GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 64-1

SUMMARY OF ACTIVITIES: FIELD, 1963

Compiled by S. E. Jenness

Price, 35 cents

1964

GEOLOGICAL SURVEY

OF CANADA

PAPER 64-1

Summary of Activities:

FIELD, 1963

Compiled by

S.E. Jenness

DEPARTMENT OF

MINES AND TECHNICAL SURVEYS

CANADA

CONTENTS

Illustration

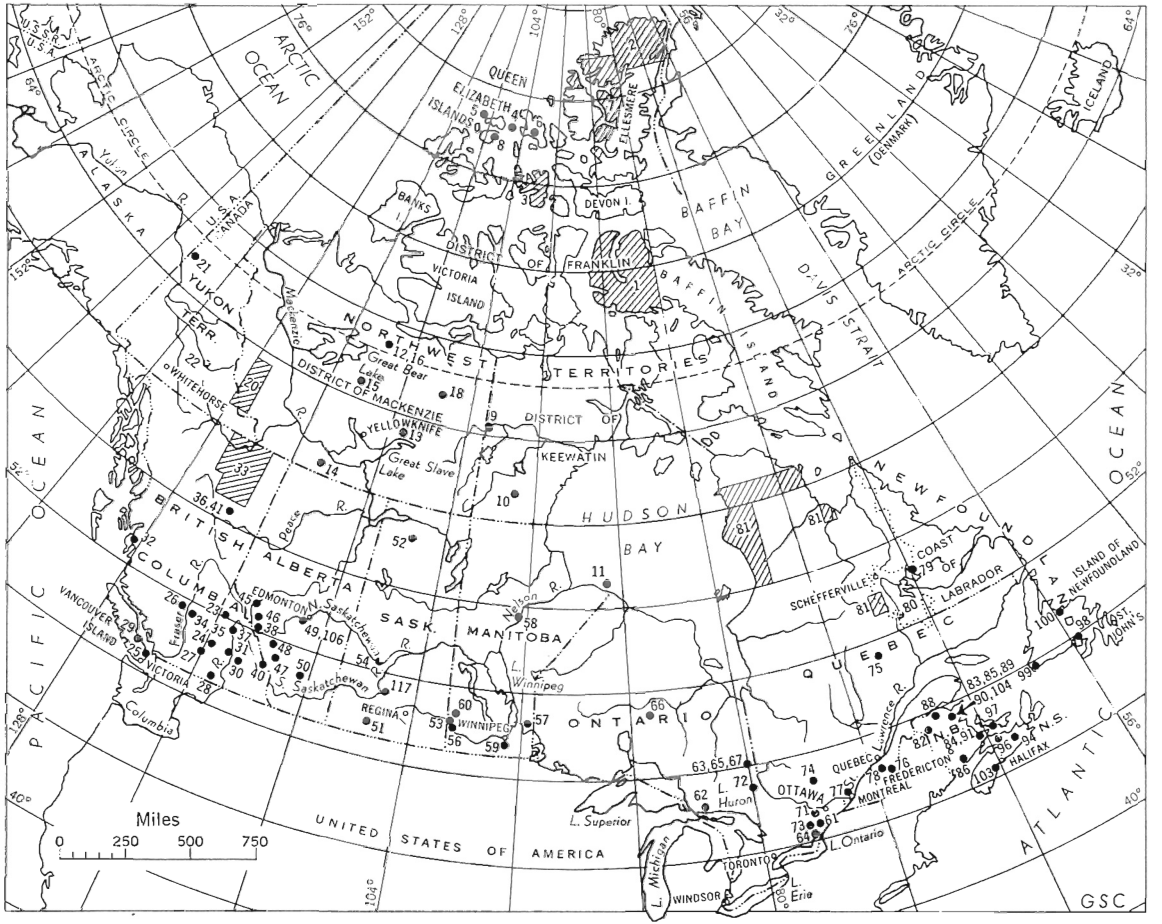

Figure 1. Map showing distribution of most of the 1963 Geological Survey field parties. Numbers correspond with numbered abstracts in text.

SUMMARY OF ACTIVITIES: FIELD, 1963

INTRODUCTION

The Geological Survey has issued early in each year since 1958 a brief report of the field work undertaken by its officers during the previous summer. The first five such reports, known as Information Circular Nos. 1 to 5, appeared in various formats and are now out of print. The sixth report, which dealt with the 1962 field season, was issued as Paper 63-1 in the Survey's 'Paper' Series; its format is used on the following pages.

Each abstract-like statement on the following pages was submitted by the field officer or officers concerned by October 1, 1963, and received only cursory editing in order to permit early publication. 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 that may result 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 31 C E 1/2 or 31 C) 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, 31 C/1 E 1/2 or 31 C/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 1963 field work will be released during 1964. The release dates of such 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.

The following reports on field activities undertaken during 1963 are arranged primarily by geographic unit (province, territory, or district) and secondarily by alphabetical order of authors' surnames. An author index and a subject index are included at the end of the report for easy reference. The locations of most of the field parties are shown on Figure 1.

DISTRICT OF FRANKLIN

1. OPERATION ADMIRALTY, NORTHWEST BAFFIN ISLAND

R.G. Blackadar

See Bulletin 157 - JPT
Bulletin 191 - RGB

This project, supported by two helicopters and one Piper Super Cub aircraft, completed the reconnaissance geological mapping of northwestern Baffin Island west of longitude 80° and north of Fury and Hecla Strait, an area of about 55,000 square miles. Four traverses were also made by W.L. Davison south of Eclipse Sound and on Bylot Island east of the map-area. Samples were collected from the prospect being developed by Baffinland Iron Mines at Mary River, also east of the map-area. A meteorite fall, reported by Eskimos to have occurred more than 10 years ago, was investigated but no remains could be located in the indicated area of impact.

R.G. Blackadar was in charge of the operation and was assisted in mapping the Precambrian areas by W.L. Davison and T.O. Frisch, a graduate student. H.P. Trettin carried out stratigraphic studies in Palaeozoic strata, assisted by A.A. Petryk, a graduate student. B.G. Craig examined the surficial deposits.

Reconnaissance mapping by Blackadar and Lemon in 1954 established the stratigraphic sequence in Admiralty Inlet area; this sequence could be recognized throughout the region mapped in 1963 although there are facies changes in some formations. Upper Proterozoic strata in the northern part of the map-area include at least 8 formations and exceed 12,000 feet in thickness. To the south, near Fury and Hecla Strait, only two formations are present but comparable thicknesses obtain. The Upper Proterozoic rocks rest unconformably on gneissic and granitic rocks exposed mainly in the southeastern quadrant of the map-area. Dykes and sills of gabbro cut both the gneissic and Upper Proterozoic strata and a few traces of copper and nickel minerals are associated with these.

Lower Palaeozoic strata with a total thickness of 5,600 feet cover about half of the map-area. A clastic sequence, the Gallery and Turner Cliffs Formations, is very thin or absent in the southern and western parts of the area. The overlying carbonate succession, Ship Point, Baillarge, and Read Bay Formations probably originally covered the entire area. Present outcrops of the Read Bay Formation, however, are confined to western Brodeur Peninsula. Isopachs and about 400 crossbedding altitudes indicate that the clastic sediments were derived from the northwest and southeast and deposited in a basin, the axis of which plunges from the head of Admiralty Inlet northeastwards across central Borden Peninsula. The Ship Point dolomite was originally assigned to the Middle Ordovician, but is now known to include some Lower Ordovician strata. A disconformity was recognized in central Borden Peninsula between the Ship Point and Baillarge Formations. The Baillarge Formation of Late Ordovician age, in the type section, has been extended into the Silurian.

Small occurrences of hematite were found in the Society Cliffs Formation southeast of Adams Sound and other hematite-rich rocks were observed in the Gallery and Turner Cliffs Formations and also in the Proterozoic quartzites north of Fury and Hecla Strait. None of these appear economic. Porous breccias are abundant in the Read

Bay Formation and contain bituminous matter. If encountered anywhere in the subsurface these strata are potential petroleum reservoirs. However, in the present map-area they occur only in the upper levels of a dissected plateau.

1a. SURFICIAL GEOLOGY, OPERATION ADMIRALTY

B.G. Craig

The northern half of the map-area (47 E, F, G, H; 48 A, B, C, D; parts of 57 E, H; 58 A, D) is almost completely devoid of the common glacial landforms indicating the former presence of widespread glacial ice. In some of the major valleys, however, end and lateral moraines, generally at or close to the sea-coast, and small patches of drumlins indicate glacial flow towards the sea. Erratics are present in all the inland areas at all elevations and these, along with ice-marginal channels that are found along nearly all the valleys indicate that the area was at one time completely covered by moving glaciers.

In the southwest part of the map-area there is widespread evidence of glaciation. A broad morainal zone extends along both sides of the trough occupied by Bernier Bay and Berlinguet Inlet and an intermittent morainal ridge extends northward from near the east end of Berlinguet Inlet for about 60 miles inland from the west side of Admiralty Inlet. Drumlin fields indicate glacial flow into the Berlinguet - Bernier trough.

Much of the southeast part of the map-area is also monotonously free of the common glacial landforms, although drumlin fields indicate glacial flow northward toward Milne Inlet and southward into Murray Maxwell Bay.

The elevation of the marine limit varies throughout the map-area and is complicated apparently by the presence of late tongues of ice in some of the major valleys and troughs while others were ice free. The high scarp-bound coasts of much of the northern part show no evidence of this limit except for high deltas near some of the valley mouths. In the south, high beaches, deltas, and the lower limit of undisturbed ground moraine give a clearer indication.

In general the marine limit seems to be highest at about 400 feet in the southwest corner of the map-area, decreases to nearly 300 feet in the southeast corner, to about 250 feet along Lancaster Sound, Navy Board Inlet, and the south end of Bell Bay, and to slightly over 200 feet at the end of Milne Inlet.

2. STRATIGRAPHIC STUDIES IN PERMO-CARBONIFEROUS TO CRETACEOUS BEDS NEAR TANQUARY FIORD, ELLESMERE ISLAND

R.L. Christie (See Paper 68-31)

Some twenty sections of Permo-Carboniferous to Cretaceous beds were measured as preliminary work to the proposed northeast Ellesmere Island mapping project. Significant findings are: (a) Permo-Carboniferous beds exhibit considerable lateral variation

in lithology and thickness—confirming the suggestion that shoreline facies are present; (b) the Triassic Heiberg Formation rests disconformably on beds of various ages, and on the pre-Carboniferous basement at certain places; a post-Penn-Permian, pre-Heiberg period of earth movement is thus established. A major fault zone between Tanquary and Hare Fiords is continuous with the Lake Hazen fault zone, which extends in a wide arc southwest from Lake Hazen through the head of Tanquary Fiord and to and along the north shore of Hare Fiord—an arc distance of about 250 miles. The zone is evidently one of thrust movement, with the northwest side uplifted.

3. BATHURST ISLAND

J.W. Kerr

See Mem 378

J.W. Kerr, along with Peter Temple, completed the first year of a two-year study of the stratigraphy and structure of Bathurst Island (86 G, H; 69 A, B). A preliminary paper including a map of the region north of the Caledonian River dome and east of Erskine Inlet, is in preparation.

The oldest rock exposed on the island is the Cornwallis Formation, a fine-grained limestone with some petroliferous sugary dolomite. The conformably succeeding Cape Phillips Formation is about 1,400 feet thick, and is predominantly a dark grey to black, non-calcareous to slightly calcareous, graptolitic shale and siltstone. At the base of this formation there occurs an interval in which carbonates are interbedded with the shales. With some variation, this interval increases in thickness southward. The following thicknesses are recorded: at Stuart Bay, 225 feet of mainly limestones; at Dundee Bight, 130 feet of mainly mottled limestone and dolomite, and limestone; at Goodsir Inlet, 200 feet of mainly dark brown petroliferous, often vuggy and nodular dolomite.

Over most of the island west of longitude 99°, the Cape Phillips Formation is succeeded gradationally by a calcareous fine-grained clastic rock of latest Silurian and early Devonian age, which includes the Bathurst Island, Stuart Bay, and Eids Formations. Limestone conglomerate horizons that occur in this interval are thicker and more numerous in its eastern exposures, thinning and disappearing toward the west. In the eastern part of the island, a structural disturbance occurred in post-Cape Phillips time, developing an unconformity in those parts of the island southward from Cockscomb Peak and eastward from Caledonian River. The associated unconformity merges to a disconformity to the north and west. In the Driftwood Bay area the unconformity is overlain by a thin quartz sandstone, the Driftwood Bay Formation, which seems to be but the basal beds of a mainly dolomitic unit, which is thick and extensive in the eastern parts of the island. This dolomite unit includes rock mapped at Driftwood Bay as the Sherard Osborne Formation, and the lower part of that mapped as the Blue Fiord Formation[1]. This dolomite is equivalent to,

---

[1]Fortier, Y.O., et al.: Geology, Bathurst Island Group, District of Franklin, Northwest Territories; Geol. Surv. Can., Map 18-1959(1959).

and grades westward into the upper Bathurst Island Formation, the Stuart Bay Formation, and probably part of the Eids Formation.

The Middle Devonian Blue Fiord Formation has its greatest thickness in the eastern part of the island, thinning westward to as little as 45 feet of coralline limestone at Dundee Bight and Helena Island.

Of the two areas of gypsiferous rocks that occur northeast of Purcell Bay, the southern one is best known. It is a large lens-shaped mass of dark grey to black gypsiferous limestone and shaly limestone with minor light grey gypsum which, although highly brecciated, retains an overall plate-like shape. Black shale, bearing late Lower or Middle Silurian graptolites was found in this mass, where it appears to lie stratigraphically slightly above the main gypsiferous limestone. The whole mass lies in a syncline where it is stratigraphically younger than the Bathurst Island and older than the Eids Formation. This block, which now occurs stratigraphically in the latest Silurian or early Devonian, is mainly limestone of possible early Cape Phillips (late Ordovician to early or Middle Silurian) age, and may have slid to the present position from a high within the Cape Phillips shale belt.

How far westward was the extent of the first-formed north-south structural belt of the eastern part of the island is not yet known for certain; however, it is probably reflected in the shapes of May and Erskine Inlets. Although the Eids Formation and younger rocks in the anticline trending through Dundee Bight were not seen to show a break in their general east-west trend, the older rocks, at least the Cornwallis and Cape Phillips Formations, do so. A doubly plunging anticline in these older rocks on the east shore of Dundee Bight may be an early north-south fold subjected to the later east-west folding. The Bathurst Island to Stuart Bay clastic unit spans the time of first folding; an unconformity could not be observed within this unit at Dundee Bight as deposition was probably continuous; however, a local thinning over the crest of the early fold is suspected. Such a thickness variation could account for the simplicity of trend of the younger rocks.

In the area of Cockscomb Peak is a new and unnamed formation, which lies unconformably upon Okse Bay and older rocks; it is several hundred feet thick, comprising light coloured quartzose sandstone at the base, overlain by dark green siltstone, bearing plant remains and brachiopods.

3a. SURFICIAL GEOLOGY, EASTERN BATHURST ISLAND

W. Blake, Jr. (See Paper 64-30)

Field work was devoted to a reconnaissance study of eastern Bathurst Island. Brief visits were made also to Lowther Island in Barrow Strait and to Helena Island north of Bathurst Island (68 NE; 69 SE, SW).

Most features that commonly indicate glaciation, such as striae, crag-and-tail hills, and drumlins, are virtually nonexistent in the areas visited on the ground (striae were seen in only two localities about 200 yards apart on northern Bathurst Island), and a

study of the airphotos revealed that drumlins are extemely rare anywhere on Bathurst Island. However, the widespread occurrence of erratics, the presence of marine shells in till at high elevations, and an abundance of marginal drainage channels show that Bathurst Island and the adjoining minor islands have been glaciated at some time. Apparently during the last glaciation (classical Wisconsin) a zone along the east coast of Bathurst Island, and Lowther Island, were covered by Laurentide ice, whereas most or all of the remainder of Bathurst Island probably was covered by local ice.

Peat deposits several feet thick, and at least in part probably interglacial in age, are widespread on Bathurst Island. In many localities they are exposed at the surface, but in a few places deposits of till or marine silt were observed overlying peat.

The limit of postglacial marine submergence varies considerably on Bathurst Island. In general it is lower along the east coast of the island than in the inlets extending southward from the north coast. In these inlets the marine limit is close to 400 feet above sea-level.

4. MARINE GEOLOGY PROGRAM, PRINCE GUSTAF ADOLF SEA

J.I. Marlowe See Paper 66-29

An investigation of sedimentation in Prince Gustaf Adolf Sea was continued during the 1963 field season. Geological Survey personnel attached to the Polar Continental Shelf Project were based at Isachsen, Ellef Ringnes Island, District of Franklin, and operated over the western half of the sea. The purpose of the investigation was to provide information on the sedimentary environment and late Pleistocene history of the region. To do this, sea-bottom core samples were obtained with a piston-type coring device.

Cores up to 5 feet long indicate cyclical, suspended-load sedimentation over much of the area studied. Undisturbed laminae suggest that no bottom fauna existed during the time of deposition of this fine sediment. A light brown upper layer, common to all cores taken, contains no fine bedding and has abundant microfaunal remains. A textural coarsening sometimes accompanies the change in colour in the tops of the cores. Studies are planned to relate this widespread change in sediment type to provenance and depositional environment.

Fine- to medium-grained quartzose sand layers in the lower parts of some cores may be related to lower stands of sea-level during late Pleistocene glacial stages. The bottom topography of the western part of Prince Gustaf Adolf Sea suggests that subaerial erosion may have influenced its present form.

5. MARINE GEOLOGY PROGRAM - ARCTIC OCEAN

B.R. Pelletier

Offshore sampling begun in 1960 over the Arctic continental shelf adjacent to the western Queen Elizabeth Islands was continued. In 1963 the study extended 50 miles across the shelf between the northwestern tips of Borden and Prince Patrick Islands.

Work was undertaken to obtain data on bottom topography, sediments, and fauna. Logistical support in the Arctic was provided by the coordinator of the Polar Continental Shelf Project. Soundings were made by means of a line and metre block, and bottom samples were obtained by means of coring tubes and grab samplers. The sediments and fauna are presently undergoing analyses at the Bedford Institute of Oceanography, Dartmouth, and at the Geological Survey of Canada, Ottawa.

Submarine topographic features exist similar to those on adjacent islands. Long, deep valleys and broad plateau-like features and shoulders extend offshore from the islands 40 to 50 miles, and then merge into the relatively uniform surface of the continental shelf proper. Between Borden, Brock, and Prince Patrick Islands, shallows occur at 35 to 50 metres below sea-level. A few miles east and west of these shallows are depths greater than 400 metres, suggesting drowned topographic basins separated by a submerged watershed.

Sediments consist of silts and muds in the troughs at greater depths, and coarse quartz sands and polymict gravels at shallow depths, which is similar to sediments on coastal segments of adjacent islands. The latter suggests considerable current action together with the occurrence of a younger geological formation (Beaufort?) on a submerged headland.

5a. MARINE GEOLOGY PROGRAM - EASTERN ARCTIC ISLANDS

B.R. Pelletier

This was part of an oceanographic program of the Bedford Institute of Oceanography carried out aboard the CCGS "Labrador" of the Department of Transport. Studies were made in the waters between and including northern Baffin Bay and Hall Basin to the north, in that narrow stretch of water separating Greenland from Ellesmere Island. The program included an oceanographic investigation of Jones Sound lying between Devon and Ellesmere Islands.

The purpose of the geological project was to obtain bottom samples, data, and geophysical records. The geophysical records will be interpreted by scientists at the Bedford Institute; as well, the sediments will be processed for analyses there.

Records, soundings, and samples indicate a geological unity of the Arctic Islands as previously suggested by Fortier and Morley[1], and that this geological unity also extends to northern Greenland at least. In the extreme north there does not appear to be a major rift system. The submarine topographic features as well as these features of the adjacent shores suggest a purely physiographic origin of subaerial erosion by rivers and glaciers (along earlier structural trends, presumably), followed by submergence and presently emergence.

---

[1]Fortier, Y.O., and Morley, L.W.: Geological unity of the Arctic Islands; Trans. Roy. Soc. Can., vol. 50, Ser. III, pp. 3-12 (1956).

In Jones Sound the geological unity of the Arctic Islands was again substantiated, and a similar physiographic history as above stated was established. Bottom sediments appear to be about 50 to 60 feet thick in the troughs and are extremely fine grained. Shoreward the modern sediments are thinner and in some instances coarser.

6. STUDIES OF GYPSUM DOME EMPLACEMENT, AXEL HEIBERG AND ELLESMERE ISLANDS

no info!

W. M. Schwerdtner

An investigation of gypsum-anhydrite diapirs was carried out on Axel Heiberg and Ellesmere Islands by a Geological Survey party attached to the Polar Continental Shelf. The principal object of the project was to provide information on the mechanics of evaporite emplacement. Two gypsum-anhydrite diapirs were studied and mapped in detail: South Fiord Dome, off Strand Fiord in the western part of Axel Heiberg Island, and Mokka Fiord Dome near the east coast of Axel Heiberg Island. In addition studies were made of the parent gypsum-anhydrite in its normal stratigraphic position in Hare Fiord on Ellesmere Island.

7. AXEL HEIBERG AND ELLESMERE ISLANDS

no info!

R. Thorsteinsson and Peter Harker

A program of reconnaissance mapping and stratigraphic studies was conducted in selected regions of Axel Heiberg Island and western Ellesmere Island. The program was designed to augment and complete the reconnaissance mapping carried out on these islands in 1961 and 1962 under the direction of Thorsteinsson. The reconnaissance mapping of Bjorne Peninsula was completed and stratigraphic studies of late Palaeozoic rocks were conducted over all of the region under investigation.

A base camp for supply and radio-communication was established at Eureka and a number of other camps were occupied during the season. A large number of unprepared landings were made for stratigraphic control. Transportation in the field was by a single Piper Super Cub aircraft operated by a pilot-engineer.

8. BOTTOM SEDIMENT AND FORAMINIFERA STUDIES IN EAST BAY, MACKENZIE KING ISLAND

G. Vilks

During the field season sampling of bottom sediments was carried out along the shores of East Bay, Mackenzie King Island. The purpose of sampling was to commence a detailed study of bottom fauna and to determine the relationship of faunal distribution to bathymetry and bottom sediments in an enclosed bay of the Arctic environment. Logistics were provided by the Polar Continental Shelf Project.

A total of 176 oceanographic stations were distributed in twenty-two 2-mile traverses extending seaward from selected points of the shore. Samples were taken at depths ranging from 4 to 283 metres.

Field observations indicate that the bottom topography is irregular, forming deeps at both south and north shores of the bay. In the north-shore deep the sediment is black, but in the shallower waters of the middle of the bay the typical colour is brown to light brown. Angular pebbles up to 20 cm in diameter occur in the deep off the north shore, and sand and silt along the shores close to deltas. The coarse sediment grades to mud, generally around 800 feet from the shore.

Typical benthonic cold-water Foraminifera that occur above 200 metres elsewhere in the area are found at depths close to 300 metres in East Bay. This would indicate that the cold surface zone of the Arctic waters may extend to deeper levels within the bay.

DISTRICT OF KEEWATIN

9. GEOLOGICAL INVESTIGATIONS OF THE DUBAWNT GROUP, NORTHWEST TERRITORIES

J.A. Donaldson

The author began a study of sedimentary and volcanic rocks of the Dubawnt Group, as outlined by helicopter reconnaissance in Operations Baker[1] and Thelon[2]. Critical areas were mapped in detail, and a paleocurrent study was initiated.

The sedimentary rocks bounded by Baker, Pitz, Bissett, and Andrews Lakes were found to underlie unconformably the "typical Dubawnt" sandstones of the Thelon plain, and they should therefore be recognized as a separate unit (tentatively called "Kazan Group"). Within the volcanic assemblage, individual flows are mappable, and laharic deposits appear to be abundant. Most of the volcanic rocks lie with angular unconformity above the Kazan sedimentary rocks, but are older than the Dubawnt (restricted sense) sandstones. This observation is significant in that numerous "Dubawnt" ages are based upon radioactive determinations for samples of these volcanic rocks.

Preliminary study of primary structures (crossbedding, ripple-marks, pebble orientations) indicates predominant westward transportation for both Dubawnt and Kazan sandstones.

An outcrop of Palaeozoic limestone was found north of Aberdeen Lake near abundant rubble earlier reported[1]. Fossils were collected at this locality and from the small Palaeozoic outlier at Nicholson Lake.

10. KOGNAK RIVER AREA

K.E. Eade

A new group of sedimentary rocks consisting of conglomerate, quartzite, and siltstone has been outlined in Kognak River area (65 G E 1/2, 65 H W 1/2). This group unconformably overlies the Archaean volcanic and sedimentary rocks and is overlain unconformably by the younger early Proterozoic (?) (Hurwitz) rocks. Disseminated pyrite is abundant in the quartzite of this group.

The basal Hurwitz quartzite of the youngest sedimentary group varies from 700 to 4,000 feet in thickness and locally a thick conglomeratic phase occurs below the quartzite. Ripple-marks are abundant in the quartzite and over 500 readings on them indicate a marked northwest trend with a northwest asymmetry.

---

[1]Wright, G.M.: Geological notes on Central District of Keewatin, Northwest Territories; Geol. Surv. Can., Paper 55-17 (1955).

[2]Wright, G.M.: Geological notes on Eastern District of Mackenzie, Northwest Territories; Geol. Surv. Can., Paper 56-10 (1957).

The Archaean volcanic rocks in the northeast quarter of the map-area are a heterogeneous unit consisting of andesite, pillowed in part, gabbro, dacite, quartz-latite, rhyolite, agglomerate, and tuff. In some localities the tuffs, ranging from acidic to basic composition, comprise the major part of the volcanic unit. Associated with the volcanic rocks are bands of iron formation of several types, banded quartz-magnetite, quartz-jasper-hematite, and quartz-magnetite-hematite. Other Archaean sedimentary rocks are abundant greywacke and minor dolomite bands.

Numerous normal faults, some of major magnitude, cut all the rocks of the area with the exception of the youngest diabase dykes. Two major east-trending thrust faults are present with the old Archaean volcanic and sedimentary rocks thrust from the south over the younger early Proterozoic (?) (Hurwitz) sedimentary rocks.

Folds in the eastern part of the map-area trend principally north to northeast, but there is evidence as well of the earlier west to northwest trend of folding.

11. SEISMIC REFRACTION SURVEY, HUDSON BAY

G.D. Hobson

Nine reversed seismic refraction profiles were shot along the coast of Hudson Bay southeast of Churchill. Six of these positions are located in a line from York Factory to Kettle Lake near Gillam, Manitoba. Depths of various strata down to the Precambrian surface have been computed. There are definite contrasts in seismic velocities observed in the various lithologic units. A cross-section has been constructed for the Kettle Lake - York Factory profile. A depth of approximately 1,800 feet to the Precambrian surface at York Factory is indicated. The intermediate strata pinch out as the profile proceeds southeast from Hudson Bay. There is no disagreement with present known depths and thicknesses.

DISTRICT OF MACKENZIE

12. DIAMOND DRILLING ACTIVITIES, MUSKOX INTRUSION

D.C. Findlay

Drilling of the Muskox Intrusion in the Coppermine River area (parts of 86 J and 86 O) began in May 1963. D.D.H. Muskox South, collared on the northwest shore of Speers Lake, was completed September 1st at a depth of 4,000 feet. The hole penetrated the middle and lower units of the central layered series, the marginal zone of the body, and intersected the west intrusion wall at depth. D.D.H. Muskox North, collared in roof rocks 8 miles north of Muskox South finished August 13th at a depth of 3,593 feet. The hole penetrated the upper border zone and upper units of the layered series and provided about 800 feet of overlap section with the upper horizons penetrated in Muskox South. Core recovery from both holes was good and a complete section through the intrusion from roof to footwall has been obtained.

A third hole, D.D.H. Muskox East, has been started on the northeastern limb of the intrusion, to obtain a thicker and more complete sequence of the upper granophyric rocks, and to obtain material for investigation of lateral variations in the layered sequence. On September 10th this hole was at a depth of 1,700 feet, in peridotite of the layered series.

Temperature profile measurements have been made in D.D.H. Muskox North to depths of 3,500 feet, and additional in-hole geophysical studies (seismic, electrical, heat-flow) will be carried out in the fall of 1963. Preliminary results from temperature measurements suggest that permafrost depth is about 700 feet at the Muskox North site.

13. BENJAMIN LAKE MAP-AREA

W.W. Heywood

Field work in Benjamin Lake map-area (75 M/2) was completed in 1963. Greenstone and amphibolite derived from basic volcanic flows and pyroclastic rocks form a northerly trending belt in the western part of the area. Intermediate to acid flows and pyroclastic rocks overlie the basic volcanic rocks and form two parallel belts in the central-southern part of the map-area. Crystalline limestone, cherty crystalline limestone, and calcareous intermediate to acid volcanic breccia form a more or less continuous unit 10 to 300 feet thick near the top of the volcanic sequence, and between the volcanic and sedimentary rocks.

Slate and phyllite overlie the volcanic rocks in the northwestern part of the area. Biotite schist, knotted schist, and hornfels containing andalusite and cordierite porphyroblasts are derived from greywacke and subgreywacke. Gneiss and migmatite occurring in the southwest are derived in part from the volcanic and sedimentary rocks.

Massive to foliated medium-grained biotite granite containing few to abundant orthoclase porphyroblasts forms the

eastern and western boundaries of the area. Many small granitic plugs and sills intrude the metasedimentary rocks. Two granitic plugs in the southwest are in part strongly sheared and as they contain meta-diabase dykes are possibly older than the other granitic plugs. Samples of the various granitic rocks were collected for age determination studies.

Mineral occurrences have been known in the area for several years. Although no new mineral discoveries of importance were found, pyrite, pyrrhotite, and chalcopyrite are of common occurrence. Massive sphalerite is exposed in a pit on the Joe Indian Mountain Mines property. Chalcopyrite and a small amount of native copper were noted in frost-heaved rubble at 63° 05 1/2'N, 110° 55 1/4'W.

14. DEVONIAN STRATIGRAPHY AND PETROLOGY, HAY RIVER (85 C) AREA

Esther R. Jamieson

Field work in 1963 established with greater refinement the facies of carbonate rocks and extended the area mapped in 1962[1]. The reef in the lower part of the Alexandra Member, Twin Falls Formation on Hay River outcrops for some 30 miles along a nearly continuous escarpment westward to near Heart Lake, where it reaches maximum development and terminates abruptly. The reef outcropping on the escarpment has been previously correlated with a biostromal unit in the Hay River Formation that lies 40 feet stratigraphically below the Alexandra Member.

The lower part of the Alexandra Member is variable in composition and manner of accumulation. While much of the limestone may be described as a stromatoporoid reef and was developed through in situ growth, some transport of material has also been involved. Clusters of reef-knolls or mounds are present locally within the main reef body.

A sequence of carbonate muds and pelleted muds is draped over the irregular upper surface of the reef and can be traced from Hay River to Heart Lake with little change in lithology. These beds contain Amphipora skeletons, algal pisoliths, calcite-filled burrows, and sun cracks, which suggest a shallow lagoon-type milieu for the sequence.

There appears to be a relationship between growth form and size of the stromatoporoids and the environment of deposition of the beds in which they occur. Further laboratory investigations will be undertaken to demonstrate whether this relationship is reflected in the species of stromatoporoids.

---

[1] Jamieson, E.R.: Stratigraphy and petrology of Upper Devonian rocks, Hay River area; (abst.) in Summary of Research: Field, 1962, compiled by S.E. Jenness; Geol. Surv. Can., Paper 63-1 (1963).

15. GRANT LAKE AREA

J.C. McGlynn

Mapping of the Grant Lake area (86 C 15 E 1/2) was completed during the past summer and a small part of the adjoining sheet (86 C/16 W 1/2) was mapped. Rocks of both the Snare and Cameron Bay Groups outcrop in the area but are not in contact. The Snare Group consists of finely interbedded silts and shales that contain beds of dolomite and quartzite. These rocks are overlain conformably by basic volcanic rocks, and many thick basic sills occur in the sediments just below the volcanic rocks. The Cameron Bay Group consists of arkose and red shales, commonly interbedded, and conglomerate. Thin beds of dolomite occur locally in the sequence. The sediments are both overlain and underlain by volcanic rocks of various compositions, most of which are porphyritic with feldspar phenocrysts. These rocks are cut by granitic rocks of various compositions and by intrusive acidic feldspar and locally quartz porphyries. Diabase dykes are the youngest rocks exposed in the area.

Extensive migmatite zones are developed in the contact areas between the older granitic rocks and Snare sediments. The older granitic rocks are not in contact with the Cameron Bay Group. The later granitic rocks, which are high level intrusions, cut both groups of sedimentary rocks and the migmatites.

The Snare sedimentary and volcanic rocks are thrown into northwest- to north-trending folds. These rocks are slightly metamorphosed except near the older granitic rocks where knotted schists are developed. The Cameron Bay Group is slightly metamorphosed and appears to be less intensely folded, with folds trending north. All rocks are cut by northeast- and north-trending faults. Quartz stockworks occur along some of these faults.

Four granitic bodies in various parts of the region were sampled for rubidium-strontium age determinations, as part of the regional correlation study.

16. PRELIMINARY PALAEOMAGNETIC STUDIES ON THE MUSKOX INTRUSION

W.A. Robertson

The object of this survey was to obtain the relative ages of (1) the Muskox layered intrusion, (2) the serpentinization of certain layers, (3) the intrusion of older and younger sets of diabase dykes, and (4) the extrusion of overlying lava flows, using the directions of natural remanent magnetization of each group. Secondary objectives were the study of ancient secular variation and the calculation of pole positions from rocks of which the age has been determined radiogenically, to improve the time basis for the polar wandering curve for North America with which other North American Proterozoic palaeomagnetic data may be compared.

Three hundred and thirty samples, oriented by sun compass and clinometer, were collected. The large number is necessary to allow statistical analysis of the results. Samples were

taken from 22 layers of the Muskox Intrusion, the marginal layers, baked contact rock, and the feeder. Samples were also taken from 25 overlying lava flows and 26 associated diabase dykes.

The work involves 'cleaning' treatment and the measurement of magnetization directions in the laboratory of cubic specimens cut from the samples collected in the field. It is hoped that preliminary results will be available early in 1964.

17. STUDY OF DRILL CORES, WINDY POINT, GREAT SLAVE LAKE

E.J. Tassonyi

Field work involved routine subsurface-data gathering and the examination of more than 18,000 feet of diamond-drill cores in the Windy Point - Prairie Lake area, drilled by the Windy Point Mining Company prior to and during 1956.

It is hoped that the core descriptions, and lithological, microfossil and macrofossil studies will help the correlation of rocks in this area with those in the lower Mackenzie River Valley.

18. BEECHEY LAKE (76 G) MAP-AREA

L.P. Tremblay

Some conglomerate and sandstone resting unconformably on both the Goulburn and Yellowknife-type sediments were mapped within the Bathurst trench. They are probably of Dubawnt age and related to the small mass of younger sediments near the source of the Ellice River.

The Bathurst trench is probably a graben as the above-younger sediments appear to have been down-faulting along and into it.

At least two cleavages were recognized in the Yellowknife-type sediments: an old flow cleavage probably related to the Slave folding, and a superimposed fracture one. The trace of these two cleavages on the bedding planes is a lineation plunging steeply either north or south. A third cleavage of the fracture type occurs locally and may represent a period of general relaxation.

The distribution of the metamorphic zones in the Yellowknife-type sediments suggests, as the many gabbro sills and dykes mapped last year near the Bathurst trench[1], two ages of granite. The granite masses that have no metamorphic aureoles are probably early, as some are known to be of Slave age. The nodular metamorphic zones that were mapped appear to be related to the large granite masses that outcrop near the east, south, and west boundaries of the map-area, but unrelated in their distribution to the early granite masses. These metamorphic zones may then be related to granite bodies of Churchill age.

A few small outcrops of banded iron formation were noted. They all carry magnetite and locally pyrite. They are all fine-grained.

---

[1]Tremblay, L.P.: Geology of Beechey Lake map-area; (abst.) in Summary of Research: Field, 1962, compiled by S.E. Jenness; Geol. Surv. Can., Paper 63-1 (1963).

DISTRICT OF MACKENZIE AND YUKON TERRITORY

19. UPPER FLAT RIVER AREA

S.L. Blusson

The area contains over 25,000 feet of sedimentary rocks ranging in age from Precambrian to Upper Ordovician. Three regional unconformities were recognized: at the base of the Cambrian, between Lower and Middle Cambrian, and between Middle Cambrian and Upper Ordovician.

Precambrian strata consisting of at least 15,000 feet of indivisible slates, phyllites, and fine-grained quartzites underlie large areas northeast and southwest of Flat River valley. These rocks are overlain abruptly by fossiliferous Cambrian dolomites, sandstones, limestones, and shales, which form the core of a complex syncline along Flat River. The Cambrian strata are in turn overlain unconformably by a widespread unit of Upper Ordovician graptolitic shales and chert.

All rocks are regionally deformed into a system of upright to moderately overturned northwest-trending folds.

Biotite quartz monzonite stocks of Cretaceous age occur on both sides of Flat River and in the immediate vicinity of the Canadian Tungsten mine. These bodies are crosscutting but deflect regional structures locally.

Sheelite deposits with minor sulphides are confined to a pure basal Cambrian limestone unit that is traceable for several miles on the southwest side of Flat River. Deposits are restricted to within a few hundred feet of the intrusive rocks and appear localized by jointing. No new deposits were found, but the area northeast of Rabbitkettle River seems worthy of further prospecting, particularly where Lower Cambrian limestones are intruded by granitic stocks.

20. OPERATION NAHANNI

H. Gabrielse

Operation Nahanni, a geological reconnaissance survey on a scale of 1 inch to 4 miles, covered about 12,500 square miles in Logan and Mackenzie Mountains of Yukon Territory and the adjoining District of Mackenzie. Mapping was completed in Flat River (95 E) and Glacier Lake (95 L) map-areas and in all but the northeastern corner of Wrigley Lake (95 M) map-area.

Stratified rocks include thick sequences of Proterozoic and Cambrian (?) slates, sandstones, grits, conglomerates, carbonates, and iron formation. Younger strata, ranging in age through Ordovician to Late Devonian are predominantly carbonate, but substantial units of shale occur in Ordovician - Silurian and Upper Devonian sequences. Ordovician and Silurian rocks change facies from carbonates in the northeast and north to graptolitic, dark-weathering, fine-grained clastic rocks to the south and southwest. Regional unconformities occur at the base of Middle Cambrian and Upper Ordovician sequences. More than 20,000 feet of strata are exposed east of Grizzly Bear Lake.

About one-quarter of Flat River map-area is underlain by medium- to coarse-grained granitic rocks that form two major batholiths and numerous stocks. Granitic rocks also outcrop southwest of South Nahanni River in Glacier Lake map-area.

A conspicuous andesitic or basaltic flow, or locally, two flows with an aggregate thickness of as much as 150 feet, occur in Ordovician strata in southeastern Glacier Lake map-area and have been traced for more than 32 miles along strike and 8 miles across strike. Several greenstone bodies, including flows, sills, and dykes of dioritic, gabbroic, and basaltic (?) composition were noted in Proterozoic (?) and Lower Palaeozoic rocks elsewhere in Glacier Lake and Wrigley Lake map-areas.

Regional trends vary from northwesterly to northerly. Strata within the area that includes granitic rocks are commonly tightly folded, but faults appear to be relatively minor. Open and tight and locally overturned folds, the latter type generally being restricted to the younger rocks, characterize a broad belt north and east of Logan Mountains. This belt of strata is separated from an area to the east and northeast that displays relatively gentle structures by a major zone of faults extending in a great arc convex to the northeast from Keele River in northwesternmost Wrigley Lake map-area to Little Dal Lake, thence, in an arc convex to the southwest, south and southeasterly to North Nahanni River.

Chalcopyrite, bornite, chalcocite, malachite, and azurite occur in bleached zones in the uppermost part of a red siltstone sequence east and north of Little Dal Lake. Tetrahedrite and secondary copper minerals have been found in several places in the structurally complex area north from Little Dal Lake to beyond Redstone River and specimens of zinckenite float were noted on a ridge 4 miles west of the mouth of Broken Skull River. Malachite occurs locally along the contact between maroon-weathering clastic sediments and overlying Ordovician carbonate rocks in Thundercloud Range on a southeast-trending spur 5 miles northeast of the peak, elevation 8,230 feet.

A thick sequence of conglomeratic mudstone, siltstone, and sandstone containing iron formation in a dark brown to brick red weathering lower part has been traced from North Nahanni River to Keele River near and roughly parallel to the major fault zone described above. East of Little Dal Lake an iron formation containing steely grey hematite and reddish orange jasper is about 100 feet thick. Pink and reddish siltstones that contain copper minerals near Little Dal Lake occur sporadically beneath a regional unconformity at the base of the conglomerate mudstone sequence to and beyond the Keele River.

A boulder containing stringers of galena was found in a pit dug at a camp site on an island in Seaplane Lake. The boulder appears to be of local derivation.

Gossans are abundant in rocks adjacent to granitic plutons in Logan Mountains and merit careful prospecting.

YUKON TERRITORY

21. BIOSTRATIGRAPHIC STUDIES OF THE CARBONIFEROUS AND PERMIAN ROCKS IN THE NORTHERN OGILVIE MOUNTAINS

E.W. Bamber

Several sections were measured in 116 F E 1/2, northern Ogilvie Mountains, through rocks of Carboniferous and Permian age, with emphasis on the detailed collection of fossils. The type sections of the Calico Bluff and Tahkandit Formations were visited in Alaska with a view to their correlation with equivalent rock units in the Yukon. This work was made possible by the assistance of the United States Geological Survey, which provided helicopter and boat transportation.

One week of preliminary reconnaissance and fossil collecting was done with Dr. G.C. Taylor in the northwestern corner of the Operation Liard area, in northeastern British Columbia.

22. DAM SITE INVESTIGATIONS

E.B. Owen

At the request of the Water Resources Branch of the Department of Northern Affairs and National Resources four potential dam sites were investigated on Stewart River, one of the larger tributaries of Yukon River. One of these sites, i.e. Fraser Falls, is presently being considered as a source of hydroelectric power by California Standard Oil Company for their newly discovered iron prospect. Another site was investigated on Lupie River near the settlement of Ross River. One site was investigated in Mackenzie River drainage basin. This site is in Frances River about 70 miles north of Watson Lake. To complete the dam site investigation in the northern part of Yukon Territory, commenced in 1962, one site was visited in Porcupine River about 12 miles downstream from the mouth of Bill River.

BRITISH COLUMBIA

23. ADAMS LAKE AND CANOE RIVER MAP-AREAS

R.B. Campbell

Adams Lake (82 M W1/2) map-area is underlain mainly by two groups of metamorphic rocks with which granitic rocks are associated. Tertiary (?) and Cenozoic basaltic volcanic rocks underlie small areas in the northwestern part of the area.

The two groups of metamorphic rocks come together along an irregular line, which extends in a zig-zag pattern from the south side of Raft Mountain to the central part of Adams Lake and from there to the south end of Seymour Arm. North and east of the line the rocks are a complex association of gneiss, schist, amphibolite, marble, pegmatite, and medium-grained granitic rocks. South and west of the line is a succession of phyllite, sericitic quartzite, limestone, and, particularly in the southern part of the area, meta-volcanic greenstone and greenschist. The latter group may be of Carboniferous or Permian age.

Granitic rocks form batholiths west from the north end of Adams Lake and east from the south slopes of Raft Mountain. Smaller intrusive bodies occur near the southeast corner of the map-area and along Scotch Creek north of the forks. A narrow body of serpentinite was found near the west boundary mid-way between Fadear and Sinmax Creeks.

Except for small areas of Tertiary (?) and Cenozoic volcanic rocks all the rocks in the southern third of Canoe River (83 D W1/2) map-area are metamorphic or granitic. The metamorphic rocks, commonly associated with much pegmatite, consist of gneiss, schist, amphibolite, marble, and phyllite. A body of biotite-muscovite granite underlies the mountains at the head of Murtle River north of Murtle Lake.

24. SURFICIAL GEOLOGY, VERNON (WEST HALF) MAP-AREA

R.J. Fulton

Surficial-geology mapping of Vernon west half (82 L W1/2) map-area was begun in 1963. Interest in this area was raised in part by a request for assistance from the British Columbia Department of Agriculture, with encouragement coming from those working with problems involving forest soils. In addition to the interest of those working directly with the surface materials, government and university personnel connected with fishery research look on the history of deglaciation as a possible answer to problems concerning the distribution and migration of certain species of fish.

The last ice-sheet retreated from the area by down-wasting with the uplands uncovered while inactive ice remained in the valleys. High-level kettled terraces indicate that lakes developed marginal to ice tongues in the Shuswap and Okanagan valleys. Lower non-kettled terraces show that the main valleys were occupied at

several levels by lakes larger than those present today. The outlets of these "nonglacial" lakes may have been controlled by crustal warping or ice dams outside the area of study.

Sand, silt, and gravel exposed below till in several places probably consists of both proglacial outwash and interglacial sediments. Wood collected from a section north of Shuswap Lake will permit radiocarbon dating of at least one of these subtill deposits.

Two thin bands of volcanic ash form well-defined marker horizons in post-glacial bog and alluvial deposits. The ash falls are tentatively correlated with the Mount Mazama eruption 6,700 ± B.P. Radiocarbon datings on organic material collected from above and below the two ashes and a petrographic study of the ashes will be used to test the validity of this correlation.

25. SURFICIAL GEOLOGY, COWICHAN LAKE AND DUNCAN MAP-AREAS

E.C. Halstead

The last major ice advance into the map-areas (92 C 16; 92 B 13) followed a south-southeast direction along the Strait of Georgia. Till deposited during this advance fills the valleys and rests upon older unconsolidated materials or bedrock. Deglaciation was accomplished with an advancing sea into which ice contact deltas as well as stony clays were deposited upon the till. Older Pleistocene deposits, consisting of gravel, sand, laminated silts and clays, stony clays, and peat underlie the till and are exposed in sea cliffs. Organic materials from these older deposits were collected at several localities for radiocarbon dating.

Bedrock is exposed over much of the Gulf Islands, except in the low areas where younger stony clays have accumulated, commonly overlying till.

Subtill sands and gravels provide a source of groundwater for the Cowichan Bay area. Four observation wells were established to provide data for further hydrological studies of this important aquifer.

26. STRATIGRAPHY AND CORRELATION OF LATE UPPER JURASSIC AND LOWER CRETACEOUS ROCKS OF TASEKO LAKES AREA

J.A. Jeletzky

No reliable lithological horizon markers have been found in the Lower Cretaceous and late Upper Jurassic rocks of Taseko Lakes (92 O) map-area. These rocks are characterized by irregular recurrence of the same lithological types and exceedingly strong lateral facies changes within short distances. Their subdivision, correlation, and structural interpretation is, therefore, only possible on a palaeontological basis. In the late Oxfordian to late Valanginian part of sequence Buchia (=Aucella) species are the best, and mostly the only zonal fossils available. So far as known to date, the zonal sequence

of Buchia species of the area is essentially the same as that already described by the writer[1] for other parts of Canadian Western Cordillera. The Hauterivian - Barremain and Albian marine rocks can be zoned with the aid of Inoceramus species and ammonites. The details of the zonal scheme remain, however, to be worked out. No Aptian marine rocks were seen and the Albian rocks seem to contain only minor marine intercalations. Late Oxfordian to Hauterivian - Barremian rocks are largely or (?) wholly marine.

In spite of its extremely complex tectonics and facies changes, the late Upper Jurassic and Lower Cretaceous rocks of the area are suitable for further research aimed at the establishment of a standard sequence of faunas of those ages for the Canadian Western Cordillera.

27. SAND AND GRAVEL DEPOSITS IN SOUTH-CENTRAL BRITISH COLUMBIA

S.F. Leaming

A field study of sand and gravel deposits in the south-central part of British Columbia (parts of 92 H, 92 I, 82 E, and 82 L) was commenced to learn something of the distribution and characteristics of the reserves. The survey was conducted by visiting all known producers as well as abandoned pits to obtain brief descriptions of the material regarding thickness, extent, and characteristics. Selected sieve analyses and pebble counts will be made to give some idea of quality and quantity. The work depends to a great extent on published surficial maps for the geological setting and extent of deposits.

28. GREENWOOD MAP-AREA

H.W. Little

About 65 per cent of the east half of Greenwood (82 E/2) map-area was mapped during the field season. The rocks other than plutonic may be tentatively divided into three assemblages: (1) mainly Palaeozoic, (2) mainly Mesozoic (Upper Triassic in part), and (3) Lower Tertiary. Assemblage (1), which includes Seraphim's Knob Hill Formation, comprises black phyllite, greenstone, amphibolite, limestone, lime-silicate rocks, chert, quartzite, and chlorite schist, and may be separated on the basis of regional metamorphism into two subdivisions. These in turn may be further divided into units that contain members that differ from those of other units. Assemblage (2), which is mainly Seraphim's Attwood 'Series', is composed of sharpstone conglomerate, limestone, lime-silicate rocks, tuff, lava, siltstone, black shale, and possibly flow breccia. Assemblage (3) comprises the Kettle River Formation and Daly's Midway Group.

Regional trends of assemblage (1) are in general east to southeast whereas those of assemblage (2) are northerly even where the two assemblages appear to occupy the same fault blocks, suggesting

---

[1] Jeletzky, J.A.: Late Upper Jurassic and early Lower Cretaceous fossil zones of the Canadian Western Cordillera; Geol. Surv. Can., Bull. 103 (in press).

a regional decollement. In addition some major and numerous minor faults have been discovered that divide the rocks into isolated fault blocks, and others are suspected. Major movement occurred on most faults in the Tertiary.

The plutonic rocks are Late Mesozoic and comprise serpentinites and granodioritic rocks. Tertiary intrusions form dykes and small bodies ranging in composition from syenite to gabbro.

The productive orebodies at Phoenix occur in rocks of Late Triassic age.

29. ALBERNI (SOUTHEAST QUARTER) MAP-AREA

J.E. Muller

Mapping of the southeast quarter of Alberni (92 F) was completed for preliminary publication.

The oldest Sicker Group (Permian and ? older) occurs in an axial zone, coinciding with the height of land, and in a smaller uplift north and south of Nanoose Harbour. It contains volcanic breccia and tuff, altered to greenstone, succeeded by a greywacke - argillite sequence, overlain by limestone.

North of Horne Lake the axial zone forms the Beaufort Range, consisting of the Karmutsen Group (Triassic), with massive, pillowed and agglomeratic basalt and minor tuff. Karmutsen lavas also occupy large areas east and west of the axial region.

Fossil-bearing Upper Triassic limestone and shale of the Quatsino Formation occur south of Sproat Lake, and limestone with diabasic dykes at the south end of Alberni Inlet is probably of the same age. No Triassic sediments occur east of the central uplift.

Granitic rocks occur throughout the area, but are notably missing in the axial zone.

The trend of pre-Cretaceous formations is north-northwest to north-northeast, cutting across the island.

The Upper Cretaceous Nanaimo Group with conglomerate, sandstone, shale, and coal occurs unconformably on all older formations, along the east coast and in the Alberni depression, with outliers towards the central uplift. The group is flat-lying, or in gentle, northwesterly trending folds.

Above granitic areas the Nanaimo sediments are commonly invaded by feldspar-porphyry sills, to several hundred feet thick.

Known mineral occurrences are mainly copper - iron sulphides, in shear zones of the Sicker Group, or together with magnetite replacement bodies in Quatsino limestone. Coal has been mined from the Nanaimo Group for over a century.

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

P.B. Read

Poplar Creek (82 K/6) map-area is underlain by the Lardeau Group in its eastern part, by a zone of Milford and Kaslo Groups with leucocratic quartz monzonite stocks in the central section, and by the leucocratic Kuskanax batholith in the western part. All formations of the Lardeau Group are represented within the map-area, though the phyllites and argillites of the Triune to Sharon Creek interval are thin and the metavolcanic rocks of the Jowett Formation are lenticular. A first phase of deformation caused the group to trend northwesterly and dip gently to the southwest with a second phase forming gently southeasterly to dominantly northwesterly plunging open, asymmetric folds with a well-developed northeasterly dipping axial-plane foliation.

The stratigraphy of the Broadview Formation of uppermost Lardeau Group is a basal grit and phyllitic grit unit, a grey phyllite and buff-weathering phyllitic limestone unit, and an upper grit and phyllitic grit unit.

The Milford Group consists of a basal white crystalline limestone to dark grey arenaceous limestone unit, a sporadically developed quartz-rich meta-sandstone, and an upper unit of buff to grey phyllite, shale, and meta-sandstone, all locally limy. A first phase of deformation produced northwesterly trending isoclinal folds with steeply southwesterly dipping axial planes, which are approximately coaxially refolded by a second phase of more open style. The Milford Group is separated from the Lardeau Group by a folded fault.

The Kaslo Group consists of amphibolite developed from porphyritic flows, amygdaloidal volcanic breccia, and limy tuffaceous sediments; a hornblende meta-diorite; and a serpentine, and lies along the eastern contact of the Kuskanax batholith. The group is contiguous with a unit of similar lithology that underlies the Milford Group and overlies the Broadview Formation.

The Kuskanax batholith has a southwesterly dipping contact and gneissic border of a few miles width. In the upper reaches of Poplar Creek North Fork similar gneissic intrusions form slivers apparently incorporated into the Milford Group. Within the Milford Group numerous random-textured semi-concordant stocks tend to lie in the axial region of folds.

31. GRANITIC ROCKS, THOR-ODIN AREA (PARTS OF 82 L/8 AND 82 L/9)

J.E. Reesor

Rocks of the Monashee Group, found in this area, consist of metasediments ranging from schist and biotite-quartz-feldspar paragneiss to marble, quartzite, and amphibolite, all in the sillimanite-almandine grade of metamorphism. Structurally enclosed by the metasediments is a variegated succession of gneisses, generally containing biotite ($\pm$ hornblende), quartz, and feldspar in varying

amounts. Many of these gneisses are clearly derived from a meta-sedimentary succession, but cores of antiforms contain gneisses derived from granodiorite and quartz monzonite. Gneisses apparently derived from metasediments are heterogeneous in appearance, ranging from mafic-poor to mafic-rich and from those with well-defined, alternating mafic-rich and quartz-feldspar layers to those with ill-defined, discontinuous, irregular layering.

The major structure consists of a domal core of gneisses centred on Odin Creek and the foot of the glacier below Mount Odin. West and south from this centre, both gneisses and meta-sediments are folded in large scale overturned folds that trend east-west south of the dome, and north-south west of the dome. East and northeast of the central core, gneisses engulf and flow out over antiformed structures of metasediments (quartzite, calc-silicate, and sillimanite-garnet-quartz-feldspar paragneiss).

Minor folds in the core of the dome show strong flowage features and trend generally north-south. Lineation may either maintain an east-west direction or be formed in the later north-south direction parallel with the minor fold axes. Minor folds in the zones south and west of the dome are apparently related to the major folding and fold axes, mineral lineation and major fold axes are parallel.

32. COAST RANGE PROJECT

J.G. Souther

Field work was devoted to reconnaissance mapping in the northern half of the project area (102 M, 93 D, 103 A, 103 G, 103 H, 103 J, 103 I, 103 P) with emphasis on shoreline exposures on the sea coast and principal lakes. Approximately 4,500 miles of shoreline were mapped by five geologists using small rubber boats deployed from a large motor vessel that served as a floating base-camp and office. Ground observations were made at intervals of approximately one-quarter mile along the shore and were supplemented by observations from boats and aircraft.

The mapped area lies in the central part of the Coast Range crystalline belt and is underlain by a complex of metamorphic and igneous rocks. Most of the metamorphic rocks are confined to three northwesterly trending belts separated by intervening belts of unlayered granitic rocks. The most westerly metamorphic belt runs through the outer islands (Banks, Aristazabal, Estevan) and consists of discontinuous remnants of diorite gneiss, quartzite, limestone, slate, and ribbon chert. The central belt of metamorphic rocks extends from Porcher Island southwesterly along Grenville and Princess Royal Channels. It comprises quartz-feldspathic schists containing biotite, muscovite, and locally garnet and sillimanite. These schists are interlayered with meta-greywacke, limestone, and a widespread conglomerate containing clasts of quartzite and granodiorite. The eastern belt of metamorphic rocks is the largest and most continuous of the three, attaining a maximum width of over 15 miles at Prince Rupert and extending southeasterly for over 200 miles into Bella Coola (93 D) map-area. It includes schists and meta-sedimentary rocks similar to those in the central belt, and, in addition, a thick succession of coarsely crystalline, banded and veined gneisses.

The composition of the older granitic rocks exhibits a crude symmetry with respect to the three belts of metamorphic rocks. Diorite is the principal rock adjacent to the metamorphic belts, quartz diorite forms an intermediate belt, and uniform granodiorite occupies the central areas between the metamorphic belts. This relationship is complicated by the presence of many discrete, cross-cutting, younger plutons, ranging in composition from leucogranite to gabbro.

Major swarms of andesitic and basaltic dykes run northwesterly through the Seaforth Channel area and northeasterly in the vicinity of Portland Inlet, Douglas Channel, and Dean Channel. The youngest of these are believed to be feeders for a chain of small Tertiary and recent volcanoes that occur on the outer islands.

No metalliferous deposits of economic importance were discovered, but traces of mineralization were noted at several places. Chalcopyrite occurs in small widely spaced fractures in granodiorite along Fraser Reach, in limestone skarn along the east side of Campania Sound, in quartz veins associated with screens of schist near the head of Cascade Inlet and in narrow shear zones cutting greenstone near the head of Dean Channel. Small amounts of molybdenite were noted along a granodiorite contact at Foch Lake and associated with leucogranite bodies on Campania Island, Hastings Arm, and Alice Arm. Fine-grained, disseminated galena occurs in limestone on Lewis Island near the north end of Grenville Channel.

33. OPERATION LIARD

G.C. Taylor

The initial phase of Operation Liard was completed during this past summer. The pre-Devonian stratigraphy of the northwest part of the area was examined with the objective of establishing the succession and map-units of the pre-Silurian rocks, and establishing the correlation and distribution of the better-known Silurian and Devonian formations. The areal mapping of the overlying Devonian to Cretaceous formations was also accomplished.

Several major unconformities occur. In the west they lie at the base of the thick Cambrian, Ordovician, Silurian, and Devonian successions. To the east the Precambrian is bevelled and the Cambrian and Ordovician units are truncated beneath these unconformities so that at the Mountain Front thin Silurian and Devonian rocks lie on the oldest Precambrian in the region. This erosional thinning is accompanied by eastward convergence, particularly evident within the Siluro-Devonian succession. These stratigraphic relationships suggest a westward continuation into the mountains of 'Fort Nelson High' known in the subsurface of the Plains to the east.

Several occurrences of copper minerals were examined within the Precambrian succession. All are related to a northerly trending system of basic dykes cutting these rocks. Ore minerals present are massive chalcopyrite, chalcocite, malachite, and azurite with quartz, calcite, and siderite gangue. Several of the deposits appear to have a high copper content. Numerous showings of barite and fluorite were observed in the Siluro-Devonian succession.

34. BONAPARTE RIVER (WEST HALF) MAP-AREA

H.W. Tipper

The southwest part of Bonaparte River west half (92 P W1/2) map-area is underlain mainly by rocks of the Permian Cache Creek Group and the Triassic (?) Pavilion Group. These groups are folded limestone, argillite, ribbon chert, other sedimentary rocks and volcanic rocks.

The remainder of the area is heavily forested with poor rock exposure. The flat central part (comprising 50 per cent of the area) is underlain by flat-lying Miocene-Pliocene basalt and andesite. Chasm Provincial Park has excellent exposures of these rocks. The rounded mountains of the southern and southeastern parts are mainly flat-lying Tertiary basalt and andesite slightly older than those mentioned above. The northeast quarter is underlain mainly by granitic rocks and by sedimentary and volcanic rocks (Triassic) intruded by the granite; elsewhere isolated hills of these rocks protrude through the Tertiary cover.

35. TASEKO LAKES (92 O) MAP-AREA

H.W. Tipper

Fraser River fault zone follows the centre of Fraser River Valley from Big Bar northward and brings Permian Cache Creek and Triassic (?) Pavilion Groups on the east in contact with Cretaceous, Tertiary, and Upper Triassic volcanic and sedimentary rocks. Many faults branch from the main fault to the northwest. The fault did not disturb volcanic rocks of late Miocene age.

Between the Fraser River fault zone and the Yalakom River fault is a belt of late Lower Cretaceous and Upper Cretaceous greywacke, shale, and conglomerate. West of Yalakom fault is the mass of Shulaps ultrabasic rocks with sedimentary rocks of Permian (?) to Cretaceous age along contacts.

A major fault is subparallel to and near Relay Creek and lower Tyaughton Creek. Between this fault and the coast granitic rocks is a belt of rocks, mainly sedimentary, ranging in age from Late Triassic (Norian) to Early Cretaceous (Albian). These rocks are structurally complex as they have been affected by southwest-dipping thrusts associated with coast granitic rocks on the west and by northeast-dipping thrusts on the east associated with Yalakom River - Fraser River faults. This has been further complicated by late Tertiary normal faulting. The area between Relay and Tyaughton Creeks, where the effect of these events overlap, is a shattered zone of great complexity.

Small granitic to dioritic plugs occur at several places in the area as well as a multitude of porphyries, which occur as sills dykes and plugs, related in whole or in part to mid-Tertiary volcanism.

36. TRIASSIC BIOSTRATIGRAPHY, HALFWAY RIVER AND TASEKO LAKES MAP-AREAS

E.T. Tozer

Sections of Lower Triassic (Scythian) strata were examined in Halfway River (94 B) map-area in the western foothills between Halfway River and Needham Creek. In each section three faunal zones were recognized. The lower zone is characterized by ammonoids of lower (but not lowermost) Scythian age; it may be possible, eventually, to subdivide this zone. The middle zone is characterized by the pelecypod Posidonia mimer and several genera of early upper Scythian ammonoids. In the upper zone Posidonia aranea is accompanied by an ammonite fauna, new to British Columbia, comprising more than 10 genera, of which the most diagnostic is Keyserlingites, which occurs in the uppermost Scythian of Siberia and Ellesmere Island.

In Taseko Lakes (92 O) map-area, in cooperation with Dr. H.W. Tipper, the Upper Triassic rocks of Tyaughton Creek Valley were examined. Earlier work had revealed several faunas, but nothing was known of their relative position. A sequence of four Upper Triassic faunas is now recognized, in ascending order characterized by: 1) megalodont pelecypods and corals; 2) Monotis subcircularis; 3) Cassianella lingulata, and 4) Choristoceras sp. The Monotis and Cassianella faunas, and probably also the megalodont fauna, are of Norian age; the Choristoceras beds may be Rhaetian (latest Triassic). The Choristoceras beds are apparently conformably overlain by beds with Hettangian (Lower Jurassic) ammonites. The megalodont fauna occur in grey limestone, Monotis in calcareous shale, and the higher beds are mainly sandstone and conglomerate.

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

J.O. Wheeler

Monashee Mountains west of Columbia River are underlain by high-grade metamorphic rocks featured by gneiss domes centred around Frenchman's Cap and upper Ratchford Creek. The cores of the domes comprise layered granite and mixed gneiss surrounded by an envelope of metasediments containing increasing amounts of pegmatite toward the west and northwest.

The rocks were first deformed into attenuated recumbent folds along east- to northeast-trending axes and subsequently redeformed along northwest-trending axes. The domes appear to have risen just before the later folding and then spread eastward by underthrusting rocks of Selkirk Mountains. This is indicated by smoothly west-dipping or slightly back-folded western and southwestern margins of the domes and northwest-trending folds, which cascade downward toward the northeastern margin with increasingly flatter axial planes.

Selkirk Mountains east of Columbia River are composed principally of rocks of Horsethief Creek, Hamill, and Lardeau Groups, and Badshot Formation, with minor granitic plutons. Between LaForme and Bigmouth Creeks and southwest of the upper parts of French and Normanwood Creeks the rocks are slightly metamorphosed. This

region, opposite the gneiss domes, is characterized by early east- and northeast-trending folds redeformed by southwesterly directed thrust faults and northwest-trending folds overturned to the southwest.

The remaining part of the area to the northeast is underlain mainly by high-grade metamorphic rocks. Early northeast-trending folds have been redeformed into northwest-trending folds directed northeast into undulating nappe-like folds that appear to override Rocky Mountain structures.

BRITISH COLUMBIA AND ALBERTA

38. PRE-DEVONIAN STRATIGRAPHIC STUDIES, MAIN AND FRONT RANGES

J.D. Aitken

Stratigraphic sections measured during the past season completed the tying-in of the pre-Devonian stratigraphic sections along the Bow and North Saskatchewan Rivers with those along the Athabaska River[1]. Along the Mountain Front, the Cambrian strata thin northward from a maximum near the North Saskatchewan and Brazeau Rivers. In the Main Ranges, the Middle Cambrian succession becomes more shaly northward from Saskatchewan Crossing, while the Upper Cambrian and Lower Ordovician succession becomes less so.

Work in the Mount Assiniboine area revealed an abundance of algal carbonates in some Middle Cambrian sections, and provided clues as to the nature of the boundary across which the well-known Cambrian formations of the Lake Louise area change facies and become unrecognizable to the southwest.

Work near Mount Joffre suggests that the fish-bearing basal Devonian red beds are the same formation—"lithogenetic unit"—as the basal Devonian red beds in the Ghost River area. The discovery of two isolated occurrences of these red beds (one of them fossiliferous) along Brazeau River, where they characteristically occupy channels eroded in the Upper Cambrian Lynx Formation, has greatly extended the known distribution of these deposits.

The season was highlighted by a number of new and important fossil discoveries.

39. STUDIES OF THE JURASSIC SYSTEM, WESTERN CANADA

H. Frebold

The study of the Jurassic System in the Harrison Lake area revealed the presence of Early Jurassic faunas and beds. Some of them had already been discovered by the writer during previous field work. The faunas concerned contain both ammonites, belemnites, and pelecypods, which indicate the presence of Lower Jurassic (i.e. Sinemurian) beds that are underlain and overlain by volcanic rocks. Previously some of these volcanic rocks had been considered to be Middle Jurassic in age, but they are older. No younger Lower Jurassic and lower Middle Jurassic faunas have been found in this area. The youngest Jurassic fossiliferous beds in the Harrison Lake area are Callovian and Oxfordian in age, as already shown by Crickmay[2].

---

[1] Mountjoy, E.W.: Geology, Miette, Alberta; Geol. Surv. Can., Map 40-1959 (1960).

_____: Mount Robson (Southeast) map-area, Rocky Mountains of Alberta and British Columbia; Geol. Surv. Can., Paper 61-31 (1962).

[2] Crickmay, C.H.: Fossils from Harrison Lake Area, British Columbia; National Mus. of Canada, Bull. 63, Geol. Ser. No. 51 (1930).

Sections of the Cultus Formation at Cultus Lake, where Dr. J.E. Armstrong had found some poorly preserved ammonites some years ago, were studied in detail and more ammonites were discovered. They belong to Melanhippites and indicate a Sinemurian age of the beds concerned, i.e. they are equivalent in age to the Lower Jurassic beds in the Harrison Lake area.

Faunas were collected in the Fernie Group, particularly in the upper part. They will probably form the basis for a further subdivision of the beds concerned.

40. KANANASKIS (WEST HALF) (82 J W1/2) MAP-AREA

G.B. Leech

Dioritic sills and dykes are widespread in lower McKay strata southeast of White River. Some are associated with diatreme-like breccias. Similar pipe-like and irregular breccias occur elsewhere, especially in the upper White River - Palliser River region. Some consist solely of fragments of the host formation, others contain transported sedimentary and dioritic fragments, and still others have small dioritic dykes associated with them; the variation depends chiefly on the structural level exposed. The intrusions and breccias are Mesozoic or younger: breccias cut the Rocky Mountain Group, the youngest strata to outcrop extensively in the area mapped, and intrusions in McKay strata were emplaced during or between tectonic deformations.

Sub-Ottertail (i.e. "Chancellor") strata in and south of the Mitchell Range comprise: (1) an upper argillaceous unit in which cleavage obscures bedding, (2) a middle argillaceous unit with distinct bedding that has been mistaken for Goodsir strata, (3) a limestone unit, and (4), in the north, a still lower argillaceous unit. Fossils in and just above the upper two units will aid correlation with the eastern carbonate facies against which the sequence is jammed along the Mitchell, Cross, and Albert Rivers.

The Jubilee Formation rests unconformably on Lower Cambrian and Purcell strata in the Hughes Range just south of latitude 50°.

McKay strata were traced into rocks mapped as Goodsir and Mons-Sarbach. The McKay Group is at least 9,000 feet thick at Thunder Creek and is some 6,500 feet thick at Mount Queen Mary.

Intense cleavage is a regional characteristic of the upper part of the sub-Ottertail ("Chancellor") sequence and lower part of the McKay Group in and east of the Kootenay - White River valley. No compelling evidence for a major west-dipping fault ("White River Break") was recognized and moreover the formations on strike to the south are unruptured.

41. DEVONIAN BIOSTRATIGRAPHIC STUDIES

D.J. McLaren

During the field season the writer collected specimens and measured sections in Devonian rocks of Halfway River (94 B)

map-area, and examined the interval containing the Frasnian - Famennian boundary and collected in Fernie (82 G) map-area, as part of a study of the Devonian biostratigraphy of Western Canada.

42. FABRICS OF FOLDED ROCKS, FERNIE EAST HALF (82 G E 1/2) MAP-AREA

R.A. Price

The investigation of fabrics of folded rocks in the Crowsnest Pass - Flathead region was continued for three weeks in July. Supplementary survey control for the geometric analysis of folded bedding was obtained at a few localities in the immediate vicinity of Crowsnest Pass. Additional measurements of fracture fabrics were made at localities studied in 1961 and the sampling was extended to intervening areas.

A more detailed examination of stratigraphic relationships along the south flank of a dolomitized Peechee reef occurring in the Fairholme Group between Mount Pengelly and Mount Coulthard in Flathead Range has shown that contrary to earlier conclusions[1], the "Arcs" and "Grotto Members" are not truncated and overlapped by the Alexo Formation on the flank of the reef mass, but instead grade rather abruptly into the Peechee dolomite.

43. STRATIGRAPHY OF THE MIDDLE CARBONIFEROUS ETHERINGTON AND TUNNEL MOUNTAIN FORMATIONS, SOUTHERN ROCKY MOUNTAINS

D.L. Scott

Early Pennsylvanian (Morrowan - Atokan) marine strata formerly designated the Tunnel Mountain (restricted) are renamed Fording Formation and subdivided into four members consisting of very fine to fine grained, dolomitic and quartzitic sandstones containing some medium and coarse sand grains, and some thin dolomite lentils that are locally fossiliferous. The sands consist of quartz and chert, little feldspar, and traces of zircon, tourmaline, rutile, and magnetite. The strata weather brown and grey with some pinkish colours, are very hard, moderately resistant, and contrast readily with carbonate rocks above and below.

The Fording is conformable on the Mississippian (Chesterian) Etherington Formation, a heterogeneous unit of sandy limestone and dolomite, with some sandstone and shale, divisible into an upper persistent, dense, sandy and cherty dolomite member with sandstone interbeds, gradational downwards and westwards into skeletal limestone, and a lower division composed of two facies. The eastern facies is very thin and composed of dolomite, limestone, siltstone, and maroon to green shale; the western facies is much thicker and is composed of sandy skeletal limestone, oolite, and minor sandstone. The lower contact of both facies may be unconformable on

---

[1]Price, R.A.: Fernie map-area (east half), Alberta and British Columbia; Geol. Surv. Can., Paper 61-24 (1962).

Meramecian strata because of local, thin limestone conglomerates at the base.

The base of the Fording Formation coincides with the base of the Todhunter Member, a natural and easily recognized horizon. An interpreted erosional unconformity with associated chert-phosphorite-sandstone pebble conglomerate within the upper part of the Fording may truncate the sandstones towards the east. The Etherington and Fording Formations below the unconformity constitute a regressive sequence; the uppermost part of the Fording Formation and the Kananaskis Formation constitute a transgressive sequence.

ALBERTA

44. A VERTEBRATE FOSSIL DISCOVERY IN THE UPPER MEMBER OF THE EDMONTON FORMATION, SOUTHERN ALBERTA

T. Potter Chamney

An original contribution to the biostratigraphy of the upper member of the Edmonton Formation was the recovery of a mammal insectivore jaw from the vicinity of Scollard, Alberta, on the Red Deer River. This is the first mammal recovery from beds as old as the Lance Formation in Canada.

The writer conducted the group of international vertebrate palaeontologists through the many badland areas from Red Deer to the Milk River Canyon in southeastern Alberta and the badlands and exposures of Cypress Hills, Saskatchewan. The vertebrate fauna examined in the field ranged from the Upper Cretaceous (Maestrichtian) to the Tertiary, Olgiocene, and all Pleistocene bone beds along the routes travelled.

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

D.W. Gibson

Field work was concluded for a detailed petrologic, stratigraphic, and palaeontologic investigation, commenced in 1962, of the Whitehorse and Sulphur Mountain Formations.

The Whitehorse Formation, comprising a complex series of carbonates, sandstones, siltstones, and evaporites is divisible into three distinct lithologic members in most regions of the area investigated. In ascending order the members are the evaporitic member, the crinoidal limestone member, and the cherty carbonate member. At one locality near Smoky River, Upper Triassic Terebratulids were obtained from the crinoidal limestone member. This unit is present throughout most of the area except the eastern and southern regions near the Athabasca River, where it appears to be erosionally truncated. The other two members of the Whitehorse Formation are characterized by numerous facies changes occurring within relatively short distances.

The Sulphur Mountain Formation is subdivided into four lithologic members: a lower shaly siltstone member; a black-brown siltstone member; a black shale member; and an upper silty dolomite member. All members of the Sulphur Mountain Formation are readily correlatable throughout the area investigated and may be recognized in the Banff region.

Twenty-three sections were examined and sampled, where possible, at 10-foot intervals. Oriented specimens were collected from the Sulphur Mountain Formation in order to obtain palaeocurrent information from micro-crosslaminations, which are commonly present throughout the lower part of the formation.

Gypsum was observed at two localities--Brewster's Wall near Blue Creek, and at Sulphur Mountain on the Sulphur River. Both occurrences are very small, lenticular, and appear uneconomic.

46. DEVONIAN STRATIGRAPHY, NORTHWEST MARGIN OF THE SOUTHESK - CAIRN CARBONATE COMPLEX

W.S. MacKenzie

Several stratigraphic sections were measured along a transitional zone between carbonate and basinal facies of the Southesk Reef in the vicinity of Mount Meda, Cardinal Mountain, and Mount MacKenzie. In this area, the following informal members are present in the Southesk Formation: grey dolomite member; brown dolomite member; silty member; and upper limestone member. The grey and brown dolomite members occupy the stratigraphic position of the Peechee and Arcs Members respectively of Belyea and McLaren[1]. The combined silty and upper limestone members are correlated with the Ronde Member of McLaren and Mountjoy[2]. The Grotto Member is not present.

In the neighbourhood of Mount Meda, the presence of a brecciated zone consisting of intermixed angular blocks of coarse siltstone up to 6 feet maximum dimension and porous, reef-like dolomites, which occur at the base of the (Upper Alexo) Sassenach siltstones of McLaren and Mountjoy[2], absence locally of these siltstones and the presence of thick 2- to 3-foot algal ball beds immediately below them constitute evidence of erosion and strong current action following deposition of the Southesk Formation and equivalent Mount Hawk limestones. Near Cardinal Mountain, grey brecciated limestones with abundant colonial corals in various attitudes, which occur immediately below the Sassenach - Southesk contact, are added evidence of a shallow-water environment and strong current action prior to deposition of the Sassenach siltstones.

At Cardinal Mountain and Mount MacKenzie, small isolated carbonate reefs in the upper part of the Mount Hawk Formation occur near the reef edge. The upper part of the Southesk Formation (silty and upper limestone members) is more widespread than the lower. The silty member can be traced for several miles beyond the reef. The facies change from upper limestone member carbonates to Mount Hawk bedded limestones rises stratigraphically towards the northwest.

47. MISSISSIPPIAN STRATIGRAPHY AND PETROLOGY, BOW AND HIGHWOOD RIVERS AREA (82 J, O)

R.W. Macqueen

More than 20 partial and complete sections of the Livingston and Mount Head Formations of the Rundle Group have been

---

[1]Belyea, H.R., and McLaren, D.J.: Upper Devonian nomenclature in Southern Alberta; J. Alta. Soc. Petrol. Geol., vol. 5, pp. 166-182 (1957).

[2]McLaren, D.J., and Mountjoy, E.W.: Alexo equivalents in the Jasper region, Alberta; Geol. Surv. Can., Paper 62-23 (1962).

measured between the Beehive Mountain map-area south of the Highwood River and the Bow River valley, including several of the Etherington and Banff Formations.

The Livingston Formation consists largely of very massively bedded, resistant-weathering, medium- to very coarse-grained, spar-cemented crinoidal calcarenites, often crossbedded and frequently with dolomitic matrices. Porosity is locally developed, especially in dolomitic zones; dolomite-free zones are frequently recrystallized, showing irregular grain and matrix boundaries. A westward thickening of the Livingston Formation appears to be at the expense of the overlying Mount Head Formation.

Members of the Mount Head Formation, as established by Douglas[1], are easily recognized in the Livingston and Highwood Ranges in the south, and at Exshaw in the Bow River valley in the north; critical Front Range sections in the area between have yet to be visited. Westward in the Misty, Opal, Fisher, and Rundle Ranges the sandy Mount Head Formation members disappear, and the formation is thinner, consisting of recessive, shaly limestones and calcareous shales. Over 430 fossil collections (corals and brachiopods) have been made largely from shaly sections of the Mount Head Formation.

Sections are detailed in nature; sampling has been conducted at each change of lithology or at 10-foot intervals in the Livingston Formation, and at 5-foot intervals (or lithology change) in the Mount Head Formation. With the exception of shales, all samples are oriented.

48. BURNT TIMBER MAP-AREA

N.C. Ollerenshaw

Geological mapping of Burnt Timber (82 O/11) map-area, begun in 1962, has been completed.

Structurally, the area consists of three northwest-trending units, separated by major, southwest-dipping thrust faults, the Blue Mountain thrust on the east and the McConnell thrust on the west. The easternmost belt consists of gently deformed Upper Cretaceous (Brazeau) and Tertiary (Paskapoo) rocks, forming a broad synclinal structure, with an anticline to the northwest on James River. The central belt is more strongly folded and from east to west consists of the Yara Creek syncline, the McCue Creek anticline, the Burnt Timber syncline, the Sheep Creek anticline (overturned) and the Panther anticline. The succession in this belt is almost entirely Mesozoic, with Palaeozoic rocks exposed locally along the Panther anticline. A major thrust develops progressively southwards in the core of the McCue Creek anticline. The westernmost belt is an essentially homoclinal sequence of predominantly Palaeozoic rocks.

The McConnell fault trace curves strongly in the Burnt Timber area, in association with a structural 'high' along the Panther

---

[1]Douglas, R.J.W.: Mount Head map-area, Alberta; Geol. Surv. Can., Mem. 291 (1958).

anticline. The McConnell fault appears to have been folded, at least locally.

The oldest and youngest rocks in the area belong to the Eldon and Paskapoo Formations respectively. Channels, locally up to 50 feet in depth, are evident at the base of the established Devonian section, into Cambrian strata. Such channels are filled with pebble to boulder-sized phenoclasts from the underlying beds. The Bearpaw Formation appears to be absent. The Belly River, Edmonton, and Paskapoo Formations consist of similar non-marine, commonly lenticular sandstones and shales, making their differentiation difficult.

Fourteen wells have been drilled in the area and seven have been capped as potential gas wells. Indicated production is from the Mississippian, with supplementary Devonian gas in the wells near Panther River.

49. PETROLOGY AND CHEMISTRY OF THE CROWSNEST FORMATION, SOUTHWESTERN ALBERTA

T.H. Pearce

Two months were spent in the southern Foothills of Alberta carrying out the introductory work for a Ph.D. thesis on the petrology and chemistry of the Crowsnest volcanic rocks. Most of the known exposures of these rocks were visited and the best exposed sections were measured, sampled, and described in detail. Trachyte dykes in the same general area, which are believed to be related to the Crowsnest volcanic rocks, were also examined and sampled.

50. SURFICIAL GEOLOGY, BASSANO MAP-AREA

A.M. Stalker

Surficial geology mapping was commenced in Bassano (82 I E 1/2) map-area, and the study of the Blackfoot Indian Reserve and of the region north of Bow River was completed. As many as five Laurentide tills are present in the banks of Bow River, and it is expected that these will correlate with those previously found in the stratigraphic section along Oldman River. The various Pleistocene diversions of Bow River were studied. During the last or Classical Wisconsin glaciation major ice advances from the north-northwest and northeast met in the western part of the area. These combined into one massive ice-sheet that retreated northeastward. This ice-sheet blocked normal drainage to form an eastward-descending series of proglacial lakes. As a result, lake silt and sand covers about one-half the area mapped; ground moraine and hummocky moraine are present elsewhere.

Large quantities of good gravel are present at the base of the drift in the preglacial Bow Valley, though generally too deeply buried for commercial use. Important deltaic gravel deposits were laid down along the northwestern shores of the successive proglacial lakes.

SASKATCHEWAN

51. HYDROGEOLOGICAL STUDIES, OLD WIVES LAKE DRAINAGE BASIN

R.A. Freeze

Much of this summers' field work was aimed at a study of the relation of water chemistry to groundwater flow systems. Bedrock and Pleistocene aquifers, where horizontal flow predominates, were sampled evenly over the area (parts of 72 F, G, and H). In till, where vertical flow predominates, samples were collected along the flow system. Oil company data were obtained on deep aquifers. Understanding the interrelations and chemistry of these systems may indicate likely areas for future development.

Sloughs and streams were sampled at intervals to relate changes in chemistry to groundwater inflow and outflow. One of these studies showed that a saline slough cannot be developed by recurrent evaporation to dryness as had been suggested by some authors.

A drilling program was conducted to delineate the Gravelburg aquifer and install piezometers to assist in a detailed study of this small artesian aquifer. A pump test indicates a transmissibility of 6,000 gallons per day per foot.

Four recorders were installed for continuous study of fluctuations in four aquifers.

52. SEISMIC REFRACTION INVESTIGATION OF THE ATHABASCA FORMATION

H.A. MacAulay

Ninety-three locations were investigated by the seismic refraction method in the area in northern Saskatchewan (74 NE, NW, SE, SW) underlain by the Athabasca Formation to calculate the depth to the pre-Athabasca erosion surface. These locations gave a fairly uniform distribution of depth points over the area.

A final compilation and computation of the data obtained is presently being carried on. For some locations, minimum depths only can be obtained. Where penetration occurred the reliability of depths calculated should be generally fair.

By combining the depths calculated by seismic methods with those obtained from aeromagnetic data, it should be possible to contour the pre-Athabasca erosion surface.

53. HYDROGEOLOGICAL STUDIES, ASSINIBOINE BASIN

P. Meyboom

Field work was directed toward measuring groundwater discharge from phreatophytic vegetation. Results from fifteen plant

associations show that discharge from phreatophytes is a major item in the groundwater balance of prairie drainage basins. Actual stream-flow losses related to phreatophytes were observed in the Arm River and Qu'Appelle River.

The exact relation between groundwater flow and a saline river valley was determined in the Arm River near Bethune. The resulting flow pattern confirmed the opinion that saline areas are regions of strong upward flow.

54. HYDROGEOLOGICAL STUDIES, EAGLEHILL CREEK AREA

A.M. Toth

The topographic 'high' to the west of Eaglehill Creek (in 73 B SW 1/4) is a recharge zone for groundwater, with movement of the water in an easterly direction. Eaglehill Creek is a discharge zone for groundwater, especially where it is a deep valley. East of Eaglehill Creek towards Saskatoon is also a recharge zone, with water movement towards Eaglehill Creek, the South Saskatchewan River, and as well in a northerly direction. The South Saskatchewan River is also a discharge area for drift and Upper Cretaceous aquifers.

To the east of the South Saskatchewan River the Upper Cretaceous sands are not continuous, as to the west of the river, but occur mainly in 'lows' in the underlying continuous shale formation. Movement of water in Upper Cretaceous sands to the east of the South Saskatchewan River is from the south and flows north as well as west to the river.

Detailed and regional studies indicate that recharge can occur locally even to the Upper Cretaceous sands.

Studies of the chemistry of water from the Upper Cretaceous sands also support the above hydrogeological interpretation.

SASKATCHEWAN AND MANITOBA

55. GROUNDWATER IN BEDROCK AQUIFERS IN THE PRAIRIES

R.O. van Everdingen

For the investigation of the groundwater flow pattern near the South Saskatchewan River, and for the evaluation of the influence of the South Saskatchewan Reservoir on the groundwater aquifer in the vicinity, piezometers were installed on two sites on the east bank of the river near Riverhurst, Saskatchewan. One site lies on the edge of the valley, the other halfway down the valley slope. On each of the two sites four piezometers were completed, one in surficial gravel, one in sand of the Ardkenneth Member (Bearpaw Formation), one in sand of the Beechy Member (Bearpaw Formation) and one in the top sand of the Belly River Formation (names are indicating equivalents of the sands encountered in the GSC Beechy testhole). Two similar sites, each with three piezometers in the Bearpaw and Belly River sands, were completed in December 1962 on the west bank of the river in the same area. The surficial gravels were found from 55 to 125 feet depth in the lower location and from 185 to 232 feet depth in the upper location. The eastern extension of the gravels was found close to Riverhurst between 127 and 140 feet depth. The new town well, drilled in July 1963 by International Water Supply Ltd. from Saskatoon, is producing from this gravel. It was tested at the rate of 30 gallons per minute.

In connection with the study of groundwater in bedrock aquifers in the Western Sedimentary Basin, data concerning the drill-stem tests (water pressures) and chemical analyses of bedrock water samples were gathered from provincial agencies in Manitoba and Saskatchewan, to determine the usefulness of such data for the evaluation of groundwater flow systems.

The Red River Floodway Project in Winnipeg, Manitoba was visited to get some first-hand information for the planned model study on the influence of the Floodway on local groundwater, to be conducted later in the year with J.S. Scott.

56. SURFACE RESISTIVITY SURVEYS IN SOUTHERN MANITOBA AND SASKATCHEWAN

J.E. Wyder

A drilling program conducted in the Winkler area revealed that surface resistivity surveys completed in 1962 had accurately outlined a large potential aquifer. Drilling samples also revealed that the aquifer is at least 130 feet thick at a point 4 miles south and 1 1/2 miles east of Winkler.

In the Morris (Manitoba) area resistivity surveys were used to delineate five small surficial sand and gravel deposits. A short drilling program revealed that each of the sand and gravel deposits graded northwest and southeast into a very pebbly till. The deposits occur in an environment of lacustrine clay and till.

In the Oxbow (Saskatchewan) area attempts were made to locate and delineate the buried preglacial Missouri River valley. The surveys appear to have been successful in outlining the buried Missouri and a major tributary. Electrical interference from electric motors operating oil-field pump jacks greatly decreased the accuracy of resistivity values for Wenner a-spans greater than a = 350 feet.

MANITOBA

57. THE BIRD RIVER SILL

R.G.H. Allen

The Bird River sill in southeastern Manitoba (52 L/5, 6, 11, 12) consists of an upper hornblende gabbro unit and a lower serpentinite unit. It lies within the Rice Lake Group of volcanic and sedimentary rocks, and is exposed on the flanks of an eastward-plunging anticline. Granite occupies the core of the anticline and transects the sill. Chromitite layers occur near the top of the serpentinite, and small deposits of iron, copper, and nickel sulphides towards its base.

Although there are several types of gabbro, one that is ophitic and contains large poikilitic hornblende grains predominates. No systematic variation or preferred orientation can be observed in the gabbro.

The weathered surface of the upper part of the serpentinite exhibits small ellipsoids of uniform size attributed to the pseudomorphic replacement of olivine. Their abundance indicates that the rock is an altered dunite.

On the 20-mile long southern flank chromitite is exposed for only 3 miles. The three major chromitite layers are constant in thickness and texture, although thinner ones persist for little more than 1,000 feet. Where deformation has been intense lenses of chromite lie in sheared serpentine.

The sulphide deposits are closely related to the granite. They occur not only at the granite-serpentine contact but along the granite Rice Lake Group contact.

58. UPPER NELSON RIVER AREA

C.K. Bell

Inaccessible outcrops in Wekusko Lake (63 J) map-area were visited by helicopter and crucial areas were restudied in detail. Reconnaissance mapping commenced in Sepiwesk (63 P) map-area.

The upper Nelson River (63 NE) area is bisected by the boundary between the Churchill and Superior structural provinces. The boundary appears gradational across a 40 mile width. A high Bouguer gravity anomaly coincides with granulite-facies rocks along the southeastern contact. In the Wekusko Lake (63 J) map-area the zone arcs south from its regional southwest trend. The pivot of this alpine flexure lies north of Kiskitto Lake. Anorthosites and hypersthene granites of batholithic proportions outcrop here. Southeast of the anorthosite-granulite complex the rocks are Superior-type monzonite and granodiorite gneisses.

The Thompson-Setting Lake peridotite-bearing nickel belt occurs within a gravity low along the northwest (or Churchill province) side of the contact zone. There 'alpine' peridotites are relatively late, intruding sedimentary-volcanic rocks on Setting

Lake and layered acid to intermediate gneisses in Wabowden area. Aligned, lens-shaped stocks of Churchillian granite (1,785 m.y.) coincide with and intrude the peridotite. Northwest of Setting Lake the sediments are in conformable granitized contact with layered acid gneiss, augen-gneiss, and interlayered high-grade metasediments. These grade westerly into typical Flin Flon-Kisseynew-type Churchillian rocks at Wekusko Lake.

Three copper, zinc, lead, gold, and silver deposits are under development northwest of Wekusko Lake. The vast Thompson nickel-copper deposit has spurred explorations along the nickel belt and a few occurrences are reported in the Wabowden area.

59. HYDROGEOLOGICAL STUDY OF THE STEINBACH AREA

J.E. Charron

This is the continuation of a hydrogeological study of the Red River valley, Manitoba. The area covered this year is approximately 2,000 aquare miles. From south to north it includes townships 1 to 12 (latitude 49° 00' to 50° 00') and from east to west it includes ranges 11E to 6E (longitude 96° 00' to 96° 46'). A report concerning all known aspects of the groundwater of this area will be written up this winter, and will be accompanied by a map, figures, and cross-sections. Although groundwater is available almost anywhere within the area surveyed, it is more readily available in the central part than in the southern and northern parts.

Because the composition of the groundwater in the Emerson area pointed out the possibility of a gypsum deposit[1], a drill-hole was made in NE-5-6-3E, which yielded a 48-foot section of gypsum and red shale of the Amaranth Formation. The gypsum was first encountered at 98 feet below surface. The extent of the deposit is not yet known.

60. SURFICIAL GEOLOGY, RIDING MOUNTAIN MAP-AREA

R.W. Klassen

Mapping of the surficial deposits in the Manitoba part of the Riding Mountain area (62 K) was completed.

The Riding Mountain upland was the first part of this area to be deglaciated. Kame moraines and stream trenches across the southwest-sloping part, and southeast-sloping part of this upland are evidence for this. The stagnant marginal zone of the ice shrank progressively southwestward towards the Assiniboine valley. During initial stages of deglaciation, meltwater lakes covered stagnant ice, as indicated by hummocky lake silts.

---

[1] Charron, J.E : Hydrogeological study of the Red River Valley - Winnipeg area; abstract in Summary of Research: Field, 1962, compiled by S.E. Jenness; Geol. Surv. Can., Paper 63-1 (1963).

A test-hole drilling program to determine the bedrock-overburden interface, and the general lithology and stratigraphy of the surficial material, was completed with the cooperation of members of the Geological Survey's Groundwater and Engineering Geology Section. Thirty test-holes were located 2 to 4 miles apart in a northeasterly direction across the Pipestone and Assiniboine valleys toward the Manitoba escarpment. Seven test-holes were located across the Assiniboine valley in the northwest part of the map-area. A total of 5,800 feet of drilling was logged.

Most of the drift encountered by drilling was till, although substantial thicknesses of clay, sand, and gravel occur in some localities. The average drift thickness is 145 feet with a general thinning of the drift from the northeast to the southwest. One test-hole (NE 1/4, sec. 34, tp. 17, rge. 20 WPM) was abandoned at 450 feet in till.

At least two tills are of regional extent. A lower dark grey, sandy till is generally separated from an upper, dark grey, clayey till by either clay, sand and gravel, or a boulder horizon.

ONTARIO

61. THE CROW LAKE GRANITE

K.L. Currie

The Crow Lake granite in southeastern Ontario (part of 31 C/9) has the form of a flat-lying sill of biotite granite contained in Grenville biotite gneisses. The edges of the conformable mass are marked by narrow migmatitic zones, and gradually decreasing silicification and feldspathization of the country rock. Topographically, and probably stratigraphically below the granite is a zone of basic hornblende-cordierite gneiss. Increased basification is locally noted, resulting in the development of ophitic biotite gabbro lenses. Fine-grained trap dykes were observed originating in these lenses in two localities.

Adjacent to the Crow Lake sill, hornblende-pyroxene granite is developed in the nose of an isoclinally overturned anticline. This may represent a remobilized and diapiric basement. Just to the south of the mapping area coarse-grained massive biotite granite truncates the gneisses. East of the Crow Lake mass alaskitic granite gneisses, apparently of sedimentary origin, appear in the stratigraphic column.

The Crow Lake mass appears to represent the complementary development of basic and acid rocks by differential transfer of material within an originally homogeneous metamorphic pile. Experiments are now under way to determine the mechanisms by which this transfer took place.

62. STUDIES OF HURONIAN ROCKS NEAR SAULT STE. MARIE

M.J. Frarey

Five weeks were spent in the field, mostly devoted to checking critical localities and small gaps in previous mapping in Bruce Mines (41 J/5), Wakwekobi Lake (41 J/6), Dean Lake (41 J/3), Echo Lake (41 J/12), and Lake George (41 K/8) map-areas. Classification of some strata will be modified as a result. Further material was collected for office-laboratory study. Tours to localities in these map-areas demonstrating features of Huronian sedimentation, volcanism, and structure were conducted for Mr. Peter Dunn of the Australian Bureau of Mineral Resources, visiting personnel of the Ontario Department of Mines, and two graduate students of the University of California engaged in thesis studies in the general area.

63. REFRACTION SEISMIC SURVEY IN THE KIRKLAND LAKE - LARDER LAKE AREA

A.C. Grant

During the field season approximately 25 miles of refraction profiling were completed with an FS-2 portable seismograph in the Kirkland Lake - Larder Lake area (32 D/4) of Ontario. The purpose of this program was to measure thickness of overburden,

particularly over buried channels as interpreted from air photographs. About 21 miles of refraction profiling had been conducted to this end during the 1962 field season, employing "conventional" seismic instruments (Texas Instruments, 7000B, 12 channel). Total seismic coverage in the area now amounts to some 46 miles of refraction profiling, of which approximately 15 miles were obtained in McElroy township, 11 miles in Gauthier township, 5 miles in Lebel and lesser amounts in each of Hearst, Skead, Catharine, McGarry, McVittie, Teck, Grenfell, and Otto townships.

Results of these investigations indicate a pronounced bedrock channel running south from the southeastern extremity of Victoria Lake in northwest Gauthier township through Mousseau Lake and thence approximately south-southeast to pass 2 miles west of the southeast corner of McElroy township. A major branch from this feature extends west into Lebel township toward Conroyal Lake, and a second major branch trends east through Grassy Lake in north McElroy township. An abrupt eastward "jog" occurs in west-central McElroy township north of the Misema River, coincident with a channel depth (the maximum recorded) of at least 350 feet. Depths elsewhere in this channel depth system range from 150 to 300 feet. A somewhat shallower channel (100 to 150 feet) appears to connect west McTavish Lake south through Mud Lake to Turtle Lake in Lebel township, possibly branching at Mud Lake northwest toward Heart Lake.

64. SURFICIAL GEOLOGY, KINGSTON (SOUTHEAST) MAP-AREA

E.P. Henderson

Surficial deposits in Kingston southeast (31 C SE) map-area consist principally of till, glaciofluvial gravel and sand, and varved clay. These deposits generally are thin, and bare bedrock hills are common within those parts of the area lying within the Precambrian Shield. Striae and fluting on bedrock surfaces record glacial flow towards the south-southwest into the Lake Ontario basin.

The varved silts accumulated in a lake held up by glacial ice in the St. Lawrence valley. The distribution of the silts—on flats and in valleys rather than on topographic 'highs'—is ascribed to selective deposition by dense, cold sediment-carrying bottom currents controlled by the configuration of the lake bottom. General absence of shoreline features suggests that the lake was short-lived. Local shore and shallow-water deposits in the eastern part of the area occur at an altitude that suggests equivalence to the Belleville lake stage of Mirynech[1].

Marine clays such as those occurring farther east in the St. Lawrence valley have not been found within the map-area. Thus, contrary to some earlier reports, the Champlain Sea did not extend as far west as the area.

---

[1] Mirynech, E.: Pleistocene geology of the Trenton - Campbellford map-area, Ontario; unpub. Ph.D. thesis, Univ. of Toronto (1962).

65. GEOCHEMICAL STUDY, KIRKLAND LAKE AREA

R.H.C. Holman

A study begun in 1962 in this district for the purpose of appraising the possibilities of applying geochemical techniques to mineral exploration (especially for gold) was continued.

Attention was again confined to the geochemistry of bedrock in order to investigate the distribution of certain chemical elements, which might provide primary targets related either spatially or genetically to mineralized zones. This bedrock work was regarded as an essential preliminary to studies of surficial materials.

During 1963 some 500 specimens of the several different rocks were collected from underground in gold mines, from surface outcrops within the camp, and from the surrounding region. These specimens were crushed and pulverized in the field, and analysed spectrographically for the 14 elements, Ba, B, Cu, Pb, Cr, Mn, Mo, Ni, Sr, Sn, Ti, V, Ag, Zr, in the mobile spectrographic laboratory.

In the course of the field work a need to extend the study to an examination of specific rock-forming minerals was recognized, and begun on magnetite. Samples of magnetite were separated from about 70 rock specimens and analysed spectrographically for the elements already listed using a special semi-quantitative technique developed during the field study. Experimental work was begun, also, on the determination of gold in rocks using a chemical concentration technique prior to spectrographic measurement.

In addition, spectrographic analyses of 225 samples of glacial till collected by Dr. H.A. Lee were made for the 14 elements listed.

A preliminary examination of the data collected so far has not revealed any patterns in the distributions of the elements determined in the rocks and magnetites, either on the local or regional scale, that show a sufficiently clear relationship to the gold-bearing zones to be of immediate interest as an exploration technique. This preliminary assessment may need revising after a more thorough study of the results has been made, and further work on the suite of 950 samples is completed. No more field sampling is contemplated at this stage.

High concentrations of barium (greater than 1,000 ppm) and strontium (greater than 500 ppm) in selected samples of rocks of the Timiskaming Series and Algoman intrusive rocks were thought, at first, to be spatially related to the gold mineralization, but were later found to be markedly characteristic of most rocks of these two suites throughout the region as a whole. Specimens of rock from the Keewatin Series, on the other hand, rarely gave barium concentrations above 500 ppm and strontium above 300 ppm.

66. A MICROMAGNETIC SURVEY NEAR NAKINA

P.J. Hood

A micromagnetic survey with concomitant geological mapping on the scale of 1 inch to 10 feet was carried out on two

outcrops of Precambrian iron-formation, about 40 miles north of Nakina (42 L), in an attempt to synthesize the recorded magnetic variations from the observed geology and measured magnetic properties.

A recently-developed fluxgate magnetometer was used for a vertical-force survey and approximately 30,000 readings were obtained with this instrument. The average was about 1,200 readings per surveying day. The instrument was also utilized as a drill-hole magnetometer using a remote sensing element on 50 feet of cable, and a third application was its employment as a combined susceptibility - remanent magnetism metre.

It was found that off-scale readings were obtained over the iron-formation even though the instrument had a range of $\pm$ 100,000 gammas. A simple ancillary unit was built in the field to extend the range, thus enabling the maximum recorded value of 320,000 gammas to be obtained at the normal surveying height of 2 1/2 feet above the outcrop. Using a more elaborate arrangement a value of 870,000 gammas was obtained immediately above the surface of the outcrop at the same location. Surprisingly, the outcrop in the immediate vicinity consisted of banded, not massive iron-formation.

Dip-needle and horizontal declination surveys were also carried out on the outcrops.

A portable diamond-drill was used to obtain 235 oriented cores from the two outcrops for subsequent laboratory investigations, a sun compass being used to obtain the orientation in this highly anomalous magnetic area.

Preliminary results indicate that remanent magnetism makes a significant contribution to the production of the observed anomalies and in many cases predominates over the induced component.

A feasibility study was carried out using the fluxgate magnetometer mounted in the bow of a canoe, which was powered by an outboard motor, i.e. as a waterborne instrument. Traverses were carried out on nearby lakes to see whether the iron-formation continued along strike, air photographs being used to position the profiles. It was found that the instrument could be effectively utilized in this manner enabling traverses to be obtained in a rapid fashion.

67. GOLD DISPERSION IN THE KIRKLAND LAKE TILL FAN

H.A. Lee

Gold was found and measured in the till at Kirkland Lake. Approximately 1.7 cubic-foot samples of till were taken from pits opened with dynamite. This was washed through a nest of screens onto a riffle mat, where a valuable concentrate for measuring gold was collected.

A plot of samples having free gold in the riffle concentrate outlines a glacial fan, the source of which overlies the Kirkland Lake fault and stretches from Macassa mine on the west to Toburn mine on the east. The number of visible gold grains per sample

in the fan decreases southwards from 1 to 10 grains on the first grid line 2,000 feet south of the fault, to 1 to 3 grains on the 4,000-foot line south of the fault, and is generally absent 9,000 feet south of the fault.

Certain geological conditions have combined to make possible the recognition of this gold anomaly. Because gold in the Kirkland Lake mining camp is concentrated in shear zones, and because these are zones of physically broken rock, they provided a major selective load to the glaciers. This is apparent by an over abundance of sheared and gangue material in the till immediately south of the fault. Another geological factor of importance is the alteration of the till owing to the action of former Lake Barlow-Ojibway. Changing water levels in the lake have hastened disintegration of the pyrite, allowing any contained gold to be freed. In the Kirkland Lake mining camp the pyrite is auriferous.

The gold freed from the disintegrated pyrite goes into the fines, where it reappears on the riffle concentrate. This process explains abnormally low gold values in the sand sizes of the till of 0.001 ppm (0.00003 oz./ton) by neutron activation, compared to as much as 20 ppm (0.6 oz./ton) on the riffle concentrate. The above geological conditions at the Kirkland Lake mining camp fortunately also exist along the length of the economically important Cadillac - Larder Lake break. Dispersion of blue-black quartz (3.4 mm to 8 mm sizes), chlorite (8 mm to 16 mm sizes), and magnetite containing silver (riffle concentrate) have been measured in the till from the Kirkland Lake fault.

The results of this work are given in GSC Paper 63-45.

68. SURFICIAL GEOLOGY, SYDENHAM (31 C/7) AND BATH (31 C/2) MAP-AREAS

E. Mirynech

This area is part of an extensive limestone plain, which is divided into blocks by a succession of southwest-trending bedrock valleys that head on the adjoining Shield area. The plain surfaces are covered by a thin discontinuous sheet of stony ground moraine, the bedrock valley floors by stratified silts and clays. The absence of drumlins, the thinness of the ground moraine, and the highly irregular Palaeozoic margin suggest the eastern parts of these map-areas experienced substantial glacial erosion during Wisconsin time.

Clay occurrence is limited to the valleys and lake lowland, suggesting that deposition occurred during low-level post-Iroquois lake stages. The lack of beach deposits on the limestone plain above the clay deposits seems to support this view. A series of clay ridges, oriented northwest-southeast, occur in the Little Cataraqui Creek valley. They appear morainic yet there is almost a complete lack of sediment coarser than fine sand in size. The ridges are composed of stratified clay, which locally appears weakly varved. The beds exhibit minor deformation only. It is hoped new cuts and/or borings will provide more information regarding the origin of these ridges.

69. BOTTOM SEDIMENTS, LAKE ON THE MOUNTAIN AND ROBLIN LAKE

E. Mirynech

In February and March a winter works drilling project was carried out jointly by E. Mirynech and J. Terasmae, with the cooperation of B.A. Liberty, on Lake on the Mountain and Roblin Lake in Prince Edward county. A continuous series of Shelby-tube samples was collected to bedrock. Site selection was based on earlier echo sounding and underwater geological data, obtained through the cooperation of R.E. Deane of the Great Lakes Institute, and made with the view to obtaining complete sedimentation and palynological records from these chronologically interesting lakes. It was hoped too that the drilling information would yield further evidence pertaining to the origin of these isolated rock basins.

Neither Lake on the Mountain nor Roblin Lake are "bottomless", contrary to local popular belief, but the lakes do occupy surprisingly deep bedrock depressions, which are presently filled with substantial thickness of glacial, glacio-lacustrine, and lacustrine sediments. Neither lake basin has a buried outlet channel. It is hoped that continuing laboratory studies of the cores will provide a clear insite to the sedimentary history of these basins, the climatological history of the area from the last glacial stage to the present, and to the age of the bottom sediments. The present lakes formed after the Iroquois and Frontenac lake stages, but prior to the present lake stage.

70. LONG POINT DRILLING PROJECT, LAKE ERIE

E. Mirynech

Early in March the writer was associated with stratigraphic drilling on the tip of Long Point, a project sponsored jointly by the Geological Survey of Canada (see Terasmae, Abst. No. 118) and the Great Lakes Institute (R.E. Deane). Samples in continuous series were collected from the ground surface of this rapidly growing spit to bedrock, i.e. through nearly 400 feet of unconsolidated lacustrine, glacio-lacustrine, and glacial sediments. Continuing research projects are expected to provide considerable information regarding Pleistocene and post-Pleistocene history in the Lake Erie Basin.

71. CARLETON PLACE (31 F/1) MAP-AREA

E.W. Reinhardt

Except for minor flat-lying Palaeozoic sandstone in the northeast and southeast corners, the area is underlain by rocks of the Grenville Province of the Precambrian Shield. Medium- to coarse-grained marble, which may contain tremolite, accounts for half the area and occurs mainly as a broad northeastward-trending belt in the southwest and central parts. This belt is flanked on the east by a sequence of northward-striking amphibolites, garnetiferous amphibolites, biotite-garnet-hornblende gneiss, and concordant granite, all of which are intercalated with marble. Fine-grained dark amphibolite

follows the west boundary of the map-area, defines a complicated synclinal nose in the northwest corner, and wraps around and separates from the central marble a pluton of gneissic granodiorite, which extends into the area from the north and which appears semicircular on the map. Irregular masses of hornblende diorite occur in marble east of the west amphibolite.

Decorative stone is being quarried along the west boundary of the area southwest of Tatlock by Angelstone Limited, who recover white marble, and by Omega Limited, who recover blue marble. Mapping indicates that this marble crosses the map-area in the form of an arc, including the quarries; possibly its extension crosses the western boundary of the map-area northwest of Tatlock to continue northeastward. Pink marble suitable for architectural aggregate occurs in contact with granodiorite northeast of Clayton. Much of the marble in the area is of building stone quality. The area has an abundant supply of sand and gravel, especially at a location 2 miles northeast of Lanark.

72. GEOLOGICAL STUDIES IN THE IRON-FORMATIONS IN THE LAKE TIMAGAMI AREA

H.P. Wilton

Work was begun on a study of the depositional environment and origin of the early Precambrian banded iron-formations in the Lake Timagami area (parts of 31 NW and 41 NE). (See also Gross, abst. No. 109).

These iron-formations can be divided into two distinct ranges, the Vermilion-Iron-Kokoko Lakes range and the Timagami-Tetapaga Lakes range, the two being roughly parallel and about 1 1/2 to 3 miles apart. Field work to date has involved detailed section mapping, along pre-existing picket lines, over all but the Kokoko Lake region. In this mapping, attention was focussed on primary depositional and structural features, variations in sedimentary facies of the iron-formations, as well as the distribution and lithology of associated rocks. Before attempting to outline the Keewatin stratigraphy of the area, it is essential to further test the hypothesis of Moorhouse[1] that the two major iron ranges are related as opposite limbs of a regional syncline. To date, strong structural evidence has been obtained in support of the idea, but there is minor conflicting evidence. Stratigraphic evidence is also still inconclusive, although suspicion is cast on the hypothesis by the occurrence of interbanded chert and chloritic volcanic rocks as a persistent, non-magnetic unit on the north edges of both iron ranges.

The geological environment in which the iron-formation was deposited was undoubtedly volcanic. All of the associated rock types in the stratigraphic column are of volcanic origin. Chloritic tuffaceous bands and grey, water-laid tuffs are intimately interbanded with the iron-formation, particularly on the Timagami-Tetapaga Lakes range, and must be regarded as representative of the environmental conditions during deposition of the iron-formations.

---

[1] Moorehouse, W.W.: The northeastern portion of the Timagami Lake area; Ont. Dept. Mines, vol. 51, pt. 6, 1942.

73. TICHBORNE (31 C/10) MAP-AREA

H.R. Wynne-Edwards

The map-area lies on the Frontenac Axis and is part of the Grenville structural province of the Canadian Shield. The bedrock is Precambrian and is divided into two major units along the northeast-trending diagonal of the east half of the map-area. These units are (1) a heterogeneous, highly metamorphosed, predominantly meta-sedimentary sequence of marbles and well foliated gneisses (Grenville Series ?) to the southeast, and (2) a homogeneous, predominantly cataclastic gneiss complex of foliated quartz diorite and syenite to the northwest. The rocks of the first group are similar to those already mapped southeastward to the St. Lawrence River, but those of the second group do not occur in that part of the Frontenac Axis. They are, however, common to the northwest and north. Preliminary structural investigations suggest that the second unit, although now conformable with and locally intrusive into the first, actually represents a crystalline basement (on which the Grenville Series was deposited) recycled and remetamorphosed by the Grenville orogeny.

QUEBEC

74. AN EXPERIMENTAL AEROMAGNETIC - PHOTOGEOLOGIC SURVEY

D.T. Anderson

A colour photographic survey was made of the Coulonge River Basin in southwestern Quebec (31 K E 1/2), which consisted of 3 flight strips, each at 2,800 feet and 4,600 feet above sea-level, giving approximate scales of 1 inch = 300 feet and 600 feet respectively on 9 x 9 inch transparencies. Panchromatic film was exposed simultaneously in a second camera.

Three areas were selected for photo-geological interpretation and the results were checked in the field.

Samples were taken of all the major rock types found in these three areas with emphasis placed on selecting the weathering surface typical of that exposed to the aerial camera. These weathering surfaces will be classified according to a colour system (e.g. Munsell) and a comparison made with the colour visible from the air.

A 1 inch = 4 miles composite was made of the aeromagnetic data, and using a 1 inch = 4 mile composite of the adjacent geological mapping for reference, a geological interpretative map was made.

The following conclusions may be drawn from the investigation to date: (1) colour photography is superior to panchromatic for dilineating areas of outcrop because of its higher resolution; (2) it is very difficult to distinguish granitic gneiss from the paragneiss (generally granitized in part) on the colour photos; and (3) a reasonably valid geological interpretation could be made using the aeromagnetic data in an area adjacent to a previously mapped area.

75. GEOLOGY OF MANICOUAGAN - MUSHALAGAN LAKES

K.L. Currie

This circular feature in central Quebec (parts of 22 K and 22 N) consists of a hexagonal rounded horst of Precambrian anorthosite and garnet gneiss, intensely altered to hematite and sericite along the bounding faults, surrounded by a dissected plateau of post-Ordovician lavas. The feeders of the lava were apparently along the fault systems, and numerous such feeders and outliers of lava were discovered in an irregular ring of Precambrian rocks surrounding the central core. It appears very unlikely that the lavas ever covered the central peak. Around the outside of the feature, lavas rest disconformably on Ordovician limestone. The limestones are confined to the shores of the large lakes, apparently because the pre-lava surface sloped gently upward to a central peak. The outlines of Manicouagan and Mushalagan Lakes are at least partly caused by faults, some of which also served as lava feeders. Development of this feature is believed to have resulted from broad regional uplift, succeeded by down-dropping of an annular block, possibly along conical fractures. Volcanic eruption was the final stage of development.

76. AN EXPERIMENTAL HAMMER SEISMIC SURVEY IN THE BEAUCEVILLE AREA

J. Depatie

The writer conducted a hammer seismic survey in the Beauceville area, Quebec, in order to find and outline preglacial buried channels in bedrock. These channels, according to geologists familiar with the area, may possibly contain gold-bearing gravels. The instrument used was the MD-1 hammer refraction seismograph. The crew consisted of two men.

The project, being experimental, was carried out in reconnaissance fashion, in order to cover as much ground as possible in two and one half months. Traverses were set up every half mile or mile. On each traverse the readings were carefully taken and verified back if not satisfactory and each traverse was also surveyed with an alidade.

Some velocity measurements were affected by: (1) the presence of huge boulders in the non-consolidated material overlying the bedrock; and (2) the fact that bedrock itself, consisting of sedimentary beds that have been severely folded and faulted in the Appalachian regions, was yielding different apparent velocities. Taking account of these two major difficulties, the accuracy of the work was within $\pm$ 10 per cent for depths exceeding 20 feet.

This survey has now established 20 profiles of bedrock, half of which proved the presence of a buried channel. With the help of these profiles, two interesting buried channels have been drawn and there is no doubt about their extension.

The experiment was therefore successful and indicated that further similar projects may prove worth while in this area.

77. FIELD TESTING A PORTABLE GAMMA-RAY SPECTROMETER

R. Doig

Construction of a portable three-channel gamma-ray spectrometer was completed early in the field season of 1963. The instrument is designed to perform quantitative analyses, in situ, for potassium, uranium and thorium, in the amounts that occur in ordinary rocks.

A field procedure has been established and the resolution and the effect of geometry determined. Measurements were made on a variety of rock types in southwestern Quebec. Samples were taken from outcrops in several localities and will be analyzed using conventional methods. The results will form the basis for the calibration of the instrument.

To evaluate the spectrometer's use a number of surveys have been carried out. The major project was the mapping of the Preissac granite on Indian Peninsula, Lac Preissac, in northwestern Quebec, using the gamma-ray spectrometer.

78. NEW MORAINIC SYSTEMS IN THE ST. LAWRENCE LOWLANDS

N.R. Gadd

The glacial history of the Chaudière River valley comprises basically two periods of glaciation from Laurentian centres of accumulation and an interstadial, or perhaps interglacial, period of fresh-water erosion and deposition. The first glaciation is represented in only a few places by a compact sandy silt till, which is in contact with bedrock wherever observed.

Sediments deposited between the glacial episodes and during the advance of the second ice-sheet, are dominantly gravel and sand. Although these have been exploited from time to time over the past century as gold placer deposits, there is only one company, Beauce Placer Mining Limited, actively interested and which worked gravels and underlying fractured slate bedrock in glacially buried channels along the Gilbert River near St. Simon-les-Mines up until early summer 1963. Operation of their massive electric-powered drag-line and dredge equipment was suspended at the time of writing. Kennebec Construction Company is actively exploiting a 100-foot section of gravel in their pit 3 miles upstream from St. Georges de Beauce on the west bank of the Chaudière. Their operation requires stripping of overlying till-varved clay complex. Several smaller pits are known in this deposit and others in the area remain to be developed. Additional gravels in the areas under study are related to very extensive deposits that have been traced for many miles across the province.

A massive kame delta deposit of gravel at one time blocked the Chaudière valley at Vallee Jonction; large remnants on both sides of the valley now support a number of active gravel pits. This gravel deposit is related to major morainic features, also mainly of gravel, which were deposited during a significant halt in the retreat of the ice front at the end of the second glaciation. Related features extend southwestward at least to St. Sylvestre and northeastward at least to St. Philémon (Co. Bellechasse). These deposits attain elevations over 1,000 feet present elevation, and in many places are 100 feet or more in thickness.

A younger morainic system crosses the Chaudière valley at St. Maxime de Scott (Scott Jonction). During the field season the writer traced it northeastward for about 125 miles to where it joins the moraines at St. Antonin (St. Modeste map-area, 21 N/14 W) described by Lee[1]. Southwestward the morainic system has been traced, to date, to Danville, Quebec, and probably extends beyond there in the direction of Lake Champlain. Although the ridges are discontinuous over the distance observed, they have a very similar kame moraine character and hence are the locus of much gravel pit activity. This younger morainic system lies mainly at elevations between 400 and 700 feet above present sea-level.

It is contended that ice standing at positions marked by these newly-discovered morainic systems controlled the formation and drainage of many of the glacial lakes along the northern flank of the

---

[1]Lee, H.A.: Surficial geology of Riviere du Loup - Trois Pistoles area, Quebec; Geol. Surv. Can., Paper 61-32 (1962).

Appalachian Highlands and probably also controlled drainage northeastward of the Glacial Great Lakes. In addition it controlled occupation of the St. Lawrence valley by marine waters of the Champlain Sea entering along the lower St. Lawrence route.

NEW QUEBEC AND LABRADOR

79. KASHESHIBAW LAKE (WEST HALF) (13 L W 1/2) MAP-AREA

R.F. Emslie

The eastern part of the Michikamau intrusion[1] has been outlined, mapped structurally, and sampled. Both olivine facies and pyroxene facies rocks are found to comprise large, separate parts of the intrusion. A fine-grained marginal zone is present at the contact of the intrusion in many places. A well-developed thermal aureole exhibited in metasedimentary rocks is found along approximately one-third of the perimeter of the intrusion. Concentrations of opaque oxide minerals occur in several places near the contact of the intrusion. Disseminated ilmenite and stringers of massive ilmenite comprise up to 50 per cent of the rock over a considerable area a few miles north of Fraser Lake.

A large part of the map-area is underlain by massive and foliated granitic rocks and granitic gneisses; some are pyroxene-bearing. The northeastern corner of the map-area is occupied by part of a huge anorthositic intrusion, which appears to have a domed structure in this vicinity. A few outcrops of flat-lying metasedimentary rocks occur in the east-central part of the map-area.

Evidence has been found at Lake Michikamau of abandoned beaches, which occur 30 to 40 feet above the present lake level. Glaciation and deglaciation features trend east to southeast over most of the map-area.

80. OPOCOPA LAKE (23 B E 1/2) MAP-AREA

G.D. Jackson

Opocopa Lake (23 B E 1/2) map-area extends from 52° to 53° north latitude, and from 66° to 67° west longitude. A small area at the south end of the Shabogamo Lake area (23 G E 1/2) was also examined.

The western part of the area is underlain mainly by metamorphosed rocks of the Labrador Geosyncline, which include: quartz-biotite-plagioclase-garnet-kyanite schists and gneisses of the Katsao Formation, Duley marble, Wapussakatoo quartzite, Wabush iron-formation, quartz-muscovite-plagioclase-kyanite-garnet-graphite schists and gneisses of the Nault Formation, and the Shabogamo gabbro and meta-gabbro.

The rest of the area is underlain by felsic gneisses, minor associated granitic intrusions and pegmatites, gabbroic intrusions and derived metamorphic rocks, and a few granulites. Some of the gneisses probably represent metamorphosed Geosyncline rocks, and the granulites may represent basement rocks[2].

---

[1]Emslie, R.F.: Michikamau Lake (East Half), Quebec - Newfoundland; Geol. Surv. Can., Paper 63-20 (1963).

[2]Clarke, P.J.: Felix Lake area, Saguenay county; Que. Dept. Nat. Res., Geol. Surv. Br., Prel. Rept. 491 (1962).

Leucocratic to mesocratic coronitic, intergranular gabbros are most abundant in a north-south belt extending through the centre of the area. Melanocratic, hypidiomorphic gabbros are most abundant in the eastern and western parts of the area.

Throughout much of the area the dominant structural trend is north-northwest - south-southeast. In some places where marker horizons are present, relatively tightly folded rocks seem to have been folded again into more open, larger scale folds. Prominent lineaments and shear zones suggest that some large-scale fault zones may be present.

A small zone of quartz-magnetite iron-formation, 2 miles south of the south end of Lac Jouquet, may be a northward extension of a zone of hematite-rich iron-formation mapped by Clarke[1]. Minor disseminated sulphide minerals (Cu, Pb, Zn) are associated mainly with small ultrabasic intrusions.

81. OPERATION LEAF RIVER

I.M. Stevenson

The following NTS areas were completed for publication on a scale of 1 inch to 8 miles: 35 A, B, C, D; 34 B, G, J, O, N, K, F, C, L, M; and 25 C, D. The total area mapped was approximately 48,000 square miles. Operation Leaf River was the continuation and completion of a project commenced in 1961[1]. Survey personnel mapping bedrock consisted of I.M. Stevenson, H.H. Bostock, R. Skinner, and F.C. Taylor. E. Mirynech mapped the surficial deposits.

Bedrock consists mainly of an assemblage of granite, granite gneiss, paragneiss, and associated rocks of Archaean age. The entire region is cut by numerous pegmatite and diabase dykes. The narrow band of Proterozoic sediments along the east coast of Hudson Bay and the off-shore Nastopoka and Hopewell Islands were briefly examined. The southwest-trending band of volcanic and sedimentary rocks that form the Wakeham Bay complex is exposed only in the extreme northwestern corner of the map-area; these rocks were examined in some detail. The northern terminal of the iron-bearing "Labrador trough" is poorly exposed as a syncline in the northeastern corner of the map-area.

Sulphide minerals were noted at various locations, the chief of which are: (1) along the south margin of the Wakeham Bay belt, at or near the contact between the Archaean granites and the younger Wakeham Bay complex; (2) on Smith Island, which is a west extension of the Wakeham Bay belt; and (3) in the volcanic and sedimentary rock complex immediately north of Payne Bay. Linear bands of rusty, gossan-type rocks, of which the main sulphide appears to be pyrite, are found at various localities in the paragneisses. Individual bands are rarely more than a few tens of feet wide.

---

[1]Clarke, P.J.: Felix Lake area, Saguenay county; Que. Nat. Res., Geol. Surv. Br., Prel. Rept. 491 (1962).

[2]Stevenson, I.M.: Leaf River map-area, New Quebec; Geol. Surv. Can., Paper 62-24 (1963).

The iron formation north of Payne Bay is of possible economic interest. A small vein of anthraxolite, of scientific interest only, cuts Proterozoic volcanic rock near Port Harrison.

Routine traverses crossed the area containing Lac Couture, the basin of which has recently been suggested to have an impact crater origin. Rocks in the immediate area consist chiefly of gneissic and massive granites with rare mafic inclusions of sedimentary and volcanic rocks. Foliation in the area trends northward. Evidence favouring an impact origin for the lake basin was not found.

A two-week examination of the rock types in Clearwater Lake was made by Dr. H. Bostock (see Abstract No. 81a).

In addition to Leaf River map-area, the areas NTS 23 G (W 1/2) and 24 K (E 1/2) were mapped for publication on a scale of 1 inch to 4 miles. The area 23 G (W 1/2) is underlain by a mixed assemblage of massive granite, granite gneiss, paragneiss, and granulite-type rocks. The granulite-type rocks may be either massive or gneissic, commonly contain blue quartz, and are of a distinctive olive-green colour. The area 24 K E 1/2 consists of granitic gneisses and highly metamorphosed sedimentary and volcanic rocks, which are part of the Labrador Trough. Barren pegmatite is common, in many places forming more than 50 per cent of the rock.

81a. GEOLOGICAL STUDIES, CLEARWATER LAKE

H.H. Bostock

Two weeks were spent mapping the islands in West Clearwater Lake (in the Operation Leaf River area) and a traverse by helicopter was flown about the periphery of this part of the lake. Samples were collected for radiometric age determination, paleomagnetic study, chemical analysis, heavy mineral separation, and petrographic study.

The rocks are tentatively divided into five main units in order of decreasing age: —

(1) Basement rocks (Precambrian), intruded by small basic bodies of uncertain age found only on the island ring.

(2) Ordovician limestone.

(3) Friable breccia, locally glass-bearing.

(4) Coherent breccia.

(5) Massive dacite.

Excluding unit (2), transitional lithologies exist between each successive pair.

Units (4) and (5) show no preferred lateral deposition, but unit (3) appears principally along channels separating islands, or in the vicinity of bays or lineaments. Several vertical contacts between basement and units (4) and (5) have been exposed for up to 20 vertical feet, and at one locality in the northwest sector a semi-friable breccia body is exposed in bluffs that are 180 feet long and some 200 feet high,

with nearly vertical contacts at either end. Inland, however, the structure is completely drift covered.

Three previously unreported bodies of limestone lying on granite basement up to 350 feet above lake level have been found on the large island in the northeast sector. Since limestone is not evident elsewhere at the unconformity between basement and breccia-dacite it is inferred that the limestone was largely eroded prior to development of the Clearwater Lake structure and that there was considerable uplift of the island circle associated with this development.

The disposition of friable breccia, the nature of contacts between basement and breccia-dacite, the possible sequence of intrusion with early basic bodies followed by breccia and dacite within the island ring, and the similarity of these lithologies to those found at Manicouagan Lake (see Abstact No. 75) where the structural relations are perhaps better exposed lead the author to believe that these rocks were extruded from below and may be entirely the result of volcano-tectonic processes as proposed by Kranck[1]. The possibility that volcanism may have been triggered by meteorite impact, however, remains open.

81b. PLEISTOCENE GEOLOGY, OPERATION LEAF RIVER

E. Mirynech

The region mapped lies between the east coast of Hudson Bay and the 75th meridian extending northward from latitude 56° 00' to latitude 61° 00'. It continues eastward from the 75th meridian, between latitudes 60° 00' and 61° 00', to Ungava Bay. This area was glaciated during the Wisconsin continental glaciation. There is also evidence of valley glaciation in the extreme northeastern corner of the area and the narrow zone between latitude 61° 00' and the south side of Hudson Strait, west of Diana Bay.

Continental ice flowed westward to the west of a northwesterly trending ice-flow and meltwater-divide belt that extends between Lac Couture and the Iktotat River. On the Ottawa Islands, off the coast of Hudson Bay, the striations are nearly north-south, but the writer could not ascertain definitely whether flowage was to the north or south. Bell[2] reported flowage was to the north, which is perpendicular to flow direction on the mainland. Ice-flow was northeast to the east of the ice-flow and meltwater divide belt, becoming more northerly in the vicinity of Hudson Strait. Valley glaciers appear to have existed during the final stages of deglaciation along the south side of Hudson Strait. Small slightly arcuate transverse morainic ridges in the heads of some fiord-like valleys indicate southerly withdrawal of ice in the valleys.

As the Wisconsin ice-sheet contracted in Ungava marine waters spread over low-lying areas bordering Hudson and Ungava Bays.

---

[1]Kranck, S.H., and Sinclair, G.W.: Clearwater Lake, New Quebec; Geol. Surv. Can., Bull. 100 (1963).

[2]Bell, R.: Observations on the geology, zoology, and botany of Hudson's Strait and Bay, made in 1885; Geol. Surv. Can., Ann. Rept. 1, pt. DD, pp. 1-20 (1885).

Morainic ridges developed at or near the ice-front, of the washboard type, reflecting its lobate character. Marine beaches, bars, terraces, and deltas formed along the ancient shorelines, which were subsequently uplifted due to glacial rebound. Eskers, kames, kame moraine, and outwash deposits occur above and below the marine limit, but washboard moraine ridges were not found above it. Vast areas of felsenmeer occur east of the ice-flow and meltwater divide belt.

Low rounded mounds are common in the southern part of the area wherever marine silts occur. These frost-heaved forms are oval to elongate in outline and occur both with and without brown organic caps. Well formed string bogs are common in the southern part of the map-area as well.

QUEBEC AND NEW BRUNSWICK

82. RESTIGOUCHE AREA

W.H. Poole

Geological mapping of Restigouche area (21 O/11, 12, 13, 14) totalling 1,600 square miles in northernmost New Brunswick and adjacent Quebec was accomplished in one summer.

Quartzite, slaty argillite, and minor grit underlying the central and eastern part of the area comprise the lower division of the Ordovician Matapedia Group. Argillaceous limestone and calcareous slate of the upper division extend more or less along the Restigouche River, west of the lower division. The upper division gradationally and conformably overlies the lower division.

Silurian and Devonian strata to the northwest adjoin the upper division of the Matapedia Group along a major steeply dipping strike fault. A band of Silurian quartzite and argillite pinches out from southwest to northeast against the fault near Patapedia River. Silty slate and slate with minor sandstone of the Lower (?) Devonian Fortin Group is exposed in most of the northwestern third of the map-area. The group overlies Silurian quartzite southwest of Patapedia River, and lies in fault-contact with Matapedia calcareous rocks northeast of the Patapedia.

In the extreme northwestern corner of the map-area, dark grey sandstone and argillite of the Lower Devonian York River Formation lie in apparent fault-contact with Fortin Group rocks.

The southeastern corner of the map-area is underlain by several bands of calcareous and argillaceous strata of uncertain ages and relations. These rocks are better exposed in the adjacent Upsalquitch Forks map-area (see Potter, R.R., abstract No. 88).

Devonian felsite dykes are locally common.

Strata are cleaved and openly folded. Folds plunge as much as 50° either northeast or southwest.

Other than a long-known, small copper prospect near the village of St-Francois d'Assise, Quebec, no mineral prospects or occurrences of economic minerals worthy of note are known in the area. Hydrocarbons suggestive of petroleum possibilities are lacking.

NEW BRUNSWICK

83. SKARN DEPOSITS IN THE ROCKY BROOK - MILLSTREAM AREA

D. Bachinski

The Lavigne Brook copper deposit was mapped on a scale of 1 inch to 200 feet, and all available drill core was examined from both the Lavigne Brook and Millstream Iron magnetite-chalcopyrite bodies.

Country rocks and deposits were sampled for trace-element analysis and petrographic studies. Whole-rock analyses are in process and trace-element analysis of magnetite will be undertaken at the Missouri School of Mines and Metallurgy in the forthcoming months.

The deposits occur in lime-silicate rocks within the contact metamorphic aureole of the Nicholas Denys granite. The deposits are spatially related to the Main Break of the Rocky Brook - Millstream fault system. The Main Break presumably lies along the crest of an anticline whose core is occupied by serpentinized peridotite.

84. GEOLOGY AND GROUNDWATER STUDIES IN THE MONCTON AREA

P.A. Carr

Groundwater studies and the geologic mapping of Moncton (21 I/2 W1/2) map-area have been compiled. No large supplies of groundwater are available for the city of Moncton in the bedrock or Pleistocene aquifers.

The geologic and groundwater data are now being compiled into a doctoral thesis at the University of Illinois.

85. GEOLOGY OF THE NIGADOO RIVER AREA

J.L. Davies

Field work consisted of regional mapping (scale 1 inch to 2,000 feet) of the northern limb of a large synclinorium consisting of Ordovician and Silurian rocks within Bathurst (21 P/12) map-area. This work completed the mapping begun in 1962[1]. A report and map, now in preparation, will describe the geology of the Nigadoo, Sturgeon River, and Lavigne Brook sulphide deposits.

The northern limb of the synclinorium is structurally simpler than the southern limb[1], which is complicated by the Rocky Brook - Millstream fault system. The northern limb consists of

---

[1]Davies, J.L.: Geology of the Rocky Brook - Millstream area, New Brunswick; Abst. No. 71 in Summary of Research: Field, 1962, compiled by S.E. Jenness; Geol. Surv. Can., Paper 63-1 (1963).

Rocky Brook - Millstream fault system. The northern limb consists of unfossiliferous grey and black phyllites and argillites, and subgreywacke of the Elmtree Group (Ordovician?), overlain by fossiliferous Middle Silurian rocks of the Chaleur Bay Group. The Chaleur Bay Group is made up of a lower sequence of grits, greywackes, conglomerates, and argillites intercalated with slate and phyllite, which is overlain by a thick sequence of limy slates, phyllites, argillites, and limestone with intercalated maroon sandstone, phyllite, and slate.

The Elmtree Group rocks generally display a higher degree of mechanical deformation than the rocks of the Chaleur Bay Group, suggesting the two groups of rocks are separated by an unconformity, although part of the contact is a fault.

Sills and dykes of quartz and feldspar porphyry, diabase, and diorite intrude the rocks of the northern limb of the synclinorium, but most of the intrusive rocks observed seem to be confined to the Chaleur Bay Group rocks. Aplite dykes cut the Chaleur Bay Group rocks within the northern part of the metamorphic aureole surrounding the Nicolas Denys granite stock.

A few small occurrences of galena were observed in a conglomerate of the Chaleur Bay Group in the vicinity of Nigadoo River, and one small occurrence of molybdenite was seen 2 miles north of Nicolas Denys. Minor disseminated pyrite and pyrrhotite are associated with the acidic intrusive dykes.

86. CAMBRIAN STRATIGRAPHY OF THE SAINT JOHN AREA

B. A. Greene

Rocks of Cambrian age occur in several isolated basins in the Saint John area, and Lower Ordovician strata overlie the Cambrian in one of these basins.

The sequence begins with a basal conglomerate, disconformably overlying the Precambrian, followed by the red and green sandstones and slates of the Ratcliffe Brook Formation. These grade upward into a white quartzite (the Glen Falls Formation), which grades in turn into medium grey sandstones and slates, with Protolenus, at the top of the Lower Cambrian.

Middle Cambrian strata begin with a thin bed of dark grey limestone, or with limy slates, followed by medium-dark grey slates and siltstones, bearing Paradoxides eteminicus and P. abenacus. These are overlain by dark grey slates with the laminae and lenses of light grey sandstone, and occasional limestone lenses with P. matthewi.

The top of the Middle Cambrian, and all of the Upper Cambrian, is formed of a thick sequence of interbedded sandstones and sandy slates. This sequence has yielded fossils of the Paradoxides matthewi, Agnostus pisiformis, Olenus, Parabolina, and Peltura zones at various places, but no satisfactory basis for its lithological subdivision has so far been established.

The topmost Cambrian beds contain many dark grey, sandy, slate horizons, which grade by a decrease in coarseness and an increase in abundance into the graptoliferous black slates of the Dictyonema flabelliforme and Tetragraptus zones of the Lower Ordovician.

87. A GEOCHEMICAL STUDY OF THE DEVONIAN GRANITIC ROCKS OF NEW BRUNSWICK

R. Martin

The initial phase of a petrographic and geochemical study of the Devonian granitic rocks of New Brunswick was undertaken during this field season. Sampling was restricted to granitic stocks and gneissose granitic rocks exposed north and west of Newcastle.

Samples are being analyzed for various trace elements, including Pb, Zn, Cu, Ag, Sn, Mo, W, As, and Sb. Selected samples will undergo mineral separation, and the trace-element distribution in the various fractions of these rocks will be studied.

Preliminary results of whole-rock analyses indicate that systematic variations in the trace-element distribution from one stock to another are recognizable, although the evaluation of this data has not yet been done.

Field work in the southern part of New Brunswick will be done during the next field season. As a result of this study, it is hoped that a correlation between the nature of mineralization in the country rocks and the geochemistry of the granitic rocks will be possible.

88. UPSALQUITCH FORKS 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 Forks (21 O/10) map-area. They appear to be overlain unconformably by an Upper Silurian lithic greywacke succession, consisting of green, maroon and grey conglomerate, sandstone, siltstone, and argillite. Maroon, green, and grey grits and argillites, which may be equivalent, outcrop in the vicinity of the International Paper Company Road, south of and parallel to Jerry Ferguson Brook and Mulligan Gulch Brook. They have been found to the west, on the head of Nine Mile Brook. These rocks are overlain conformably by green-grey argillites of Early Devonian age, which have been mapped in the vicinity of McCormack Fire Tower, Lawson Brook, and Williams Brook. Basic flows and dykes are abundant near Lawson Brook and Nine Mile Brook. Rhyolitic and andesitic volcanic rocks outcrop on the ridge west of Williams Brook and on the large hills south of McCormack Fire Tower.

Lower and Middle Silurian rocks underlie most of the northwestern part of the map-area. Dark grey chert and graphitic slate, containing graptolites (probably Middle Ordovician) were noted on the ridge northwest of Pat Brook, and on the Little Popelogan Brook, approximately 4 miles north of its mouth. Basic flows and pyroclastic rocks are associated with these rocks. East of Little Popelogan Brook, Silurian sedimentary rocks are overlain by rhyolites and andesites, which are in turn overlain by Lower Devonian argillites, and basaltic flows and tuffs. Devonian rhyolites were found on the large hills north of Jerry Ferguson Brook. A large fault, which is the western extension of the Rocky Brook - Millstream fault, has been mapped near Meadow Brook, Oxbow Brook, Mulligan Gulch Brook, and Pat Brook. Rocks south of this fault are in general more highly deformed than those to the north.

No mineral occurrences of economic interest were found.

89. GEOCHEMISTRY OF MOLYBDENUM, BATHURST - NEWCASTLE DISTRICT

M. Tauchid

Under the direction of R.W. Boyle, the writer completed field work on the geochemistry of molybdenum in the soils, rocks, ores, gossans, stream sediments and waters of the Bathurst - Newcastle district. (See also GSC Paper 63-1, abstract No. 74).

From analyses of over 100 soil profiles of podzolic type ($\pm$ 450 samples) the following observations were noted:

(1) Normal soils (outside any type of deposits) generally contain from less than 0.5 ppm up to 3.5 ppm molybdenum, though values as high as 18 ppm were encountered.

(2) The common enrichment of the element in the B horizon (where iron and aluminum hydrates are concentrated) of the profiles.

(3) High results were found in soils around and above molybdenum and other polymetallic deposits, and in soils rich in manganese oxides.

Over 150 rock samples of different rock units in the district[1] were collected and analyzed for molybdenum. Special emphasis was laid on granitic rocks, as data on other trace element analyses are available. Molybdenum values in the different types of rock range from less than 0.5 ppm to 3.0 ppm, with the exception of black schist and rocks disseminated with sulphides, which generally have higher values.

---

[1]Smith, C.H.: Bathurst - Newcastle area, Northumberland, Restigouche, and Gloucester Counties, New Brunswick; Geol. Surv. Can., Map 1-1957 (1957).

Detailed studies of the distribution of molybdenum in and around known deposits of the district were made. These include analyses of the different sulphide minerals, iron ores, manganese ores, and gossans and iron hydroxides being precipitated around springs.

90. GEOCHEMICAL STUDIES, BATHURST - NEWCASTLE DISTRICT

W.M Tupper

A 30-square mile area centring around the Brunswick No. 6 and New Larder W deposits was mapped on a scale of 1 inch to 1,000 feet. The map-area also includes the Austin Brook sulphide and iron deposits, and the mineralized belt that cuts across the Pabineau River east and north of Brunswick No. 6. The rocks in the map-area were extensively sampled for trace-element studies to supplement and assist in the evaluation of similar detailed studies in the wall-rocks at Brunswick No. 6.

The stratigraphy in ascending order in the map-area has been tentatively established as follows: phyllites and greywacke; quartz feldspar augen schists (quartz porphyry); iron formation; rhyolite; andesite; argillites and graphitic slates; rhyolite; quartz feldspar augen schist; and rhyolite. These rocks belong to the Ordovician Tetagouche Group. They are intruded by gabbro sills and plugs. The phyllite sequence is intruded by granite.

The Brunswick No. 6 and Austin Brook sulphide deposits are found along the quartz-feldspar augen schist-iron formation contact. Considerable amounts of sulphide are found along the phyllite - quartz feldspar augen schist contact in the Pabineau River area. The New Larder W deposit is believed to exist in a shear zone in the phyllite-greywacke sequence.

The rocks in the map-area are folded into a broad anticline and syncline, which plunge to the south. The Brunswick No. 6 deposit is found in a small parasitic syncline on the west limb of the anticline. At least three phases of structural deformation can be outlined.

A deep diamond-drill program was carried out on both the Captain and Owan Brook deposits during the field season. The drill core was examined to supplement studies undertaken in 1962.

NEW BRUNSWICK AND NOVA SCOTIA

91. SEISMIC SURVEY OF CHIGNECTO ISTHMUS

P. Killeen

A reconnaissance seismic program was carried out in the Chignecto Isthmus, which straddles the provincial boundary between Nova Scotia and New Brunswick. The Model FS-2 hammer refraction seismograph was used, and field operations confirmed the value of its directional properties in noise suppression.

A bedrock contour map was compiled from 279 seismic shots, numerous outcrops, and 283 bore-hole locations. Correlation of seismic velocities with the marine clays and sediments overlying the bedrock was carried out. Locations of buried preglacial channels were outlined.

It was found that no continuous channel extends across the isthmus, although several truncated channels exist.

92. MINERAL COLLECTION AREAS FOR TOURISTS IN NEW BRUNSWICK AND NOVA SCOTIA

Ann Sabina

Field work consisted of an investigation of mineral deposits of potential interest to the amateur mineral collector and tourist along the south shore of New Brunswick including Grand Manan Island, the Bay of Fundy shore of Nova Scotia, and the Atlantic shore of Nova Scotia from Yarmouth to Halifax. The deposits are within easy access of the main highways and branching roads. About 150 deposits were examined.

For the collector, the area furnishes a wide variety of minerals and rocks. Although most of them are primarily specimen material, a number of the deposits supply the type of minerals and/or rocks that can be used for ornamental purposes. Those suitable for polishing include amethyst, jasper, agate, chalcedony, epidote, breccias, some zeolites, and petrified wood. Other minerals available to the collector include gypsum, barite, zeolites, siderite, hematite, manganese minerals, fluorite, staurolite, andalusite, garnet, and various sulphides. A few fossil occurrences were visited and will be included in the report being prepared for publication.

Most of the collecting localities are accessible to motor vehicles and may require a hike of up to a mile. For some of the shoreline deposits, a boat is necessary.

NOVA SCOTIA

93. CARBONIFEROUS PALYNOLOGY, NEW GLASGOW AND PORT HOOD AREAS

M.S. Barss

Collecting of samples for palynological studies was carried out in the New Glasgow and Port Hood areas of Nova Scotia. In the New Glasgow area 13 samples were collected from the type section of the Pictou Group, as well as several samples in key areas bordering the type section. It is hoped that any spores recovered from these samples will provide more precise age relationships of the strata assigned to the Pictou Group throughout the Maritime Provinces. Also in the New Glasgow area, 5 samples were collected from the River John Group. At present the River John Group is considered to be equivalent to some part of the Horton Group. Since there is no paleontological evidence to support this assignment, it is hoped that spores can be recovered from these samples that will support a more definite age assignment.

In the Port Hood area 32 samples were collected from the type section of the Ainslie, Strathlorne, and Craignish Formations (Horton Group) on the Southwest Mabou River, for correlation with the type Horton Group, and for reference material in dating individual samples submitted by geologists for age determinations. An additional 17 samples were obtained from the nearby Graham River to further extend stratigraphically the coverage of the Horton Group. In this area it has already been discovered from spore studies that strata assigned to the Horton Group are older than the type section. It is felt that these samples could provide the necessary evidence for an accurate stratigraphic placement of these strata. Evidence as to the possible occurrence of a Mississippian - Devonian contact is also being sought with these samples.

94. LOCHABER (11 E/8) MAP-AREA

D.G. Benson

A narrow strip of tightly folded Goldenville (Ordovician) quartzite and phyllite occurs along the southern edge of the map-area. Andalusite and staurolite schist occur near the old Crow's Nest Gold Mine, southeast of Glenelg.

A fault separates the Goldenville from the moderately folded Horton (Lower Carboniferous) sediments to the north. These rocks underlie the central half of the area and are divisible into three units: a lower light grey quartz arenite and medium grey siltstone; a middle dark grey siltstone and wacke; and an upper reddish brown, green and grey shale, mudstone, and conglomerate.

The structurally complex Ordovician and Silurian rocks are also in fault contact with the Horton rocks. They consist of andesitic and rhyolitic flows, tuffs, and agglomerates intruded by

granite and minor diabase and gabbro. These rocks are overlain by fossiliferous Silurian wacke and siltstone on the west side of Lochaber Lake.

The northeast corner of the map-area is underlain by Windsor (Lower Carboniferous) shale and limestone.

Near College Grant, minor chalcopyrite occurs in diabase at an old prospect shaft. Galena was seen in Goldenville quartzite around an old adit southwest of Glenelg along the Horton - Goldenville contact.

95. PETROLOGICAL STUDIES, CAPE BRETON HIGHLANDS

S.E. Jenness

Two and one-half weeks in July were spent examining contact relationships and rock types of the pre-Carboniferous rocks in the northern half of Cape Breton Highlands. Special attention was given the granitic and gabbroic rocks in Ingonish (11 K/9) map-area. Much of the granite contains xenoliths of mica-quartz metasediments, and large areas of feldspathized mica-quartz rocks occur north and west of Ingonish. Field relationships suggest the present erosion surface has unroofed only the uppermost part of the granitic pluton, leaving a wide, variety of granitized rocks associated with more homogeneous, intrusive (?) granitic bodies. Specimens of the pre-Carboniferous rocks were collected for further study and for the Geological Survey's petrological collection.

Some observations were also made on the Carboniferous strata near Ingonish.

96. COBEQUID MOUNTAINS

D.G. Kelley

Systematic geological examination of the Cobequid Mountains was commenced near the eastern end of the range and the east half of Tatamagouche (11 E/11) map-area was completed.

The area north and south of the Cobequids, which is underlain by Carboniferous rocks, was included in the study.

The oldest rocks mapped are Silurian sedimentary rocks and probable Silurian sedimentary and volcanic rocks.

Red and grey sedimentary rocks, possibly correlative with the Lower Devonian Knoydart Formation, overlie the Silurian

rocks. These red and grey strata are transitional with a sequence of andesitic flows that contain minor sedimentary rocks. The andesites are intruded by quartz-feldspar and feldspar porphyries, although some of them may be flows.

Granitic rocks are known to cut probable Silurian rocks and may possibly cut the andesite.

Rocks on the south side of the Cobequids include Carboniferous sedimentary rocks that have been mapped in adjoining map-areas[1] as: Canso, Riversdale, Cumberland, and Pictou Groups, and a sequence of sedimentary and igneous rocks of possible Carboniferous age.

On the north side of the Cobequids are lower and upper River John Formation of possible Mississippian age and the Boss Point Formation and Millsville conglomerate of the Riversdale Group and the type section of the Pictou Group, all of Pennsylvanian age. The stratigraphic relations of several of these units is vague. All are present in the adjoining New Glasgow (11 E/10) map-area to the east (Gillis, W., pers. comm.).

---

[1]Stevenson, I.M.: Truro map-area, Nova Scotia, Geol. Surv. Can., Mem. 297 (1958).

PRINCE EDWARD ISLAND

97. SURFICIAL AND BEDROCK GEOLOGY, CHARLOTTETOWN (WEST HALF) MAP-AREA

V.K. Prest

Examination of the surficial deposits of Charlottetown (west half) map-area was carried out with the object of producing a map of the "soils" on a scale of 1 inch to 1 mile. Glaciofluvial deposits, ablation till, and ice-sloughed debris are not as common as in areas to the north and east. The practice of attempting to separate the basal till into three types (clayey, clay-sand, and sand phases) was continued inasmuch as these diverse though gradational phases have somewhat contrasting physical properties that have a direct bearing on soil development and land use practice.

In the course of the surficial geology studies the bedrock exposures were also examined as regards their geology. This has provided a sounder basis for further speculation as regards the continuity of the major "red bed" units including the conglomeratic (gravel) units. It has also provided information concerning the major structure of the island, though appraisal of this facet of the geology must await completion of the outstanding Summerside E/2, Tormentine, and Rustico W/2 map-areas.

NEWFOUNDLAND

98. BELLEORAM MAP-AREA

F.D. Anderson

Geological mapping of Belleoram (1 M) map-area, for publication on a scale of 1 inch to 4 miles, was completed. Parts of the map-area had been previously mapped on various scales[1].

The Garrison Hills gneissic granite consists mainly of meta-gneiss, derived from probable Ordovician sediments of the Bay d'Espoir Group. Granite, commonly porphyritic, occurs in a narrow belt a few miles wide along the southern margin of the meta-gneiss, and also in small lenticular masses and in injection gneiss, within the meta-gneiss.

Hungry Grove Pond (1 M/13) map-area is almost entirely underlain by granite. Three different ages of granitic intrusion were recognized.

Rock of Brunet Island, previously mapped as Cambrian is now believed to be mainly of Precambrian age and equivalent to the Musgravetown Group.

Molybdenite occurs in a quartz vein about 200 yards west of Hungry Grove Pond, longitude 55° 07', latitude 47° 54'40". The quartz vein cuts granite, ranges in width from 8 to 14 inches over an exposed length of 20 feet, strikes N5° E, dips vertically, and contains about 10 per cent molybdenite and minor bismuthinite.

99. PORT AUX BASQUES (11 O) MAP-AREA

J.W. Gillis

Pre-Carboniferous igneous and metamorphic rocks and minor sedimentary rocks underlie all but the northwestern part of the area. Sedimentary rocks of the Mississippian Anguille[2] and Codroy Groups and the Pennsylvanian Barachois Group occupy the remainder of the region.

---

[1]Bradley, D.A.: Gisborne Lake and Terrenceville map-areas, Newfoundland; Geol. Surv Can., Mem. 321 (1963).

Hutchinson, R.D.: Cambrian stratigraphy and trilobite faunas of southeastern Newfoundland; Geol. Surv. Can., Bull. 88 (1963).

Jewell, W.B.: Geology and mineral deposits of the Baie d'Espoir area; Geol. Surv. Nfld., Bull. 17 (1939).

Rose, E.R.: Geology of the area between Bonavista, Trinity, and Placentia Bays, Eastern Newfoundland; Geol. Surv. Nfld., Bull. 32, Pt. II (1948).

[2]Bell, W.A.: Early Carboniferous Strata of St. Georges Bay area, Newfoundland; Geol. Surv. Can., Bull. 10 (1948).

In the pre-Carboniferous terrain a distinct lineament that extends east-northeast for 40 miles from Cape Ray to the headwaters of Garia Brook apparently marks the boundary between dioritic and minor gabbroic intrusive rocks to the northwest and mainly granitic intrusive rocks to the southeast.

The gneisses, schists, and minor amphibolites southeast of the linear feature, which are well exposed along the coast from Cape Ray east to Garia Bay, may pass into rocks of the Lower to Middle Devonian Bay du Nord Group to the northeast along strike. Most of the granitic bodies southeast of the lineament are elongate parallel to and concordant with the gneisses, schists, and amphibolites. However, an equidimensional body of granite cuts across gneisses, schists, and granitic rocks as well as nearby argillites and metaquartzites in the Bay Le Moine - Little Garia Bay district.

Mineral prospects for copper, lead, zinc, and silver are known northeast of North Bay[1] and for copper and gold at Cinq Cerf[1]. Pods of magnetite less than 3 inches in diameter occur in the pre-Carboniferous granitic rocks southeast of the linear feature. A few crystals of sphalerite are disseminated through siltstones of the Mississippian Anguille Group 2 miles north of the village of Codroy.

100. BOTWOOD (EAST HALF) MAP-AREA

H. Williams

Botwood East Half (2 E E1/2) map-area was mapped suitable for 1 inch to 4 mile publication and the results of earlier 1-mile mapping integrated into a more regional pattern. Rocks of the area are chiefly Ordovician and Silurian sedimentary and volcanic rocks, which are folded, faulted, and intruded by a variety of igneous rocks. Silurian rocks of the Botwood Group were outlined and interpreted to form a northeast continuation of those mapped previously in the west half of the Botwood area[2]. Silurian rocks outcrop continuously from Notre Dame Junction eastward and northeastward to Horwood Bay.

Rocks of the Fogo Group[3] previously considered to be Ordovician have been assigned to the Silurian system on lithological grounds. Sedimentary and volcanic rocks of the South End and North End Formations, Fogo Group, closely resemble similar rocks of the Silurian Botwood Group and display a multitude of primary features typical of extreme shallow water and/or terrestrial deposition. In contrast Ordovician rocks of the area consist of grey to black slate,

---

[1]Cooper, J.R.: LaPoile - Cinq Cerf map-area, Newfoundland; Geol. Surv. Can., Mem. 276 (1954).

[2]Williams, H.: Botwood (West Half) map-area, Newfoundland; Geol. Surv. Can., Paper 62-9 (1962).

[3]Baird, D.M.: Fogo Island map-area, Newfoundland (2 E/9); Geol. Surv. Can., Mem. 301 (1958).

greywacke, and basaltic pillow lava with chert and thin limestone interbeds, all typical of deep water marine environment.

The discovery of many new fossil localities throughout New World Island shows that Heyl's[1] interpretation of the stratigraphic succession in his Ordovician Exploits Series is in place erroneous. Polymictic conglomerates of Goldson lithology and Silurian age have been traced into beds previously mapped as the Hornet Formation formerly interpreted to occur near the base of the Ordovician Exploits Series. In addition thick volcanic assemblages (Mortons and Breakheart Formations) presumed to form the top of the Exploits Series are absent in continuous Ordovician - Silurian sections of eastern New World Island.

On Cann Island south of Seldom a previously worked chalcopyrite prospect was found in possible Silurian volcanic rocks. This prospect, to the author's knowledge, has not previously been recorded.

---

[1]Heyl, G.R.: Geology and mineral deposits of the Bay of Exploits area, Newfoundland; Nfld. Dept. Nat. Res., Geol. Sec., Bull. 3 (1936).

GENERAL

101. GEOLOGY OF THE NATIONAL PARKS

D.M. Baird

Field observations for the preparation of a geological guide book were made in Banff National Park (Alberta). Further observations and photographs were taken to complete the reports on Glacier, Mount Revelstoke, Waterton, Kootenay, and Riding Mountain National Parks.

102. STUDIES OF GYPSUM - ANHYDRITE IN CANADA

D.M. Baird

Field studies on gypsum - anhydrite in Canada, a project started in 1959, were completed. The results of these studies will be incorporated in a manuscript now in preparation for publication by the Geological Survey in its Economic Geology Series.

103. MARINE GEOLOGY, ST. MARGARETS AND MAHONE BAYS SOUTHWEST OF HALIFAX, NOVA SCOTIA

G.A. Bartlett

A detailed study of bottom sediments and microfauna in St. Margarets and Mahone Bays, southeastern Nova Scotia (11 D, 21 A) was completed in 1963. Both field and laboratory studies were undertaken to establish the ecological factors influencing foraminifera distribution in estuaries, back-bay lagoons, intertidal mud-flats, beaches, and normal marine conditions. Closely spaced sample stations were variable both in sedimentary facies and faunal content. The nature of the bottom sediments changed rapidly from a boulder till, gravel, and coarse sand along the coastal shoreline, windward side of drumlin islands, and isolated ledges, to a rich sour-smelling black ooze in the less turbulent areas characterizing back-bays and estuaries.

Most samples were collected by means of SCUBA-diving equipment, which permitted visual examination of the bottom to depths of 100 feet. SCUBA-diving equipment permitted "on the spot" planning of underwater traverses, thus allowing the collection of the most satisfactory bottom sample from any given area. Bottom samples were obtained from depths greater than 100 feet by means of various oceanographic sampling devices. Preliminary investigations indicate that only a secondary relationship exists between sediments and the contained fauna. Marine algae is important in the areal distribution of many foraminiferal species. The influence of many other oceanographic features on the distribution of both living and dead foraminifera is presently being analyzed.

104. GEOCHEMICAL STUDIES IN NEW BRUNSWICK, NOVA SCOTIA, AND ONTARIO

R.W. Boyle

In addition to supervising the geochemical projects carried out by Davies, Tupper, Bachinski, Martin, and Tauchid in the Bathurst area, New Brunswick, the writer carried out the following field work:

1. Visited a number of gold deposits in Nova Scotia to ascertain their geologic and geochemical setting and their silver content. Samples of ore were obtained to determine the Ag/Au ratios of typical ore in the Meguma Group.
2. Obtained large bulk samples of Meguma Group rocks, especially the Halifax slates, for determination of their silver and gold content.
3. Visited a number of silver deposits in the Cobalt, South Lorrain, and Elk Lake areas to ascertain their geological and geochemical setting. Representative core and chip samples of Keewatin greenstones and sediments, Cobalt sediments, and Nipissing diabase were collected to ascertain their silver, arsenic, antimony, nickel, and cobalt contents.
4. Collected representative samples of reef material from the Guelph Formation in southwestern Ontario, from outcrop in the Bruce Peninsula and from drill cores provided by Imperial Oil Limited at Chatham, Ontario. In addition, collected representative samples of all formations in the Ontario basin from cores supplied by Imperial Oil Limited, Chatham. These samples will be analyzed for their silver content and will provide a basis for the calculation of the silver content of a suite of sedimentary rocks that have not been subjected to metamorphism.

105. GROUNDWATER STUDIES, NOVA SCOTIA AND PRINCE EDWARD ISLAND

L.V. Brandon

Groundwater investigations were carried out in parts of Nova Scotia (11 E E1/2; 11 F W1/2; parts of 11 D E1/2 and 21 H E1/2) to gather information for the compilation of groundwater probability maps, for publication on a scale of 1 inch to 4 miles. Adequate supplies of groundwater are available for rural and domestic use throughout the area from springs and drilled wells. Towns and villages underlain by Annapolis sandstone and Pictou and Cumberland sandstone and shale can obtain good water supplies from well fields. Large water supplies for industries may occur in sands and gravels under glacial till and in river valley alluvium in several areas. Test drilling would be necessary to prove up the supplies. More than 100 samples of water were obtained from springs and wells for complete chemical analysis.

In Prince Edward Island advice was given to the Provincial Government on groundwater potential at two proposed industrial sites. The only problem in developing large water supplies on the island is the danger of salt water intrusion, which could result from overpumping in coastal localities.

106. STUDIES IN CARBONATE GEOCHEMISTRY

E.M. Cameron

Carbonate reefs are a major habitat for petroleum in Western Canada. If distinctive chemical trends exist in the sediments surrounding these reefs laterally, chemical methods could prove to be a useful tool in reef exploration. To test for the presence of such chemical trends two important reef horizons in Western Canada were sampled from both drill cuttings and core. Reef and non-reef areas of the Slave Point Formation in northeastern British Columbia and adjacent parts of Alberta and the Northwest Territories were sampled in 90 wells. In central Alberta the upper part of the Cooking Lake Formation and the lower part of the Duvernay Formation in areas surrounding the Upper Devonian reefs were sampled in 109 wells. Seven hundred of the samples collected are presently being quantitatively analyzed for a variety of elements by rapid spectrochemical methods.

107. GEOLOGICAL STUDIES OF NICKEL DEPOSITS IN MANITOBA AND ONTARIO

J.A. Chamberlain

Using a 15-foot house trailer as an office-house combination, an attempt was made to examine and sample most of the known nickel deposits in southeastern Manitoba and in western Ontario from the provincial border to the Sudbury district. In addition, several deposits were studied elsewhere in Ontario, in Quebec, and in the Yellowknife areas.

As most nickel deposits are genetically related to a restricted group of rocks of magmatic affiliation, any attempt to classify nickel deposits according to the type should take advantage of this fact. All of the deposits examined so far can be grossly categorized into three groups: (1) those associated with gabbros (or norites); (2) those associated with peridotites; and (3) a much rarer group of deposits that are related only structurally to their host rocks. Within the first two groups, the nickel-bearing sulphides may occur as disseminations, as bands of veins, or as massive concentrations. In the third group, they have been found to occur only as narrow veins. Laboratory work and additional field work will, it is hoped, explain some of these consistencies and expand on their theoretical basis.

108. DEVELOPMENT OF LOW FREQUENCY RESISTIVITY EQUIPMENT — RESEARCH FOR GROUNDWATER GEOPHYSICS

L.S. Collett

The transmitter, which will deliver 1/3 ampere into any load between 10 cps and 0.1 cps, has proven to be adequate for experimental field testing. The main emphasis of the work is being put into the receiving equipment. Three methods of measuring phase have been tried. One method has been found to be impractical while the remaining two methods show merit. The results can be recorded in digital form. Phase shifts have been measured as anticipated. A filter is required to attenuate the 60 cycle interference. The method of measurement is now worked out. Design construction and field testing are continuing.

109. STUDY OF IRON FORMATIONS OF CANADA

G.A. Gross

Investigation of iron-formations in two areas in Ontario and in Alberta were carried out as part of a continuing study of iron-formation in Canada. The aim of this study is to provide information on sedimentary and stratigraphic features of the deposits and their environment of deposition, and provide geological information necessary for an evaluation of their economic potential.

A detailed geological study and mapping of iron-formation north of Nakina, Ontario was carried out by D.F. Sangster (see abstract No. 109a). The objective of this project was to correlate detailed geological features with magnetic properties of the iron-formation being studied concurrently and in comparable detail by Dr. P.J. Hood (see abstract No. 66).

A special study of sedimentary features and depositional environment of the iron-formation and the nature of associated volcanic rocks in the Timagami Lake area, Ontario was started by H.P. Wilton (see abstract No. 72) with the writer's supervision. The results will be used for a doctorate thesis.

An examination of the sedimentary environment and primary features of an oolitic siderite and chamosite iron-formation in the Clear Hills area of Alberta showed a number of features of significance regarding the origin of iron-formations.

109a. GEOLOGICAL AND MAGNETIC STUDY OF EARLY PRECAMBRIAN IRON-FORMATION NORTH OF NAKINA, ONTARIO

G.A. Gross and D.F. Sangster

The purpose of the project was to study in detail the geology and associated magnetic properties of iron-formation. Several

magnetic vectors were measured directly in the field using a fluxgate magnetometer and dip needle. The effect of topography on the magnetometer survey was also studied. The area investigated is about 40 miles north of Nakina, in 42 L.

Preliminary field studies show that some of the highest magnetic anomalies ever recorded occur over areas of relatively low magnetite content. The effects of diabase and pegmatite intrusions on the magnetic properties of iron-formation are of fundamental interest. Primary sedimentary and metamorphic features studied in detail show two periods of deformation separated by intrusion of simple pegmatite dykes.

More than 230 oriented diamond drill core samples were taken on a systematic basis using a portable drill. These samples are to be used for petrological studies and for measuring magnetic properties (see also Hood, abstract No. 66).

110. STUDY OF ORGANIC MATTER IN RECENT SEDIMENTS SOUTHEAST OF HALIFAX, NOVA SCOTIA

L.H. King

Study of the organic matter in recent sediments off the coast of Halifax, Nova Scotia, a continuing laboratory and field project, was begun in August. The area chosen for the first investigation is bounded by latitudes 43° 25' and 44° 05', and longitudes 62° 30' and 63° 45'. A preliminary sampling program was carried out and fourteen grab samples were obtained. The area includes a part of Emerald and Sambro Banks, as well as a part of two topographical basins.

An important part of the project is to study the chemical nature of the organic matter with respect to environment and environmental changes on a regional basis. A number of structural chemical parameters of the organic matter will be mapped and integrated with the data obtained by the more conventional techniques of sediment analysis.

On the basis of the information provided by the distribution studies, critical samples will be chosen and studied in detail with respect to their optical, physical, and chemical properties. Changes in organic matter with respect to depth of burial will also be studied. These analyses will be undertaken at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

111. METALLOGENIC STUDY IN NOVA SCOTIA, NEW BRUNSWICK, AND SOUTHEASTERN QUEBEC

W.D. McCartney

An orderly sequence of mineralization related to the tectonic history of the Canadian Appalachians was confirmed, although some vein deposits are of uncertain age.

Geological relations of initial and early stages of mineralization are best displayed in the Eastern Townships. Ordovician mafic volcanic rocks of the Eastman belt appear to have controlled massive pyrite-chalcopyrite mineralization, and ultramafic rocks controlled chromite and probably controlled nickel-pyrrhotite mineralization. Nickeliferous gabbro at St. Stephen, New Brunswick, recently dated[1] as 462 m.y., is thus similar in age to nickel mineralization in the Eastman belt rather than being of Devonian age as previously accepted.

The younger Ordovician Sherbrooke belt differs in having a higher ratio of acidic over mafic volcanic rocks and tuffs, with quartz-feldspar (albite) porphyry common, and in the abundance in some pyrite-chalcopyrite deposits of galena and sphalerite. The marked stratigraphic control of mineralization and paucity of granite implies that massive sulphide mineralization accompanied Middle Ordovician volcanism.

Massive sulphides and host rocks in the more complex Bathurst camp, New Brunswick, are remarkably similar to the Sherbrooke belt, but numerous base metal veins seem controlled by Devonian granite near Bathurst.

Middle stage mineralization (Au, Mo, Sb, W, Sn, Be) related to Devonian granites is best developed in southern New Brunswick and Nova Scotia in sediments that formed southeast of the Ordovician eugeosyncline. Porphyry from Gaspé Copper mine was collected for age determination.

Post-magmatic (late and final stage) mineralization includes vein and replacement deposits of barite-lead-zinc-siderite (or iron oxides)—fluorite and manganese oxides in various ratios or combinations. These seem controlled by structural deformation, especially regional transverse faults, as well as by proximity to the Windsor-Horton contact. Cupriferous or galena-bearing grey Pennsylvanian sandstones and siltstones seem related to source areas, to sedimentary features and, in the copper-bearing beds, possibly to groundwater movement or levels.

111a. HEAVY MINERAL STUDIES IN NOVA SCOTIA AND NEW BRUNSWICK

C.R. McLeod and W.D. McCartney

During one week of the field season, C.R. McLeod collected 19 concentrations of heavy minerals to afford a preliminary appraisal of the use of such minerals as an aid to detecting post-magmatic mineralization in regional metallogenic studies. The possible eastward extension of post-magmatic mineralization associated with a major transverse fault extending east from Windsor area to and

[1] K-Ar ratio in biotite, determination by Isotope Laboratory, Geological Survey of Canada.

beyond Brookfield, Nova Scotia is suggested by strong traces of barite in two of nine samples from West St. Marys River, and one sample contains garnets of varied but as yet undetermined composition. Some samples from a metallogenically favourable Windsor-Horton basin at Upham, New Brunswick, in which no mineralization is known, contained small quantities of barite. Galena was visible in the field in panned concentrates from stream sediments at the Talisman property, Salmon River, Cape Breton, but laboratory separations of these concentrates remain in progress. All mineral separations have been only cursorily examined as yet.

112. STUDIES OF TIN AND BERYLLIUM OCCURRENCES IN CANADA

R. Mulligan

About one months' field work was done in Yukon and British Columbia including: —

1. Examination of and collection of samples from a deposit of rare tin minerals in calcite veins at the head of Coal River about 100 miles northeast of Watson Lake.

2. Examination and collection of samples from tin-bearing vesuvianite skarns about 1 mile north of Ash Mountain in the Jennings River area 64 miles southwest of Watson Lake.

3. Collection of samples of placer concentrates from cassiterite-bearing creeks near Surprise Lake, Atlin district, British Columbia.

4. Investigation of reported presence of cassiterite at the Dodger mine, Canadian Explorations Limited, near Salmo, British Columbia.

Analyses and other laboratory investigations will furnish more information regarding the tin and beryllium-bearing metallogenic province in the Cordilleran region.

113. ORDOVICIAN STRATIGRAPHY, SOUTHERN ROCKY MOUNTAINS

B.S. Norford

Field work in the southern Rocky Mountains consisted primarily of a study of the post-Canadian, pre-Richmondian stratigraphic interval. The Mount Wilson Quartzite commonly directly underlies the Beaverfoot-Brisco Formation, and in the Western Ranges rests on the Glenogle Shale. In the Main and Front Ranges, a carbonate formation separates the Mount Wilson Quartzite from the Sarbach Formation and is largely coeval to the Glenogle Formation. This formation is divisible into two members, the lower of which approximately corresponds to the Skoki Formation as erected by Walcott in 1928. The faunas of the formation are now being studied.

114 STRUCTURAL PROTOTYPES AND REMANENT MAGNETISM STUDIES, ALBERTA AND DISTRICT OF MACKENZIE

D.K. Norris

The field season consisted of three phases: visits to stress laboratories in the western United States, continuation of studies of structural prototypes in southwestern Alberta, and the collection of material for remanent magnetism studies in Franklin Mountains, Northwest Territories.

One week was devoted to visiting laboratories where research is being carried out on the effects of high pressures on geological materials, the modelling of geological structures and the measurement of stress in underground excavations. The visits to these laboratories served to emphasize the high degree of specialization of this type of research and the fact that significant contributions in this field can be made only if it is a full time endeavour.

Work was continued on fold-fault prototypes in southwestern Alberta in conjunction with the collection of data of the Lewis thrust plate with a view to assessing the degree of Laramide strain penetration in these rocks.

A brief trip was made to Mount Cap in Franklin Mountains where oriented specimens were collected in Cambrian (?) and Precambrian formations to supplement data on remanent magnetism studies in the northern Cordillera of Canada.

115. METALLOGENIC STUDIES BETWEEN TIMMINS (ONTARIO) AND CHIBOUGAMAU (QUEBEC)

S.M. Roscoe

The nature and geological environments of base-metal deposits and a few gold deposits in the region between Timmins and Chibougamau were studied. Samples of ores and rocks were collected for microscopic, chemical, and isotopic studies, which were concurrently in progress and are continuing.

Massive sulphide deposits may have formed near the surface at a certain stage in the volcanic history. Simultaneously, at greater depth, copper-rich sulphide concentrations may have formed in basic intrusions and eventually have been segregated into fracture systems to form orebodies such as those at Chibougamau. Nickel deposits associated with ultrabasic rocks were also formed early in the orogenic cycle. The Marbridge deposit appears to be younger than an adjacent non-nickeliferous sulphide zone.

Molybdenite, lithium and allied deposits in certain granite bodies are related to a later, climactic phase of orogeny.

Distinctively rich auriferous massive sulphide deposits in the Noranda area occur in volcanic terrane that is

lithologically different, relatively rich in soda and younger than some or all of the host terrains of the more common types of massive sulphide deposits. Soda granites and granodiorites contain some concentrations of disseminated chalcopyrite with a little molybdenite and a few gold deposits.

The relationships of small sodic intrusions, stratified rocks, highly altered rocks, and gold deposits along regional fault zones require extensive investigation.

Potassium-rich igneous rocks and sediments (Kirkland Lake) near the same zones represent a younger orogenic event characterized by tellurium, bismuth, lead, and barium as well as gold mineralization.

116. PRELIMINARY INVESTIGATIONS ON THE GEOLOGY OF VANADIUM

E.R. Rose

Field work was conducted from Quebec and Ontario, across the Interior Plains and Western Cordillera to Vancouver Island in search of vanadiferous occurrences mainly in previously untested sedimentary and volcanic terranes. The known rare occurrences on Vancouver Island were mapped and sampled. Seventy formations of various types and ages were tested for vanadium, using a hydrogen peroxide method, with standards adapted in collaboration with John Lynch of the Geological Survey's Geochemistry section. Vanadium was detected in very faint traces in twelve of the samples tested, but no unusual or strong concentrations of the element were found such as to warrant optimism in the search for vanadiferous occurrences in Western Canada. As yet very little is known regarding the conditions necessary for the occurrence and concentration of vanadium; therefore few leads may be given for prospecting.

117. LANDSLIDE STUDIES IN MANITOBA, SASKATCHEWAN, AND ALBERTA

J.S. Scott

Landslides of the rotational slump type are of common occurrence in Western Canada along river valleys that are carved into clay shales of the Bearpaw Formation and its stratigraphic equivalents.

Representative slide areas in Manitoba, Saskatchewan, and Alberta were examined to determine variations in the morphology of failed and stable slopes as related to geological and hydrogeological factors. Samples of slide material were obtained for mineralogical, paleontological, and lithological analysis and for the determination of engineering index properties such as moisture content, Atterberg limits, and activity.

It is concluded that:

1. Argillaceous phases of the Bearpaw Formation, particularly those containing bentonite layers, are more susceptible to slope failures than the arenaceous phases of the formation.

2. Terrace development along some river valleys has contributed to slope stability.

3. Groundwater discharge toward rivers has, in some areas, reduced slope stability by increasing seepage pressures and has provided moisture for rehydration of expanding lattice clay minerals with the consequent generation of swelling pressures.

4. The orientation of the slope with respect to the local groundwater flow system and, in some cases, with respect to insolation may be significant factors controlling slope stability.

5. The pressure of joints or incipient fractures as evidenced by angular drainage patterns indicates the need to consider these planes of weakness in shear strength determinations and the existence of preferred zones of groundwater flow in the Bearpaw Formation.

The field work has provided a basis for a more detailed examination in 1964 of a specific area of slope failure as a cooperative project between the Geological Survey and the Department of Civil Engineering, University of Alberta.

118. SEA MAGNETOMETER SURVEY OFF NEWFOUNDLAND AND NOVA SCOTIA

W.J. Stauffer

This year's sea magnetometer project consisted of the following two phases:

1. Working in the Sheet Harbour - Liscomb area from approximately May 20 - June 21. This magnetometer survey was conducted aboard the C.S.S. "Kapuskasing". Two-range Decca was used for navigational positioning.

2. Working in the Tail of the Banks area of the Grand Banks of Newfoundland, from approximately July 6 - September 20. This magnetometer survey was conducted aboard C.S.S. "Baffin", with Decca Lambda position fixing with slave stations at Lance Cove, Newfoundland, and Sable Island. This system allowed us to work to a maximum distance of 395 miles from Sable Island. Sounding depths encountered ranged from 40 to over 1,000 fathoms.

119. PLEISTOCENE PALYNOLOGICAL STUDIES

J. Terasmae

Field work in 1963 included a winter drilling program near Belleville, Ontario (see also Mirynech, abstract No. 69), where new techniques were employed in sampling of lake-bottom sediments through ice in February. Preliminary results of this study and additional palynological investigations have indicated that in the Belleville area the Glacial Lake Iroquois level was lowered rapidly from its high stand to a level some 15 feet lower than the present Lake Ontario.

A joint project with the Great Lakes Institute, Toronto, included reconnaissance of five lakes in the Trenton-Kingston area for the purpose of environmental studies and later coring of the sediments. This study was successfully supported by extensive echo-sounding and SCUBA-diving.

Another joint program with the Great Lakes Institute included winter drilling and continuous coring of Pleistocene and recent deposits in Lake Erie. This phase of the project was completed successfully and more than 500 feet of core obtained (see also Mirynech, abstract No. 70).

In June, Dr. H.G. Ignatius of the Geological Survey of Finland participated with the writer in field excursions to the Kingston area, with the specific purpose of studying varved sediments. Dr. Ignatius' experienced with bottom sediments of the Baltic Sea was very helpful in determining the environmental conditions for such sediments and their fossil content. No marine sediments were found in the area visited. However, Dr. Ignatius had found in the Baltic Sea region that varved sediments were not necessarily limited to fresh-water glacial environments.

Palynological reconnaissance was extended to the Wawa-White River area in northern Ontario for the purpose of studying the Great Lakes history and ice retreat north of Lake Superior basin.

Samples of bog deposits were collected near Rivière-du-Loup, Quebec, for further palynological studies and radiocarbon dating related to the chronology of late-glacial events, as previously studied by Lee[1].

Palynological-geological studies were integrated with archaeological investigations made near Pembroke by C.C. Kennedy. A close relationship was indicated between archaeological materials of different age and the abandoned Ottawa River terraces of different elevation.

---

[1] Lee, H.A.: Surficial geology of Rivière-du-Loup - Trois-Pistoles area, Quebec; Geol. Surv. Can., Paper 61-32 (1962).

An airborne pollen survey was initiated in the Ottawa area and in the Eastern Arctic[1] for the purpose of relating modern pollen deposition to the regional vegetation. This basic information is required for an improved interpretation of the fossil pollen assemblages.

120. FORAMINIFERA STUDIES OF MAGDALEN SHELF AND A SECTION OF THE ATLANTIC CONTINENTAL SHELF OFF HALIFAX, NOVA SCOTIA

G. Vilks

Bottom sampling was carried out in late August from the CNAV "Sackville" on the Atlantic Continental Shelf between latitudes 42.32N and 44.24N and longitudes 61.24W and 63.28W, and in the Gulf of St. Lawrence over Magdalen Shelf area (latitude 47.20N to latitude 46.30N and longitude 61.20W to longitude 64.13W). The purpose of the sampling was to provide information of foraminiferal content in the sediments of these areas. This material will be studied in the laboratory at Bedford Institute of Oceanography, Dartmouth, Nova Scotia, during the winter.

[1]Arctic pollen collections were made for Terasmae by various members of the Department of Mines and Technical Surveys.

GEOLOGICAL COLLECTING

Collection of fossils, rocks, minerals, and other geological data is an important phase of many field projects. Some parties, however, are sent to the field in order to make collections for a specific research project. Such collections are returned to Geological Survey headquarters for further study, and any account of the field work involved can only record the collecting phase. These collections provide the materials for office and laboratory research and subsequent publication in the various reports of the Geological Survey.

Nine collecting projects are recorded below.

A.R. Cameron and T.F. Birmingham spent the month of May in the Fernie - Michel area of British Columbia and in the Stettler - Drumheller areas of Alberta, collecting additional samples for the petrological and carbonization studies presently underway on coals from these localities.

Three column samples were collected from the Michel area. One was taken of the Balmer Seam in the Balmer mine, one of the "A" Seam in a prospect pit on Natal Ridge, and one of the No. 1 Seam in the Michel Colliery. These three samples represent a total thickness of coal of about 85 feet. In addition to the column sample, two 1,000 lb. carbonization samples, representing the top and bottom halves of the No. 1 Seam were collected and submitted to the Mines Branch for coke tests.

Four column samples of sub-bituminous coals were collected from the Edmonton Formation at Delburne, Halkirk, Drumheller, and East Coulee, Alberta. These cover a total thickness of about 30 feet of coal. These samples supplement those collected in 1961 and were taken with a view toward clarifying questions of lateral variation arising from examination of the latter material.

M.J. Copeland collected samples for a preliminary study of the microfauna (Ostracoda) of the Middle Ordovician strata of southern Ontario. Until laboratory and microscopic examinations are completed it is not known whether zonal classifications of these rocks will be possible, based on the contained microfauna.

W.F. Fahrig continued the field study and sampling of diabase dykes begun in 1962. The 1963 phase comprised work on bodies of diabase in Shield areas in the southern part of the Northwest Territories, northern Saskatchewan, Manitoba, and in northwestern Ontario.

J.A.C. Fortescue initiated a long-term program in forest biogeochemistry. During the summer he collected 168 samples of peat from the Mer Bleue bog near Ottawa, located away from known mineral deposits, to provide background information on the minor element content of Canadian peat. He also collected more than 1,000 samples of soil and plant material in the vicinity of a drilled but otherwise undisturbed, mineral deposit in eastern Canada. These

samples will form the basis of a systematic study of the occurrence of lead in superficial materials lying over a known mineral deposit.

C.H.R. Gauthier collected more than 15 tons of minerals, rocks, and ores from 50 localities in the provinces of Manitoba, Ontario, and Quebec. Most of the material will be used in the preparation of various collections for sale to the public.

In addition, two large boulders of jasper conglomerate were brought frim the Bruce Mines area (Ontario) and several specimens of special interest were taken from other localities for the Geological Survey's National Mineral Collection.

A few hundred pounds of exchange material (minerals) have been collected.

R.D. Howie collected oil and gas well data from the Mines Departments of Quebec, New Brunswick, Nova Scotia, and Prince Edward Island.

He also examined cores from Imperial Hillsborough #1, and Imperial Pollett River #1 on file in Fredericton, New Brunswick, and studied sections of the Palaeozoic in Prince Edward Island. This work is expected to aid in the examination of well samples and interpretation of the subsurface stratigraphy in these areas.

B.A. Latour spent 16 days collecting data required to maintain an up-to-date estimate of the coal reserves of Canada. During that time visits were made to provincial agencies concerned with coal mining and coal geology in Alberta and Saskatchewan and to several of the larger coal operators in those two provinces as well as British Columbia.

In the plains area of Alberta extensive exploratory drilling is being done to locate commercial coal deposits in the Foremost, Oldman, and Edmonton Formations. This is a cooperative undertaking by Alberta Research Council, Canadian Pacific Railway, and Calgary Power Limited. As a result of these activities very large reserves of cheap, strippable coal, suitable for thermal power plants, have been proven up.

D.C. McGregor spent three weeks in Taseko Lakes (92 O) map-area, British Columbia, collecting Cretaceous megafossil plants, as well as Triassic, Jurassic, and Lower Cretaceous rocks for spore-pollen analysis. The objectives were to determine more precisely the age of the associated rocks, and to obtain reference plant microfossils from rocks that have been dated faunally. In most instances the spore-pollen samples were collected from measured sections from which faunal collections were also obtained by J.A. Jeletzky, E.T. Tozer, and H.W. Tipper.

H.R. Steacy made three brief trips to mineral localities in Ontario and Quebec to collect specimens for the National Mineral Collection's Systematic Reference Series. Chrysoberyl was subsequently identified in specimens collected in old development rubble

at a pegmatite at the north end of Lac des Isles, Robertson township, Labelle county, Quebec[1]. Additional collecting trips will be made to field occurrences as long as weather permits, and to mines in the winter.

[1]Mulligan, Robert: Beryllium occurrences in Canada; Geol. Surv. Can., Paper 60-21 (1960), p. 31.

AUTHOR INDEX

SUBJECT INDEX

	Abstract Numbers
Petrographical and mineralogical studies	12, 14, 30, 31, 47, 49, 57, 61, 72, 81a, 83, 92, 95, Fahrig p. 87, Gauthier p. 88, Steacy p. 88.
Marine geology studies	4, 5, 5a, 8, 103, 110, 120.
Engineering geology studies	22, 117.
Miscellaneous	101.

ROGER DUHAMEL, F. R. S. C.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1964
Price 35 cents Cat. No. M44-64/1