Revelstoke and Glacier (British Columbia). Further photographs were taken to complete the reports on Jasper and Kootenay National Parks.

86. HYDROGEOLOGICAL STUDIES, MARITIME PROVINCES

L.V. Brandon

Field work, which included measuring of springs, sampling of wells, and making notes on the relation of topography, geology, and vegetation patterns, was carried out so that a preliminary report and map on the hydrogeology of Prince Edward Island can be prepared this winter. All water supplies for towns and farms are obtained from wells throughout the island. The results of field work indicate that more well fields can be safely installed in valleys without causing any serious depletion of water levels. There are some localities near the sea-shore where heavy groundwater pumping may lead to salt water intrusion. Three observation wells were drilled for recording seasonal changes in groundwater levels. These were drilled in locations where detailed studies of the hydrology of a basin may be carried out.

In Truro (11 E/6) map-area, Nova Scotia, 45 waterwell and spring samples were obtained from various geologic formations. Sufficient work was done to prepare a groundwater probability map, which will be based on the published geologic maps of the area. Water supplies sufficient for small towns and light industries are available in the Triassic rocks and from glacial deposits and alluvium in some localities. The older rocks (e.g. Pennsylvanian and Mississippian rocks) yield small quantities of water to wells, but in some localities—particularly karst areas—the water is not potable. A well was drilled at Kentville and a continuous water level recorder installed.

A reconnaissance of groundwater problems in Newfoundland was carried out. The St. Lawrence Fluorspar mine was visited; this mine pumps 2,500 gpm continuously for operations. Discussions were held with engineers of the Bowater Power Co. Ltd. (Deer Lake) concerning hydrologic data in the Grand Lake basin. Well-drilling activity in Newfoundland is increasing and drillers report that sufficient supplies are usually obtained from rock wells in the eastern part of the province. In the west part of the province there are some valleys with deep glacial deposits, which may contain excellent aquifers.

87. STUDY OF DIABASE DYKES IN THE CANADIAN SHIELD

W.F. Fahrig

Two hundred diabase dykes were examined and sampled in three areas of the Canadian Shield—the Noranda - Val d'Or region of Quebec, the Shield area of southern Ontario, and the Shield of the western Northwest Territories. These dykes range from a few inches to 1,000 feet in width and from a few feet to several hundred miles in length. More than one thousand individual samples were collected, comprised as follows:

1. Three hundred fine-grained oriented specimens designed to study the palaeomagnetic orientation of the dykes.

2. Various dyke samples and related samples, particularly of micaceous material, collected for the purpose of determining the age of the dyke swarms by the K-Ar method.

3. Samples of dyke material from various locations in the dykes to study the geochemistry of the dykes and the geochemical processes operative during the intrusion and consolidation of dyke magma.

4. A series of specimens at measured distances outward from a young dyke cutting the Preissac - Lacorne batholith, collected in order to study the effect of a calculable heat addition on the retention of argon in mica, and particularly to compare argon loss in biotite with that of muscovite.

5. A sample of country rock collected at each dyke locality as additional randomly selected material for current Survey studies to determine the abundance of elements making up the Canadian Shield.

88. STUDIES ON THE STRATIGRAPHY OF THE UPPER FERNIE GROUP IN THE ROCKY MOUNTAINS BETWEEN THE INTERNATIONAL BOUNDARY AND JASPER, ALBERTA

Hans Frebold

Some detailed studies of the Upper Jurassic beds in parts of the Rocky Mountains and Foothills were made. These beds belong to the upper part of the Fernie Group. At the base of the sequence the Oxfordian Green beds are uniformly developed in the southern and northern parts of the area whereas the overlying beds show facies differences, i.e. they are more shaly and more fossiliferous in central and northern parts of the area than farther south where they are known as "Passage beds". A number of guide-fossils found in recent years in the lower beds of both facies prove that these lower parts of the beds concerned are of the same age, i.e. late Oxfordian and/or early Kimmeridgian. The age of the upper parts of the Passage beds is not accurately known as no guide-fossils have been found, but it is likely that they belong to the upper Kimmeridgian and/or lower Portlandian, an age that is fairly well established for the upper beds in the northern facies. Further studies on this subject

are necessary before a final decision can be made. These studies have also a decisive bearing on the question of the age of the Kootenay Formation.

89. STUDIES OF IRON FORMATION IN EASTERN CANADA

G.A. Gross and K.L. Chakraborty

Detailed and systematic sampling was done on metamorphosed Precambrian iron formation in different parts of the Labrador Geosyncline. From Mt. Reid to Lake Jannene the iron formation was followed northward to the Knob Lake area to see the nature of variation of the ore in different grades of metamorphism. The problem of concentration of iron ore by the leaching of silica was also studied. Evidence of leaching was definitely observed in the Wabush Lake and Knob Lake areas. Special emphasis was given on the collection of ferro-magnesian amphibole and associated silicate minerals from different sedimentary facies of the iron formation. Samples of anthophyllite, cummingtonite-grunerite, mangano-cummingtonite, hypersthene, diopside, etc., were collected from different localities for laboratory investigation. The structure and stratigraphy of the iron formation in different sedimentary basins were reassessed by studying recent company maps and a large number of drill cores. The anthophyllite and mangano-cummingtonite were found to be the source of secondary manganese enrichment in the iron ores.

Different stratigraphic sections of the unmetamorphosed Precambrian iron formation of Temagami and Moose Mountain (north and western Ontario) were studied in detail to find out the primary sedimentary features. Large scale maps of these sections were prepared, and samples were collected for mineralogical and chemical study.

90. OIL AND GAS WELL INVESTIGATIONS, NEW BRUNSWICK AND PRINCE EDWARD ISLAND

R.D. Howie

Cores from Imperial Berryton, No. 1, and Imperial Port Elgin No. 1 wells, on file in Fredericton, New Brunswick, were examined. In addition specified sections of the Palaeozoic in New Brunswick and Prince Edward Island were studied. This work will aid in the examination of well samples and interpretation of the subsurface stratigraphy in these areas.

91. SEA MAGNETOMETER STUDIES SOUTH OF HALIFAX, NOVA SCOTIA

J.E. Lee

Measurement of the earth's magnetic field is done by the use of nuclear-precession direct-reading type magnetometer. The sensing head is towed 400 feet behind the ship (the C.H.S. "Kapuskasing").

The position of the ship is plotted using the Decca navigator. The data from a shore-based magnetometer station, which is run continuously, is used to correct the data at sea.

Estimated number of line miles for the season will be about 10,000. These lie within an area bounded by longitudes 61° to 65°W, latitudes 42° to 44°N approximately, and adjoin studies made on the C.H.S. "Baffin" (see Stauffer, W.J., No. 98).

92. METALLOGENIC STUDIES, CANADIAN APPALACHIANS

W.D. McCartney

Five weeks were spent doing preliminary field work in eastern Quebec and southern New Brunswick, during which time particular attention was paid to the mineral assemblage of various types of mineral deposits and to the age and petrology of wall-rocks or adjacent intrusive rocks. Some field evidence suggests that the nickel-bearing mafic rocks at St. Stephen, New Brunswick, may be pre-Middle Silurian and post-Lower Ordovician in age, rather than Devonian as hitherto believed. Where an intimate genetic association was indicated between mineralization and specific igneous rocks, material was collected for absolute age determinations. These determinations are especially critical in eastern Quebec in order to relate younger granitic rocks to the tectonic evolution of the Appalachians farther to the east.

93. STUDIES OF CANADIAN TIN DEPOSITS

R. Mulligan

Studies of tin deposits and occurrences in Yukon and British Columbia occupied about eleven weeks of the field season. A tin-bearing dyke near Bird Lake in southeastern Manitoba was also briefly examined, and a week was spent at the Mount Pleasant mine in southern New Brunswick, where a 2,300-foot adit has recently intersected the north tin-bearing zone of the property.

The tin occurrences of the western Cordillera lie chiefly within a belt extending southeastward from near Dawson and Mayo, Yukon, to Kimberly and Kootenay Lake, British Columbia. Aside from placer tin occurrences of Dawson and Dublin Gulch (Mayo), most of the known occurrences are near the northern fringe of the Cassiar batholith and related satellites, in the north, and the eastern fringe of the Nelson granitic complex in the south. A few, such as the Coal River, Yukon, and some properties near Rocher de Boule, Hazelton, lie outside this belt.

Tin occurs chiefly as cassiterite in quartz veins of the greisen type, pegmatites, and some sulphide bodies, and in some sulphide ores as stannite. It is commonly concentrated with tungsten, especially wolframite, and fluorite is commonly present. Elsewhere such associates may be absent, as at the Sullivan mine, where cassiterite occurs chiefly in pyrrhotite, and tourmaline in the nearby country rock is the only common associate.

Cassiterite is generally too fine grained to recognize by eye, and stannite is difficult to distinguish from other sulphides. Spectrographic checking of samples for tin is recommended. Cassiterite is a heavy resistant mineral, and would tend to concentrate in stream sediments near primary occurrences.

94. YUKON DAM SITE AND WELLAND CANAL INVESTIGATIONS

E.B. Owen

Part of the field season was spent with a field party of the Water Resources Branch, Department of Northern Affairs and Natural Resources, investigating potential dam sites in Yukon Territory and the Northwest Territories. Two sites were examined in the Yukon River drainage basin and thirteen in the Mackenzie River drainage basin. A geological map, scale 1 inch to 100 feet, was prepared for each site and the availability of construction materials was determined.

Three weeks at the end of the field season were spent in the Welland Canal area, Ontario, consulting with the St. Lawrence Seaway authority regarding foundation conditions beneath the proposed new lock and approach wall structures. The materials exposed in several quarries in the area were examined to assess their potential as fine and coarse aggregate and as riprap.

95. MINERAL COLLECTING AREAS ALONG THE TRANS-CANADA HIGHWAY, ONTARIO AND MANITOBA

Ann Sabina

Mineral collecting areas were visited along the Trans-Canada Highway between Sudbury, Ontario and Falcon Lake, Manitoba. The occurrences selected for examination were those that furnish minerals and rocks of interest to the tourist, the amateur collector, and the amateur gem cutter. The localities are within a few miles of the Trans-Canada Highway and require a walk of not more than one mile.

The area in the vicinity of Lake Superior yielded the most varied and productive collecting sites. Of particular interest are the occurrences of amethyst, jasper, and chert in the Lakehead area. The amethyst is found principally in the old silver mines, the jasper and chert along lake shores and in stream beds. Along the north shore of Lake Superior the road-cuts and the rocks along the shoreline furnish a variety of material suitable for ornamental purposes; these include nepheline syenite rock, laurvikite, epidote, laumontite, and chalcedony. Ornamental jasper conglomerate is found in the rock exposures along the highway in the Bruce mines area. An unusual form of magnetite and crystals of cobaltite were found in two prospect pits near Espanola. Former lithium and molybdenum properties were investigated in the Falcon Lake area.

96. SUBSURFACE STRATIGRAPHY OF PALAEOZOIC ROCKS IN SOUTHWESTERN ONTARIO

B.V. Sanford

Numerous key Lower and Middle Silurian sections along the Niagara escarpment were examined to provide data for a report on the subsurface stratigraphy of Silurian rocks in southwestern Ontario. A brief field trip was made through northern parts of Indiana and Illinois to examine Silurian rocks there, particularly several bioherm reefs of Niagaran age. Similar reefs are present in the subsurface throughout various parts of southwestern Ontario.

Various Middle Devonian sections in southwestern Ontario were also examined.

97. GEOPHYSICAL INVESTIGATIONS, MONCTON MAP-AREA AND PRINCE EDWARD ISLAND

J.A. Slankis and G.D. Hobson

A hammer refraction seismic survey of the Moncton (21 I/2) map-area was almost completed using Model MD-1 equipment to determine thickness of overburden. Good velocity contrasts exist between drift and bedrock, permitting reliable contouring of the bedrock surface from seismic data. The Peticodiac River channel before Pleistocene time can be traced in a northwesterly direction from Moncton to the Kingston Uplift. This geologic feature is prominent on the bedrock topographic map. Other buried depressional features can be defined, which may be potential aquifers.

The project on Prince Edward Island was intended to outline the bedrock profile across selected rivers and streams flowing into the ocean and across certain inland geological features. One line of control was shot on Hog Island, which indicates a buried channel, suggesting movement of the sands of the island.

98. SEA MAGNETOMETER STUDIES OFF HALIFAX, NOVA SCOTIA

W.J. Stauffer

Measurement of the earth's magnetic field by the direct-reading nuclear-precession magnetometer is a continuing project in conjunction with the Canadian Hydrographic depth-sounding program. Number of line miles covered was 4,959, in an area bounded by longitudes 62° and 63°W, and latitude 43°45'N to the Nova Scotian shoreline.

99. PLEISTOCENE PALYNOLOGICAL STUDIES

J. Terasmae

The writer spent some time on board the research vessel Porte Dauphine, participating in coring and study of bottom sediments in Lake Erie.

Examination of exposures available in the construction of the Toronto Rapid Transit Subway has been continued, with further information being compiled on the stratigraphy and chronology of the surficial deposits.

In August, the first Canadian conference on muskeg vehicles was held at Parry Sound, Ontario, where performance of different tracked vehicles was evaluated against the background of muskeg environment, which in large measure is dependent on the geology of the area.

GEOLOGICAL COLLECTING

Collection of fossils, rocks, and minerals is an important phase of many field projects. In some instances, however, parties are sent to the field in order to make collections for a specific research project. Such collections are returned to headquarters for further study, and any account of the field work involved can only record the collecting phase. Further work on these collections provides the material for office and laboratory research and subsequent publication in the various reports of the Geological Survey.

Several collecting projects are recorded here and are assembled under a somewhat different format from that followed in the rest of this report.

R.F. Black collected 253 oriented samples from igneous and sedimentary rocks of Cambrian to Carboniferous age from central and western Newfoundland and the south coast of Labrador. The collection was made with the object of adding to and refining the polar wandering curve during the Palaeozoic era as well as attempting correlation between various formations and groups. The remanent magnetism of samples collected from the Bradore Formation from the highlands of St. John (12 I W 1/2) will be compared with that of the same formation on the south coast of Labrador (12 P) to determine the amount of rotation, if any, since Cambrian time between the adjacent mainland and the island of Newfoundland. Samples to be used for resolving the polar wandering curve include: Middle Cambrian sandstones of the March Point Formation (12 B W 1/2); Lower Ordovician siltstones and sandstones of the St. Georges Group (12 B E 1/2); Silurian volcanic rocks and sandstones of the Botwood Group (2 E W 1/2); Lower Devonian sandstones of the Clam Bank Group (12 B E 1/2); Devonian intrusive gabbro and diabase from the Botwood area (2 E W 1/2) and the Gull Pond area (12 H E 1/2) respectively; Pre-Carboniferous gabbro from the Bay of Islands igneous complex (12 G E 1/2); Upper Mississippian sandstones of the Windsor Group (12 H W 1/2) and Codroy Group (12 B E 1/2); and Lower Pennsylvanian sandstones from the Searston beds (11 O W 1/2). The results obtained from this collection will be combined with those from collections made in central and eastern Newfoundland as well as other regions of the Maritime Provinces.

A.R. Cameron collected samples of coal from the Michel-Natal area in British Columbia for petrographic and coking studies. Four mines were sampled in this area: "A" North, Michel Colliery, Balmer, and Baldy Strip. Ten column samples and channel samples covering 217 feet of coal were collected from three seams, namely the "A", Balmer, and No. 1. Of these ten samples, seven were collected from the "A" seam, two from the Balmer seam, and one from the No. 1 seam. Column samples in the normal sense, that is samples composed of large, coherent, blocks of coal, could not be collected from these very friable coals with the exception of one of the Balmer samples and the No. 1 seam sample. Instead the seams were divided into 6-inch intervals and bags of broken coal representing these intervals were collected. Two channel samples were collected in a similar fashion except that the intervals were much larger. The size of the intervals in the latter case depended upon the occurrence in the

seam of what were considered to be significant stratigraphic breaks, for example, rock partings.

In addition, two 900 lb. samples of megascopically dissimilar benches in the Balmer seam were collected for carbonization studies in the 500 lb. coke oven at the Mines Branch.

All samples were shipped to Ottawa where detailed petrographic, physical, and chemical analyses will be carried out.

T.P. Chamney, while attached briefly to Operation Porcupine in the Yukon and Northwest Territories, completed sequential sampling of 6,912 feet of Mesozoic strata. The sections described, measured, and sampled were from the Aklavik Range in the Richardson Mountains, Northwest Territories, and from Babbage River in the Yukon.

Chamney also described, measured, and sequentially sampled approximately 1,363 feet of the marine Middle Albian (Lower Cretaceous) strata in Hudson Hope (93 O) and Pine Pass (93 P) map-areas, British Columbia. This material will provide the type reference for micropalaeontological zonation of the Middle Albian of northeast British Columbia and adjacent areas.

M.J. Copeland collected material for a preliminary micropalaeontological study of the Silurian-Devonian boundary (St. Alban, Cap Bon Ami, and possible equivalent formations) in a narrow belt of rocks extending the length of the Gaspé Peninsula, Quebec, from Cap Bon Ami to west of Lac Matapedia. It is hoped that a zonal classification of these rocks may be established by means of the contained microfauna, particularly Ostracoda.

J.L. Davies, A. Kamili, R. Martin, T.H. Pearce, and W.M. Tupper, under the direction of R.W. Boyle, spent part of the field season sampling the granite bodies within the Bathurst-Newcastle district, New Brunswick. These samples will be analysed for trace elements and the data utilized to determine if there are any chemical relationships between the granites and the ore deposits. This sampling is also part of a larger scale program designed to learn more of the geochemistry of the New Brunswick granites.

A.H. Debnam, a National Research Council Post-Doctorate Fellow, spent the month of June collecting soil samples over oil and gas fields in southwestern Ontario (Gables and Colchester) and Alberta (Innisfail and Pincher Creek), as part of a study of the geochemical methods of prospecting for oil and gas. Sampling was in much greater detail than that carried out during a preliminary survey in 1961 in the same areas. All samples were forwarded to Ottawa for analysis.

E. Gaucher collected 330 oriented specimens of diabase dykes and sills from 160 localities in northern Ontario, northwestern Quebec, and from the Grenville structural province north of Ottawa, for studies of the palaeomagnetic orientation and geochemical composition of the many swarms of diabase dykes. At each of the 160 localities, 3 other samples were taken: one of 'chilled' diabase at the contact of the dyke, one of the middle of the diabase dyke, and one of

the intruded country rock away from the dyke. From field observations the northeastern diabase dykes in Abitibi (northwestern Quebec) showed a variety of compositions, from granodiorite or syenodiorite to an olivine diabase.

Some disseminated pyrrhotite with specks of chalcopyrite was observed in the gneisses along the new highway from Chapleau to Timmins. In one road cut about 35 miles east of Chapleau, a foot-wide band of disseminated pyrrhotite contained two 1-inch seams of disseminated chalcopyrite. A grab sample of the best material was taken.

C.H.R. Gauthier collected approximately 1,500 pounds of various sulphides plus a few hundred pounds of ultrabasic rocks from the Muskox Intrusion between Speers Lake and Coppermine River, Northwest Territories. In order to obtain fresh materials, drilling and blasting had to be done at 40 different sites along the complex.

More than 16 tons of minerals, rocks, and ores have been collected from 40 localities in New Brunswick, Nova Scotia, Ontario, and Quebec, to be used in the preparation of various collections for sale to the public. Several specimens of special interest were also collected for the Survey's National Collection.

P.A. Hacquebard and G. Playford visited twenty different areas in New Brunswick and Nova Scotia to collect samples for palynological investigations of Carboniferous rocks. A total of ninety samples were obtained, twenty-nine from the Pennsylvanian rocks and sixty-one from the Mississippian.

The Pennsylvanian samples were collected from critical areas, where on the basis of previous studies, specific stratigraphic intervals were thought to be present. This included the eastern part of New Brunswick, around Richibucto and Miramichi River. Other samples were taken from map-areas in which proper assignment of the Pennsylvanian sediments has not been made, due to lack of plant megafossils. These areas included Coldstream (21 J/6) map-area, New Brunswick, and Kennetcook (11 E/4) map-area, Nova Scotia.

Mississippian samples were all taken from the Horton Group. Detailed collections were made in the type area of the Horton-Windsor district. Only in this area has the Horton Group been subdivided into two formations, based on plant megafossils. The microflora of the lower formation had been partly studied by Hacquebard in 1957, but no studies had been made of the upper formation. A separation of the two by means of fossil spores will permit their recognition in other parts of the Maritimes, where the Horton Group has been subdivided on lithological grounds only. For a comparison with the type section, several other Horton localities were visited, and promising samples of shales, sandstones, and coal were obtained.

A column sample of the No. 3 seam in the Syndicate mine, Springhill coalfield, was taken for coal petrological studies.

F.M. Hueber visited the type section of the Ghost River Formation in Alberta. Compressions and/or petrifactions of four plants were collected; two have been reported earlier and two are new. The occurrence of petrifactions is a new report.

Hueber also collected Tertiary plant remains from Driftwood Creek and Williams Lake, British Columbia, and obtained three collections from Jurassic-Cretaceous strata near Hazelton, British Columbia. (See also McGregor and Hueber, below.)

H.A. Lee completed Pleistocene studies commenced in 1961, in the lower St. Lawrence basin, in the Rivière du Loup - Trois Pistoles region, Quebec. Emphasis was placed on absolute dating of events previously established by stratigraphic and geomorphologic observations. Small, thin and sparsely distributed shells of Yoldia arctica were collected from the glacial-marine clays and have been submitted for Carbon-14 dating. In addition bulk samples of both shells and clay were collected and submitted for Carbon-14 dating. These bulk samples are more easily obtained, but whether they will give true dates of the enclosed shells is not yet known.

D.C. McGregor and F.M. Hueber re-examined plant-bearing Devonian sections at Gaspé Bay, and on the lower Restigouche River in Quebec and New Brunswick. Collections were made to obtain further material for a joint megafossil-microfossil study of these beds by Hueber and McGregor. Several previously undescribed fossil plants were obtained. This year's work, and that of previous years by McGregor, proves that the Devonian flora of Gaspé Peninsula is even richer in species and in new forms, both mega- and microfossil, than was previously thought, and further indicates the urgency for publication of this flora.

At the request of Dr. Ely Mencher, of Massachusetts Institute of Technology, collections were made from several Devonian plant-bearing sites in northern Maine for which datings are requested. Both spores and megafossils will be studied in the laboratory.

Collections of plant remains and bone fragments were made from the Permian strata of Prince Edward Island, with the object of dating more precisely the age of these rocks. Numerous specimens of fossil wood were obtained as well as some samples that will be analysed for spores.

S.C. Robinson visited Silver Crater mine, the Wilberforce molybdenite deposit, and the lowest levels at Faraday Uranium mine and Bicroft Uranium mine, in the Bancroft-Wilberforce area of Ontario, and collected approximately 150 pounds of specimens for further study.

C.H. Stockwell spent seven days in Labrador and nearby parts of Quebec collecting samples for isotopic age determinations as an aid in the preparation of a Tectonic Map of Canada. Additional samples were also collected from the Grenville structural province.

AUTHOR INDEX

SUBJECT INDEX