GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 63-2

SUMMARY OF ACTIVITIES: OFFICE AND LABORATORY, 1962

Compiled by S. E. Jenness

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1963

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CONTENTS

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INTRODUCTION

In recent years the Geological Survey has undertaken an increasing amount of geological research utilizing special office and laboratory facilities. Investigations are presently under way into many problems, some small, some large, some dealing with basic or fundamental principles, others dealing with matters having a more obvious, practical application. The results of some of these projects will ultimately be published in the Survey's Paper or Bulletin series; the results of others will be published in scientific journals. Until such publications appear, however, there is generally a void in public knowledge of the type and amount of investigations currently in progress within the confines of the Geological Survey's buildings. This report is an attempt to fill, at least partly, that void. It and its counterpart dealing with the Survey's field activities (G. S. C. Paper 63-1, 'Summary of Research: Field, 1962') provide in brief form the results of much of the Survey's current geological activities.

Late in 1962 the Geological Survey published a brief summary of many of the office and laboratory projects, indicating to what extent they had progressed by the end of 1961. That report, which appeared as G. S. C. Paper 62-30 ('Summary of Research: Office and Laboratory, 1961'), was based largely upon information secured by unit heads for the internal annual report. In December, 1962, the scientific staff members were asked to supply brief abstract-like statements of those of their research projects on which progress had been made, for publication early in 1963. The statements subsequently received are contained in the following pages. Initials following the statements are those of the authors; where no initials are present, the statement is by the compiler.

Individual statements vary considerably in general presentation, although the compiler has endeavoured to bring about some degree of uniformity, without formal editing. Considerable latitude has been allowed some of the entries where the projects involved are not easily described in the general format used in this report. This applies particularly to some of the palaeontological accounts.

STRATIGRAPHY AND PALAEONTOLOGY

1. PROJECT: RESTUDY OF MISSISSIPPIAN CORAL TYPE SPECIMENS IN THE GEOLOGICAL SURVEY OF CANADA TYPE COLLECTION

PERSONNEL: E. W. Bamber

The specimens under study have been thin-sectioned and photographed. Their redescription is in progress.

(E. W. B.)

2. PROJECT: STRUCTURE, ISOPACH, AND FACIES MAPS OF UPPER CRETACEOUS MARINE SUCCESSION IN WEST-CENTRAL ALBERTA AND ADJACENT BRITISH COLUMBIA

PERSONNEL: C. F. Burk, Jr.

A regional stratigraphic framework for the Upper Cretaceous marine succession is established by the correlation of three prominent electric-log marker horizons, (Fish Scales, Second White Specks, First White Specks) derived from the study of 400 wells in an area of about 39,600 square miles. Lithofacies and sandstone isolith maps show regional distribution patterns of sandstone formations and indicate their relationship to the stratigraphic framework established by the marker horizons.

The major stratigraphic units under study include the Alberta, Smoky, Ft. St. John (part) and Colorado (part) Groups, which consist chiefly of marine shale. Sandstone formations include the Dunvegan, Cardium, and Bad Heart. The Cardium is one of western Canada's major oil reservoirs, while the other two must be regarded as potential economic objectives. The present analysis demonstrates the following with respect to these sandstone formations:

1) The presence of sandstone at several horizons, separated by shale, within each "formation".

2) Regional parallelism in trend between sandstone isolith patterns and isopachs of the enclosing marker-defined units; a marked degree of tectonic control of sandstone deposition is implied.

3) Gradation from east to west of relatively smooth, lobate, sandstone isolith patterns, to digitating and more complex patterns; marine to fluvial environmental controls, respectively, are implied.

4) General increase in total sandstone thickness to the northwest; a northwesterly source of sediment supply is implied.

(C. F. B. Jr.)

3. PROJECT: MIDDLE ORDOVICIAN OSTRACODA, LAKE TEMISKAMING, ONTARIO

PERSONNEL: M. J. Copeland

Middle Ordovician Ostracoda having affinities with similar faunas from Scandinavia and eastern and mid-western United States have been obtained for the first time from Northern Ontario. Identification and description of this microfauna neared completion during 1962, and, it is anticipated, will soon be completed and submitted for publication as a Geological Survey Bulletin.

(M. J. C.)

4. PROJECT: CANADIAN FOSSIL ARTHROPODA, OSTRACODA

PERSONNEL: M. J. Copeland

Office, laboratory, and field studies of certain Canadian eastern and Arctic Middle and Upper Silurian Ostracoda have continued during 1962. At present, papers are being prepared on Ostracoda from Arisaig, Nova Scotia, and Canyon Fiord, Ellesmere Island, District of Franklin. Laboratory examination and extraction of ostracoda from field samples from Gaspé and Anticosti Island, Quebec, are continuing. Results from the Quebec investigations are not anticipated until at least 1964.

(M. J. C.)

5. PROJECT: MIDDLE DEVONIAN (HAMILTON) OSTRACODA FROM DRILL CORES, SOUTHWESTERN ONTARIO

PERSONNEL: M. J. Copeland

Detailed examination for microfossils of recent drill cores from southwestern Ontario is being undertaken to determine, if possible, the stratigraphic occurrence of Ostracoda from the Hamilton Group. Examination of microfauna from these beds is part of a joint project being undertaken with B. V. Sanford and D. J. McLaren. Laboratory preparation (disintegration and microfaunal separation) is being continued by A. Matte.

(M. J. C.)

6. PROJECT: THE PADDY AND CADOTTE MEMBERS OF THE PEACE RIVER FORMATION

PERSONNEL: R. L. Cox

The purpose of the study is to correlate the Paddy and Cadotte Members from their type sections at the surface, to the subsurface, and to show their regional relationships to the overlying and underlying formations. The study, initiated in 1962, involves an area in central western Alberta, from the fifth meridian to the British Columbia border, and from townships 60 to 100.

The Paddy and Cadotte Members are Lower Cretaceous sandstones. At the type sections on Peace River, the Paddy is a poorly sorted, quartzose, crossbedded continental unit, and the Cadotte is a fairly well sorted, fine-grained marine sandstone. The Cadotte overlies the Harman Member (shale) of the Peace River Formation, and is overlain unconformably by the Paddy Member. The Paddy Member is in turn unconformably overlain by the Shaftesbury Formation (shale).

The study included one month examining and sampling outcrop sections along Peace River and sampling well cores. A series of electric log cross-sections has been completed to provide a framework for detailed lithologic correlations. Samples from the outcrops and cores are being investigated for microfossils by T. P. Chamney and the writer. Cuttings from one well per township, where available, are being logged in detail through the interval of interest.

(R. L. C.)

7. PROJECT: GRAPTOLITE FAUNAS FROM THE ORDOVICIAN AND SILURIAN OF GASPE PENINSULA

PERSONNEL: L. M. Cumming

Collections were received from Dr. P. Lespérance, University of Montreal, from the Ordovician of the Percé area, and from M. J. Copeland from several Silurian areas of Central Gaspé. Study of these fossils is under way.

(L. M. C.)

8. PROJECT: REPORT ON CLASSIFICATION OF STROMATOLITES

PERSONNEL: J. A. Donaldson

This project supplements field study of stromatolites in a part of the Precambrian Denault Formation of the Labrador Trough. Information gathered has been submitted for publication as a Geological Survey Bulletin, which presents a non-biologic classification of stromatolites, and outlines criteria for recognition of stromatolite origin. Incorporated in the Bulletin are illustrations of representative specimens from the Denault Formation.

Ref.: Donaldson, J. A.: Stromatolites in the Denault Formation, Marion Lake, Labrador; Geol. Surv., Canada, Bull. (in press).

(J. A. D.)

9. PROJECT: HURONIAN METAZOAN OCCURRENCES

PERSONNEL: M. J. Fracy and D. J. McLaren

Distinctive markings thought to be traces of Huronian Metazoans occur in the Lorrain Formation near Desbarats, Ontario, about 25 miles southeast of Sault Ste. Marie. The age of the formation, as indicated by whole-rock K/Ar dating of nearby basic dykes, exceeds 1600 m.y. The geology and palaeontology are to be described, illustrated, and discussed in a forthcoming Geological Survey publication.

(M. J. F.)

10. PROJECT: THE DEVONIAN-JURASSIC CONTACT IN THE BANFF AREA, ALBERTA

PERSONNEL: H. Frebold

The Devonian is not resting on rocks of the Kootenay Formation as previously assumed, but on the Lower Jurassic (Toarcian) Paper shale. This was proved by fossils on sections both on the east side of Cascade Mountain and near the Banff Traffic Circle. Other rocks previously described as Kootenay Formation belong actually to the Fernie Group, i.e. to the Rock Creek Member, Grey beds (Callovian), the equivalents of the Passage beds (Oxfordian and younger), as is shown by both the lithology and guide-fossils.

Ref.: Frebold, H.: The Devonian-Jurassic Contact and the Subdivision of the Fernie Group in the Banff Area, Alberta; Geol. Surv., Canada, Paper 62-3 (1962).

(H. F.)

11. PROJECT: AMMONITE FAUNAS AND THE STRATIGRAPHIC POSITION OF THE GREY AND GRYPHAEA BEDS OF THE FERNIE GROUP, WESTERN CANADA

PERSONNEL: H. Frebold

The ammonite faunas and the stratigraphic position of the Grey and Gryphaea beds of the Fernie Group were revised. The succession of faunas from the bottom upwards is Paracephalites Buckman (formerly also described as Arctocephalites or Cadoceras respectively), Warrenoceras n. gen. Frebold (formerly described as Arcticoceras), Kepplerites mclearni Imlay, Kepplerites aff. tychonis Ravn, and Imlayoceras n. gen. Frebold. Apparently these ammonite faunas belong to a special fauna province.

Ref.: Frebold, H.: Ammonite Faunas of the Upper Middle Jurassic of the Fernie Group in Western Canada; Geol. Surv., Canada, Bull. 93 (1963).

(H. F.)

12. PROJECT: LOWER AND MIDDLE JURASSIC FAUNAS OF NORTHWESTERN BRITISH COLUMBIA AND SOUTHERN YUKON

PERSONNEL: H. Frebold

The study of Lower and Middle Jurassic faunas of northwestern British Columbia and southern Yukon revealed the presence of the following stages and zones (from the bottom upward): Nettangian (Psiloceras canadense), lower Sinemurian (Paracoroniceras, Arnioceras?) Pliensbachian (Prodactylioceras, Becheiceras, Amaltheus Arieticeras) lower Toarcian (Harpoceras, Peronoceras, Dactylioceras), upper Toarcian (Grammoceras? Catulloceras?), middle Bajocian (Sonninia, Chondroceras, Stephanoceras). Some major and minor gaps are present in the sequence. Some of the ammonite genera are new for North America particularly the abundant representatives of Arieticeras in the Pliensbachian.

Ref.: Frebold, H.: Ammonites and Subdivision of the Lower Jurassic and Bajocian Beds in Northwestern British Columbia and Southern Yukon; Geol. Surv., Canada, Bull. (in press).

(H. F.)

13. PROJECT: OUTLINE OF THE JURASSIC SYSTEM IN CANADA

PERSONNEL: H. Frebold

A short abstract on the Jurassic System in Canada was presented at the Colloque du Jurassique, Luxembourg et Nancy, in 1962.

Ref.: Frebold, H.: Outline of the Jurassic System in Canada (Abst.); Colloque du Jurassique, Luxembourg, Intern. Geol. Congress (1962).

(H. F.)

14. PROJECT: PALAEONTOLOGY, STRATIGRAPHY AND STRUCTURE OF THE JURASSIC ROCKS IN SALMO MAP-AREA, BRITISH COLUMBIA

PERSONNEL: H. Frebold and H. W. Little

This is an up-to-date report on the faunas, formations, and structure of the Jurassic rocks. The following stages and formations are recognized: Nettangian? (lower Archibald Formation); lower Sinemurian (upper Archibald Formation); Upper Sinemurian, Pliensbachian, lowermost Toarcian (mainly volcanic rocks - Elise Formation); lower Toarcian, Toarcian or lower Bajocian, early middle Bajocian, younger than middle Bajocian (Hall Formation). All the mentioned formations belong to the lower Rossland Group, while the undivided volcanic rocks and sediments on top belong to the upper Rossland Group.

Ref.: Frebold, H. and Little, H. W.: Palaeontology, Stratigraphy, and Structure of the Jurassic Rocks in Salmo Map-area, British Columbia; Geol. Surv., Canada, Bull. 81 (1962).

(H. F.)

15. PROJECT: SCAPHITES OF THE BEARPAW FORMATION AND EQUIVALENT ROCKS OF ALBERTA, SASKATCHEWAN, AND MANITOBA

PERSONNEL: J.A. Jeletzky and W. A. Cobban

Palaeontological and biochronological study of Scaphites faunas of the Bearpaw Formation and its equivalents in Saskatchewan and Manitoba is now in progress. Particular attention is being paid to the zoning of these rocks by means of their Scaphites species and their dating in terms of the United States and European zones and international standard stages. Part of the project covering some Scaphites faunas common to Canada and the United States is being carried out in cooperation with Dr. W. A. Cobban of the United States Geological Survey. This part of the project is to be published in three joint papers, the first of which is now completed. Other results are to be published as G. S. C. Bulletins and/or incorporated in publications on project dealing with the Cretaceous Marine Zones of the Western Interior of Canada (see next project).

(J. A. J.)

16. PROJECT: CRETACEOUS MARINE ZONES OF THE WESTERN INTERIOR OF CANADA

PERSONNEL: J.A. Jeletzky

A detailed palaeontological zoning of marine Cretaceous rocks of the Western Interior of Canada (including the Canadian Eastern Cordillera) is now in progress. This study is based on the study of this Survey's fossil collections as well as of those made by various outside organizations and the writer. The objective is to provide Canadian geologists with a refined and regionally valid biochronological framework for correlation and dating of the Cretaceous rock units. Most results obtained to date are included in the following publications; 1) paper in press with XXth Intern. Geol. Congress at Mexico City; 2) publications listed in connection with project dealing with Cretaceous Index Fossils of Canadian Sedimentary Basins; and 3) paper on the allegedly Danian dinosaur-bearing rocks of the globe and the problem of Cretaceous-Tertiary boundary; Journ. Palaeontol. vol. 36 (5), pp. 1005-18, 2 figs, 1 plate, 1962.

(J. A. J.)

17. PROJECT: MONOGRAPH OF THE CANADIAN BUCHIA (= AUCELLA)

PERSONNEL: J. A. Jeletzky

Pelecypods of the genus Buchia (better known as Aucella) are extremely important for palaeontological zoning of late Upper Jurassic and early Lower Cretaceous rocks of western and Arctic Canada. In most parts of this region they are the only index fossils known in rocks of that age. A monographical palaeontological and biochronological study of this important genus is now in progress. Results already obtained are most encouraging. Independent sets of Buchia zones have, however, to be used in the Canadian western Cordillera and in the Canadian Arctic (including northeastern British Columbia). Most results obtained to date are listed in connection with the writer's projects dealing with Cretaceous Marine Zones, Cretaceous Index Fossils, and Late Upper Jurassic and Early Lower Cretaceous Buchia (= Aucella) Zones of the Canadian Western Cordillera. Results pertaining to the morphology, taxonomy, and evolution of Buchia and related genera have been published in outside papers: 1) Malayomaorica gen. nov. (Family Aviculopectenidae) from Indo/Pacific Upper Jurassic, with comments on related forms; Palaeontology, London, vol. 6 (1), 1963; and; 2) Evolution and Biochronology of North American Buchia in latest Jurassic and Lower Cretaceous Time (Abst.); Proceed. Geol. Soc. America for 1962.

(J. A. J.)

18. PROJECT: MONOGRAPH OF CANADIAN BELEMNITES

PERSONNEL: J. A. Jeletzky

A detailed palaeontological and biochronological study of the Triassic, Jurassic, and Cretaceous belemnite faunas of Canada is now in progress. Special attention is being paid to the morphology and taxonomy of this but little understood fossil group and to their use in correlation and dating of the Mesozoic rocks of western and Arctic Canada. Some of the hitherto obtained results are incorporated in reports listed under the writer's projects dealing with Cretaceous Index Fossils of Canadian Sedimentary Basins and Late Upper Jurassic and Early Lower Cretaceous Buchia (= Aucella) Zones of the Canadian Western Cordillera. This study is carried out in conjunction with the writer's work on the Dibranchiata volume of the Treatise of Invertebrate Palaeontology.

(J. A. J.)

19. PROJECT: CRETACEOUS INDEX FOSSILS OF WESTERN AND ARCTIC SEDIMENTARY BASINS OF CANADA

PERSONNEL: J. A. Jeletzky

Preparation of illustrations and brief systematic descriptions of Cretaceous index fossils of marine rocks of the western interior region of Canada (including the Canadian Western Cordillera) and Canadian Arctic Archipelago is now in progress. This research includes publication of information about the zonal value and succession of these fossils. The first part of the project covering the uppermost Jurassic and Neocomian (Berriasian to Aptian) fossils is now in press. The second part dealing with the Albian fossils is 90 per cent completed. Parts dealing with Upper Cretaceous fossils are about 25 per cent completed.

(J. A. J.)

20. PROJECT: LATE UPPER JURASSIC AND EARLY LOWER CRETACEOUS BUCHIA (= AUCELLA) ZONES OF THE CANADIAN WESTERN CORDILLERA

PERSONNEL: J. A. Jeletzky

This project deals with palaeontological zoning of late Upper Jurassic and early Lower Cretaceous (latest Portlandian in sensu stricto to late Valanginian inclusive) rocks of the Canadian Western Cordillera by means of Buchia species. Six reasonably refined, regionally valid Buchia zones are proposed. All zonal indices and some other important fossils are illustrated in the accompanying fossil plates; zonal Buchia species are fully described whereas other species figured are mostly only briefly commented upon in the text and explanation of plates; one new Buchia species - Buchia pacifica n. sp. - is erected to accommodate forms hitherto placed in B. crassicollis Keyserling by North American workers. Project is now completed, and a G. S. C. Paper incorporating the results is in press.

(J. A. J.)

21. PROJECT: OUTLIERS IN THE CANADIAN SHIELD

PERSONNEL: B. A. Liberty

In 1957 the writer started collecting data on the distribution and geology of the outliers in the Canadian Shield, to permit evaluation of their palaeogeographical and other geological significances. To date some 64 locations of Palaeozoic and Mesozoic strata are known, although 13 of these are known only by

the presence of loose material rather than outcrop. Cambrian, Ordovician, Silurian, Silurian-Devonian, Jurassic-Cretaceous, and Cretaceous strata are represented. Data on four new outliers and five localities where loose Palaeozoic material occurs were added during the past year.

Most of the outliers are located on the southern side of the Shield, generally close to the Palaeozoic-Precambrian contact. A considerable number, however, are well within the Shield boundaries. The distribution of these outliers indicates that large areas of the Precambrian Shield were once covered by Palaeozoic strata, and that large arms of the Palaeozoic seas must have spread across the Shield to connect with Hudson Bay and the Arctic region.

The search for new unreported outliers continues.

(B. A. L.)

22. PROJECT: MICROFOSSILS FROM THE ORDOVICIAN RED RIVER FORMATION, MANITOBA

PERSONNEL: D. C. McGregor

Studies of the microfossils have been completed and a manuscript has been prepared for publication by the Geological Survey. It will accompany manuscripts by W. L. Fry (University of California) on megafossil algae of the same beds, and by G. W. Sinclair on the stratigraphy of the Red River Formation.

The microfossils obtained from the Red River Formation include Gloeocapsomorpha prisca Zal., Tasmanites sp., Leiosphaeridia spp., Baltisphaeridium longispinosum (Eis.) Eis., Veryhachium trispinosum (Eis.) Deunff, and V. rhomboidium Downie. They provide an example of the presence of microplankton in beds that also contain a rich marine megaflora and fauna, and furnish additional evidence for interpretation of the palaeoecology of the biota of the Red River Formation.

(D. C. McG.)

23. PROJECT: DEVONIAN PLANT MICROFOSSILS OF EASTERN CANADA

PERSONNEL: D. C. McGregor

This project as originally envisaged included study of both the plant megafossils and the plant microfossils of the Devonian beds of Eastern Canada. F. M. Heuber, formerly with

the Geological Survey of Canada and now with the Smithsonian Institution in Washington has undertaken to study the plant megafossils. Two months were spent in the field in 1962 in connection with this project, familiarizing Dr. Hueber with the floral occurrences, and obtaining additional collections of micro- and megafloras.

Preliminary results of this project were published in abstract form in 1962.

Ref.: McGregor, D. C.: Large Spores from the Gaspé Sandstone (Abst.); Pollen et Spores, vol. 4, no. 2, p. 365 (1962).

(D. C. McG.)

24. PROJECT: PLANT FOSSILS FROM THE TYPE SECTION OF THE GHOST RIVER FORMATION, ALBERTA

PERSONNEL: D. C. McGregor

A preliminary report on this project was published in 1962 in which plant remains were discussed and evaluated briefly, and in which the Ghost River Formation at its type locality was redefined. A second paper, submitted for publication by the Geological Survey, describes thirteen types of spores from the plant bed at the type section. The spores support a late Givetian to early Frasnian age for the Ghost River Formation.

Ref.: McGregor, D. C., Greggs, R. G., and Rouse, G. E.: Devonian Plants from the Type Section of the Ghost River Formation of Western Canada; Science, vol. 135, pp. 930-931 (1962).
McGregor, D. C.: Devonian Miospores from the Ghost River Formation, Alberta; Geol. Surv., Canada, Bull. (in press).

(D. C. McG.)

25. PROJECT: THE AGE AND FAUNA OF A LATE MIDDLE DEVONIAN REEF ON HORN PLATEAU, NORTHWEST TERRITORIES

PERSONNEL: D. J. McLaren and A. W. Norris

The Horn Plateau Formation outcrops on the east flank of Horn Plateau, 53 miles north of Fort Providence. It consists of a small, circular, reef-like, richly fossiliferous limestone body developed within either the upper part of the

Middle Devonian Horn River Formation or strata mapped as the lower part of the Upper Devonian Port Simpson Formation, both of which consist largely of shales. The fauna is unusual in that most of it has not been observed elsewhere in the Devonian of the Mackenzie region.

One pelecypod, twenty-three brachiopods, and one trilobite species are being described by Norris. Ten of the brachiopods are new. Although most are Middle Devonian species, three show close affinity but not identity with forms in the Upper Devonian basal Waterways Formation of northeastern Alberta. It is concluded that the Horn Plateau Formation is either late Givetian or early Frasnian in age.

Fourteen species of corals are being described by McLaren. Of these, nine are new. The suite indicates a late Middle Devonian age, possibly late Givetian, although some genera are more common in the early Givetian of Europe. Several genera have not been recorded in North America before.

(D. J. McL.)

26. PROJECT: THE STRATIGRAPHY OF STANLEY SMITH'S MACKENZIE RIVER DEVONIAN CORALS

PERSONNEL: D. J. McLaren

Owing to the premature death of E. J. Whittaker in 1924 before he was able to describe the stratigraphy of the Upper Devonian of the Upper Mackenzie region, the corals he collected were described by Stanley Smith (Geol. Soc. America Special Paper 59, 1945) without a stratigraphic framework.

Smith's species are being referred to the current formational scheme for the region, and the figured specimens can be given an accurate stratigraphic fix, owing to field work carried out by the Geological Survey during 1957, on Operation Mackenzie. Some of the coral species are stratigraphically useful and the value of Smith's important work is thereby greatly increased.

(D. J. McL.)

27. PROJECT: MIDDLE DEVONIAN MEGAFOSSILS FROM DRILL CORES IN SOUTHWESTERN ONTARIO

PERSONNEL: D. J. McLaren

Examination of the cores is proceeding.

(D. J. McL.)

28. PROJECT: STRATIGRAPHY AND PETROGRAPHY OF THE CAMBRIAN AND PRECAMBRIAN STRATA OF NORTHERN JASPER PARK, ALBERTA

PERSONNEL: E. W. Mountjoy

A detailed study of the stratigraphy and petrography of the Cambrian and Precambrian strata of northern Jasper National Park is continuing. This study will provide data concerning the depositional history and environment of these strata and the overlaying Pre-Devonian unconformity. Preliminary results have been published in Geol. Survey Paper 61-31. A paper with J. D. Aitken on palaeocurrent data from crossbeds of the Lower Cambrian and Precambrian sandstones is in preparation.

Ref.: Mountjoy, E. W.: Mount Robson (Southeast) Map-area, Rocky Mountains of Alberta and British Columbia; Geol. Surv., Canada, Paper 61-31 (1962).

(E. W. M.)

29. PROJECT: STRATIGRAPHY AND PETROLOGY OF DEVONIAN REEF COMPLEXES, NORTHERN JASPER PARK, ALBERTA

PERSONNEL: E. W. Mountjoy

A study of the stratigraphy and petrology of reef complexes in this region is important and fundamental to a proper evaluation of the geological history of the Devonian System and provides valuable data concerning the development of Devonian reefs in adjacent areas and in the subsurface to the northeast. Research up to 1961 has been summarized in a report which has been prepared for publication as a Geol. Survey Bulletin. Some of these results were reported at the March 1963 annual meeting of the American Association of Petroleum Geologists. Preliminary data on the Ancient Wall reef complex have been published (Geol. Survey Paper 61-31). A more detailed report on the southeast edge of the Ancient Wall reef complex is in preparation with W. S. MacKenzie.

Ref.: Mountjoy, E. W.: Mount Robson (Southwest) Map-area, Rocky Mountains of Alberta and British Columbia; Geol. Surv., Canada, Paper 61-31 (1962).

Mountjoy, E. W.: Stratigraphy of the Devonian Miette Reef Complex and Associated Strata, Eastern Jasper National Park, Alberta; Geol. Surv., Canada, Bull. (in press).

(E. W. M.)

30. PROJECT: STRATIGRAPHY AND PETROLOGY OF THE MISSISSIPPIAN ROCKS OF NORTHERN JASPER PARK, ALBERTA

PERSONNEL: E. W. Mountjoy

This study was commenced in 1957 to obtain data on the extent, thickness, petrology, and correlation of units within the Banff Formation and Rundle Group. Some petrological studies have been initiated to determine depositional environments of these units. A brief summary of part of this work appears in Geol. Survey Paper 61-31.

(E. W. M.)

31. PROJECT: MESOZOIC STRATIGRAPHY OF NORTHERN YUKON

PERSONNEL: E. W. Mountjoy

A series of papers summarizing data collected on Operation Porcupine in 1962 are in preparation. These reports will outline the stratigraphy and petrography of the Mesozoic sediments in northern Yukon.

(E. W. M.)

32. PROJECT: LATE ORDOVICIAN AND SILURIAN FAUNAL STUDY OF SOUTHERN BRITISH COLUMBIA

PERSONNEL: B. S. Norford

This study, conducted in association with a field investigation of the Ordovician and Silurian biostratigraphy of British Columbia and Alberta, has developed into a monographic study of the faunas of the Beaverfoot-Brisco Formation. Etching of carbonates for silicified fossils has established the presence of at least four faunal zones within the formation. A paper reporting on this study was published during the year.

Ref.: Norford, B. S.: The Beaverfoot-Brisco Formation in the Stanford Range, British Columbia; Jour. Alberta Soc. Petrol. Geol., vol. 10, pp. 443-453 (1962).

(B. S. N.)

33. PROJECT: CIRRUS MOUNTAIN "HALYSITES" BEDS FAUNAL STUDY, BANFF PARK, ALBERTA

PERSONNEL: B. S. Norford

Initial results of this study have recently been published, but study of the fossils continues; many of them have been illustrated in Geological Survey Paper 62-14.

Ref.: Norford, B. S.: The Beaverfoot-Brisco Formation at Cirrus Mountain, Alberta; Jour. Alberta Soc. Petrol. Geol., vol. 9, pp. 248-250 (1961).
Norford, B. S.: Illustrations of Canadian Fossils: Cambrian, Ordovician and Silurian of the Western Cordillera; Geol. Surv., Canada, Paper 62-14 (1962).

(B. S. N.)

34. PROJECT: MIDDLE ORDOVICIAN STRATIGRAPHIC AND FAUNAL STUDY, SOUTHERN ALBERTA AND SOUTHEAST BRITISH COLUMBIA

PERSONNEL: B. S. Norford

This study originated in 1962 out of field work directed at establishing the basal boundary relations of the Beaverfoot-Brisco Formation to various subjacent units. An undescribed dolomite unit is present between the Sarbach and Mount Wilson Formations in the westernmost Front Ranges of the Rocky Mountains, and is probably in part equivalent to Walcott's Skoki Formation. Cursory examination of the fossils suggests a Chazy age.

(B. S. N.)

35. PROJECT: STRATIGRAPHIC STUDY OF BASAL DEVONIAN UNIT, WESTERN RANGES, ROCKY MOUNTAINS, SOUTHEAST BRITISH COLUMBIA

PERSONNEL: B. S. Norford

Field work was completed in 1962 on this problem and laboratory studies are now in progress. It is expected that the results will be reported in a scientific journal when available.

(B. S. N.)

36. PROJECT: SUBSURFACE STUDY OF LOWER CRETACEOUS ROCKS OF SOUTHERN SASKATCHEWAN

PERSONNEL: L. L. Price

The unconformity beneath Cretaceous rocks embraces a period of early Cretaceous and probably Jurassic time. It merges with a pre-Jurassic unconformity to the northeast where Cretaceous rocks rest on Palaeozoic rocks. Several thin rock units of doubtful age underlie Cretaceous non-marine coarse sandstone and are in turn unconformable with the rocks below.

One of these units in south-central Saskatchewan is a post-Oxfordian deposit of both marine and non-marine fine-grained sandstone and shale. The partly marine aspect of these beds has heretofore been overlooked in published correlations.

To the north and east, non-marine Cretaceous coarse sandstone is in close proximity to, and nearly indistinguishable from, older coarse, non-marine sandstone. The older sandstone, near the outer limits of the Jurassic Williston basin, is the nearshore equivalent of Oxfordian or older marine rocks of the central region.

Both Cretaceous and Jurassic sandstones are largely uncemented and form equally prolific salt-water aquifers where encountered in mining and drilling operations.

(L. L. P.)

37. PROJECT: FAIRHOLME GROUP STRATIGRAPHY, CROWSNEST-FLATHEAD DISTRICT, BRITISH COLUMBIA AND ALBERTA

PERSONNEL: R. A. Price

Stratigraphic data collected in the course of regional mapping are being analyzed to establish the nature and significance of differences in lithofacies and stratigraphic relations of the Devonian Fairholme Group and contiguous strata in the Crowsnest-Flathead District and more northerly parts of the Rocky Mountains. The shapes and spatial relations of dolomitized reef masses comprising the Peechee Member of the Southesk Formation have been studied to establish the time and nature of reef growth and its influence on later sedimentation. Some preliminary results were published in 1962.

Ref.: Price, R.A.: Fernie Map-area, East Half, Alberta and British Columbia; Geol. Surv., Canada, Paper 61-24 (1962).

(R.A.P.)

38. PROJECT: SUBSURFACE STUDY OF MISSISSIPPIAN, PENNSYLVANIAN, AND PERMIAN SYSTEMS OF NORTHEASTERN BRITISH COLUMBIA

PERSONNEL: R. M. Proctor

Regional study of the subsurface Upper Palaeozoic units of northeastern British Columbia indicates that marine sedimentation was continuous from Late Devonian to Early Pennsylvanian. In the Ft. St. John area this interval is represented by almost 6,000 feet of sediments. To the north and east periods of severe erosion prior to Permian, Triassic, Jurassic, and Cretaceous times have destroyed much of the section, leaving less than 500 feet at the extreme northeastern part of the province.

Mississippian sedimentation began with the thin bituminous "Exshaw" shale followed by Banff shales and argillaceous limestones. The overlying Pekisko-Shunda carbonates are increasingly argillaceous northwestward where the interval is best considered all Shunda containing tongues of a Pekisko facies. Northern limits of good Pekisko development are related in part to the position of the former Peace River "Arch". The overlying Debolt Formation comprises several thin but extensive cherty carbonates, which appear to represent cyclic sedimentation. Mississippian carbonates are overlain conformably by clastic rocks of the Stoddart Group, a sequence of lensing sands, shales, and silty to sandy carbonates, containing the Mississippian-Pennsylvanian boundary. Although the Stoddart can be considered dominantly shale at the base and carbonate at the top, attempts to subdivide it into readily mappable units of regional significance have been unsuccessful. The Stoddart is overlain with regional unconformity by the Belloy cherts of Permian age.

Preliminary results of this study are incorporated in "Carboniferous of Western Canada" in the Western Canada Sedimentary Basin Symposium of the Alberta Society of Petroleum Geologists.

(R.M.P.)

39. PROJECT: SUBSURFACE STUDIES, CAMBRIAN TO MISSISSIPPIAN IN SOUTHWESTERN ONTARIO

PERSONNEL: B. V. Sanford

This project involves a subsurface study of the individual Systems from Cambrian to Mississippian inclusive in southwestern Ontario. As reports on the stratigraphy of Cambrian and Ordovician rocks have been published, present emphasis is being placed on the Silurian System. Structure, isopachous, and lithofacies maps are now being prepared for the complete Silurian from the data obtained by the examination of sample cuttings from about 3,500 wells.

Ref.: Sanford, B. V., and Quillian, R. G.: Subsurface Stratigraphy of Upper Cambrian Rocks in Southwestern Ontario; Geol. Surv., Canada, Paper 58-12 (1959).

Sanford, B. V.: Subsurface Stratigraphy of Ordovician Rocks in Southwestern Ontario; Geol. Surv., Canada, Paper 60-26 (1961).

(B. V. S.)

40. PROJECT: SALINE DEPOSITS OF SOUTHWESTERN ONTARIO

PERSONNEL: B. V. Sanford

A project was undertaken in 1962 to prepare for oral presentation a paper dealing with salt deposits of Ontario for the International Symposium on Saline Deposits at Houston, Texas. This paper outlining the stratigraphy, structure, and the relationship of Upper Silurian salt deposits to oil and gas occurrences in southwestern Ontario is now in manuscript for publication in the Geological Survey Paper Series.

Ref.: Sanford, B. V.: Salt Deposits and Thin Relationship to Oil and Gas Occurrences in Southwestern Ontario; Geol. Surv., Canada Paper (in press).

(B. V. S.)

41. PROJECT: RAPID SEDIMENT ANALYSER

PERSONNEL: J. S. Scott, D. E. Field, L. S. Collett, F. W. Jones, and A. G. Meilleur

During 1962 construction of the basic components of a Rapid Sediment Analyser, modified after a Woods Hole Oceanographic Institution instrument, was completed.

Modification in design of the apparatus, by installing additional piezometer taps, to accommodate the analysis of silt- and clay-sized fractions required the installation of a chart speed reducing unit in the automatic recorder.

Alternating current activation of the differential transformer within the differential pressure transducer caused problems of phasing the output voltage from the transformer with the recording circuitry. This problem was solved by substituting a direct current activated differential transformer and output amplification circuit.

Assembly of components for the apparatus has been completed and a preliminary testing program with a known standard sample is being conducted. Results of preliminary testing indicate proper functioning of all components, although minor mechanical modifications are required to facilitate operation.

A minimum of one month will be required for calibration of the apparatus and development of operation technique.

(J. S. S.)

42. PROJECT: SUBSURFACE STUDIES OF CRETACEOUS ROCKS IN NORTHEASTERN BRITISH COLUMBIA

PERSONNEL: D. F. Stott

This project was only recently initiated to provide sufficient data for the correlation of outcrop sections with subsurface rocks and is being carried on in conjunction with field projects. Well control near the Foothills is also expected to prove useful in permitting correlations to be made across areas where outcrop sections are incomplete or not available. Another objective is the correlation of Cretaceous rocks of British Columbia with those studied previously in the District of Mackenzie (Geol. Surv. Canada Bull. 63).

Wells already examined indicate the close relationship of the standard Plains section with the Foothills succession. Outlines of the distribution and general character of several sandstones, known to be reservoirs of petroleum and natural gas in this region, are also being obtained.

(D. F. S.)

43. PROJECT: SUBSURFACE GEOLOGY, LOWER MACKENZIE RIVER AND ANDERSON RIVER AREA, DISTRICT OF MACKENZIE

PERSONNEL: E. J. Tassonyi

The writer is preparing a report for the Geological Survey on released subsurface data on exploratory wells north of the 64th parallel, based on examination of samples, cores, and mechanical logs. The new subsurface data and the re-interpretation of the Canol reports corroborate the validity of H. G. Bassett's Devonian Stratigraphy and Nomenclature, published in the Arctic Symposium.

The penetrated Cretaceous, Devonian, and pre-Devonian strata will be described in this report. Some of them are being traced from subsurface to outcrop to substantiate regional correlation and to draw palaeogeographical and tectonic conclusions with particular emphasis on Devonian reef environment.

The formal acceptance of the spore-bearing basal "Bluefish Member" of the "Hare Indian Shale" will be proposed. Three informal members of the Bear Rock Formation are recognized: dolomite member, anhydrite member, and pellet limestone member. Facies changes within the Bear Rock Formation, the Ronning Group, and the Macdougal Group will be explained. The report will include revisions to the nomenclature and regional correlation presented in Geological Survey Paper 45-29 and Memoir 273.

(E. J. T.)

44. PROJECT: CHAPTER ON PLEISTOCENE GEOLOGY IN 'ARCHAEOLOGY IN CANADA'

PERSONNEL: J. Terasmae, J.G. Fyles, and V.K. Prest

This report will provide an outline of geological events in Canada, beginning in the last Interglacial Interval, required as background and reference for regional archaeological investigations.

It will be a joint contribution by members of the Pleistocene Geology Section of the Geological Survey of Canada and will include a considerable amount of unpublished data, as well as available information from published reports.

The planning phase of this project has been completed.

(J. T.)

45. PROJECT: THE PLEISTOCENE PALYNOLOGY LABORATORY

PERSONNEL: J. Terasmae and R. J. Mott

Forty reports have been prepared to date in 1962. Of these reports 24 have been to members of the Geological Survey. Other reports:

4	reports to	Geographical Branch, M. T. S.
3	"	" Ontario Department of Mines
2	"	" McGill University (Montreal)
1	"	" University of British Columbia
1	"	" National Museum of Canada
1	"	" Ontario Dept. Lands & Forests
1	"	" Ontario Hydro-Electric Power Commission
1	"	" Dept. Mines, Agr. & Res. Newfoundland
1	"	" BP Exploration Co.
1	"	" private person

In addition to these reports many inquiries have been answered on subjects of sampling, preparation, and examination of sediments for plant microfossils.

(J. T.)

MARINE GEOLOGY

46. PROJECT: RECENT MARINE SEDIMENTS OF EXETER BAY, BAFFIN ISLAND, DISTRICT OF FRANKLIN

PERSONNEL: Kate M. Kranck

Officers of the Canadian Hydrographic Service collected 127 samples of bottom sediments in 1955 from Exeter Bay. The area sampled is 5 by 16 miles, extending across the narrow continental shelf to the continental slope.

Size and shape analyses were made together with petrographic studies on thin sections of selected pebbles and heavy mineral mounts of unconsolidated sands. Charts were constructed to show the data. From this study distribution and properties of the sediments and agents of deposition were determined.

The sediments are coarse; 50 per cent of the samples are gravel and 35 per cent of these have no sand. High sand-content occurs close to shore and between islands off Exeter Bay. Gravels occur from about 5 miles off shore to the continental slope, where sand is again found. Sedimentary transport is by rivers and ice-rafting, the latter predominating. This is seen in the poor sorting and abundance of large pebbles. On the continental shelf, sediments are exposed to the Labrador current and fines are winnowed out leaving a coarse lag deposit.

Petrographic results indicate local derivation for some coarser fragments. Igneous and metamorphic rocks correspond to rock types on Cumberland Peninsula. Fragments of limestone and sandstone are probably ice-rafted from regions underlain by sedimentary rocks around northern Baffin Bay. Basaltic pebbles also occur and probably come from Tertiary volcanic rocks between Capes Dyer and Searle. Heavy minerals show little variation, thus illustrating the dominant masking effect of ice-rafting over normal sedimentary processes.

(K. M. K.)

47. PROJECT: IDENTIFICATION OF ORGANIC REMAINS FROM OFF-SHORE DREDGED SAMPLES, EXETER BAY, BAFFIN ISLAND

PERSONNEL: Frances J. E. Wagner

Identification of this material was completed recently. There were 127 stations. No samples were obtained from 17 of these, and samples from 20 of the remaining 110

stations were barren of any organic remains. Of these 37 unproductive stations, 21 were in areas of rock bottom, 10 in areas of pebble bottom, 5 in areas of rock and pebble bottom, and 1 in an area of sand and pebble bottom. Organisms found are as follows: Foraminifera, 91 species; Bryozoa, 6 species; Brachiopoda, 1 species; Pelecypoda, 30 species; Gastropoda, 12 species; Annelida, 5 species; Crustacea, 26 (±) species; Ostracoda, 20 (±) species; Cirripedia, 1 species; Isopoda, 3 species; Amphipoda, 1 species; Cumacea, 1 species; Echinoidea, 1 species; and Ophiuroidea, 2 species. The isopods, amphipoda, and cumaceans were identified by E. L. Bousfield of the National Museum of Canada.

A paper on the results of this study should be forthcoming in 1963.

(F. J. E. W.)

48. PROJECT: MICROPALAEONTOLOGY - MARINE SEDIMENTS

PERSONNEL: Frances J. E. Wagner

This is a continuing study involving material from the Polar Continental Shelf Project. Reports will be issued periodically as individual studies are completed. The first report was published in 1962. The next report will be a joint paper with B. R. Pelletier on samples from the Hudson Strait-Foxe Basin area. Following this, a study of the material from the Arctic Ocean collected during the 1962 field season by B. R. Pelletier will be started.

Ref.: Wagner, Frances J. E.: Faunal Report, Submarine Geology Program, Polar Continental Shelf Project, Isachsen, District of Franklin; Geol. Surv., Canada, Paper 61-27 (1962).

(F. J. E. W.)

Does this ever published?

STRUCTURAL GEOLOGY

49. PROJECT: TECTONICS OF THE ROCKY MOUNTAINS AND FOOTHILLS

PERSONNEL: R. J. W. Douglas

Investigations are being carried on into:

a) The tectonic behaviour of the Proterozoic rocks of the Lewis thrust sheet and the characteristics of sub-Lewis thrust sheets that involve natural gas-bearing Palaeozoic strata. Progress is being made in logging and interpreting the deep wells in collaboration with R. L. Kerr.

b) The fundamental features of the structures of the Central Alberta Foothills, their temporal and physical relationships, and the potentialities of the region with respect to oil and gas. Compilation of remaining map-areas is underway.

c) Relationship of tear faults to Laramide structures; their significance in the analysis of these structures, and as indicative of the presence of pre-Laramide structures. A paper is being prepared.

(R. J. W. D.)

50. PROJECT: MACKENZIE MOUNTAIN TECTONICS

PERSONNEL: R. J. W. Douglas and D. K. Norris

Investigation of the structural features of the southern Mackenzie Mountains, Franklin Mountains, and adjacent Plains was commenced to establish the structural habit, to interpret the mechanics of deformation of the sedimentary veneer, and to compare and contrast Mackenzie Mountain tectonics with other regions of the Eastern Cordillera.

(R. J. W. D.)

51. PROJECT: STRUCTURE, NORTHERN JASPER PARK, ALBERTA

PERSONNEL: E. W. Mountjoy

The extent, geometry, and suggested development of fold and thrust structures in the Front and Main Ranges of northern Jasper Park are under study. The relationship of folds associated with the abrupt termination of major thrusts

and inter-relationships of hanging-wall and foot-wall structures are being investigated in some detail. Preliminary results for part of this region have been summarized in Geol. Survey Paper 61-31.

Ref.: Mountjoy, E.W.: Mount Robson (Southeast) Map-area, Rocky Mountains of Alberta and British Columbia; Geol. Surv., Canada, Paper 61-31 (1962).

(E.W.M.)

52. PROJECT: REGIONAL STRUCTURE AND STRATIGRAPHY TETE JAUNE-EDSON AREA, ALBERTA AND BRITISH COLUMBIA

PERSONNEL: E. W. Mountjoy and R. J. W. Douglas

A study of the regional structure and stratigraphy of the Tete Jaune-Edson area (83 SW) is under investigation. This study is in part based on an interpretation of air photographs. Structural relationships and interpretations and their economic importance will be appraised and discussed.

(E.W.M.)

53. PROJECT: SHEARING STRAIN IN SIMPLE FOLDS IN LAYERED MEDIA

PERSONNEL: D.K. Norris

The traces of stratigraphic surfaces in right sections of simple folds can be empirically represented by algebraic curves: symmetrical and asymmetrical folds by Fourier series; broad, open anticlines separated by narrow synclines by curtate cycloids and overturned folds rather crudely by composite curves derived from first order Bessel functions. Chevron folds may be broken into linear components each of which can be expressed as a linear function or, in some instances by a Fourier series.

The simple shearing strain in a thin beam folded to conform to these curves was evaluated by means of models of folded stacks of paper. If it can be assumed that the above algebraic functions are continuous and periodic, that the traces of the surfaces of the laminae are continuous through one or more wavelengths, and that the amplitude of the folds is small relative to the wavelength, the following may be concluded.

1. The amount of homogeneous, simple shearing strain in any given fold is non-linearly proportional to the arc length from a fixed point of no strain, and to the degree of asymmetry of the fold. It is independent of the amplitude and wavelength of the fold.

2. In general the shearing strain reaches a maximum value at inflection points; for curves symmetrical about the phase angle axis it is equal in magnitude equidistance along the arc on either side of the inflection.

3. For the special case of simple curves in which the shearing strain is fixed at an inflection, the shearing strain will be zero at integral numbers of wavelengths therefrom and will reach a maximum at alternate inflection points.

4. There is transport of material across the axial surfaces of continuous, simple folds except where the model is fixed so that there is no strain at a given axial surface.

5. For chevron folds the amount of simple shearing strain is constant within any one limb and is proportional to the tangent of the flank angle for shallow dips.

These conclusions would appear to have geological application under ideal conditions for flexural-slip folding. 1) If stratigraphic surfaces are continuous and are uninterrupted, primary folding in layered successions will occur as anticline-syncline pairs so that in right sections of folds with horizontal axial lines there is conservation of interbed slip within each wavelength. 2) If it can be assumed that secondary structures result from simple shearing strain, they will most likely occur where the strain is a maximum i.e., at the inflection points on the fold. These preliminary investigations would suggest a possible explanation for the spacing of major thrust surfaces on primary folds on the one hand and the structural position of splays, minor thrusts and secondary folds on the other.

(D.K.N.)

54. PROJECT: GEOMETRY AND MECHANICS OF FOLDING, SOUTHERN ROCKY MOUNTAINS, BRITISH COLUMBIA AND ALBERTA

PERSONNEL: R.A. Price

Analyses of data and specimens collected during the 1961 field season have been continued with the objective of establishing: (1) geometric attributes of folds and their relationships to fold size, to associated faults, and to

stratigraphic level and tectonic environment of the folded beds; (2) the character of fracture fabrics in the folded beds; and (3) the character of micro-fabrics that might be associated with the folding. A paper on the geometry of folding is being prepared. Preliminary analyses of fracture fabric data indicate that most of the fractures are kinematically related to the folding process and that virtually all fractures have undergone external rotation during folding.

(R. A. P.)

55. PROJECT: THE LEWIS THRUST SHEET IN THE SOUTHEASTERN CORDILLERA OF CANADA

PERSONNEL: R. A. Price

This project involves the analysis of data collected in the course of regional mapping and those compiled from published reports. The objectives are to determine the relationships between the shape of the Lewis thrust fault, its path through the stratigraphic succession it cuts, and the character of structures developed within and below the thrust sheet. A kinematic analysis of the emplacement of the thrust sheet is being attempted, and the magnitude of the displacement on the thrust and the size of the thrust sheet are being evaluated in terms of their regional tectonic significance. A preliminary account has been published.

Ref.: Price, R. A.: The Lewis Thrust Sheet in the Southeastern Cordillera of Canada (Abst.); Bull. Geol. Soc. America, vol. 71, p. 1947 (1960).

(R. A. P.)

56. PROJECT: LARGE-SCALE 'BLOCK' FAULTING IN THE ROCKY MOUNTAINS OF SOUTHEASTERN BRITISH COLUMBIA

PERSONNEL: R. A. Price

The objectives of this study are to provide a kinematic analysis of 'block' faulting involving stratigraphic separations of more than 20,000 feet, to date displacement along the faults relative to thrust and fold deformation and Tertiary sedimentation, and to investigate the relationships between 'block' faulting and thrust fault deformation in the region. Results to date include preliminary calculations of components of displacement vectors along several differently oriented segments of the Flathead fault and the compilation of data relating to the age of the faulting.

(R. A. P.)

GEOPHYSICS

57. PROJECT: SOME THEORETICAL ELECTROMAGNETIC INVESTIGATIONS

PERSONNEL: B. K. Bhattacharyya

Electromagnetic fields of a vertical magnetic dipole placed above the surface of the earth have been determined. Mathematical expressions of the fields have been obtained for the time and frequency domains. Conductivity and permittivity of the earth influence the resultant electromagnetic field appreciably. These results will be useful in the interpretation of airborne electromagnetic surveys. A report of this work will appear in the June 1963 issue of Geophysics.

Studies were made on some theoretical aspects of electrode polarization in rocks. Two papers on this work have been prepared for publication in geophysical journals.

Investigations are being conducted on the electromagnetic wave propagation through a polarizable medium. Some progress has been made on this theoretical problem, which may have important practical application in the future.

A paper on the radiation resistance of horizontal electric and vertical magnetic dipole antennas has been accepted for publication in 1963 in the special issue of the Professional Group on Antennas and Propagation of the Institute of Radio Engineers on subsurface propagation. The radiation resistance is affected appreciably with the change in the conductivity or permittivity of the earth.

(B. K. B.)

58. PROJECT: PALAEOMAGNETIC MEASUREMENTS ON ROCKS FROM THE MARITIME PROVINCES

PERSONNEL: R. F. Black

(a) Among the 272 oriented samples collected from the Permo-Carboniferous rocks of Prince Edward Island, a total of 172 had their direction of remanent magnetization determined. Of these, 154 samples represent the red sandstones and siltstones, whereas the remaining 18 samples were from a younger small olivine dolerite dyke located on an island in Malpeque Bay. Of the 100 samples rejected, most had intensities below the limit of resolution of the available measuring equipment and a few were internally inconsistent. The pole positions derived from the significant samples is in agreement with those derived from other Permo-Carboniferous rocks of different parts of North America.

(b) Among the 500 samples collected from formations ranging in age between Precambrian and Carboniferous in Newfoundland and the adjacent coast of Labrador 450 have been prepared of which 200 have been measured. Results obtained from 41 samples of volcanic and sedimentary rock of the Springdale Group have been used to correlate rocks in the King's Point area with those in the Halls Bay area. A polarity reversal in one of the localities indicates that the rocks in the two localities may differ in age by a few million years but the mean directions of magnetization of both groups are not significantly different. These results plus others when finalized will be used to construct a polar wandering curve to represent the Precambrian and Palaeozoic rocks of Eastern Canada.

(R. F. B.)

59. PROJECT: SHIP MAGNETOMETER SURVEYS

PERSONNEL: Margaret E. Bower and D. A. Reveler

The compilation and interpretation of ship magnetometer surveys is a continuing project. Results of the 1959 and 1960 surveys have been published (G. S. C. Papers 61-30 and 62-6).

During 1961, magnetometers were installed on the ships, C. H. S. "Baffin" and "Kapuskasing" and M. V. "Theta". The C. H. S. "Baffin" operated in an area to the south of the Bay of Fundy; the C. H. S. "Kapuskasing" in an area to the west of Sable Island, and the M. V. "Theta" made traverses in Hudson Bay.

Maps from the Baffin survey are ready to be contoured, but will require certain corrections to compensate for errors made by the recording equipment. The area to the west of Sable Island has been contoured, and requires only final checking and interpretation. At present the ship magnetometer compilation is being done by D. A. Reveler.

Ref.: Bower, M. E.: Sea Magnetometer Surveys of the Grand Banks of Newfoundland, Burgeo Bank and St. Pierre Bank, Geol. Surv., Canada, Paper 61-30 (1962).

Bower, M. E.: Sea Magnetometer Surveys Southwest of Nova Scotia, from Sable Island to St. Pierre Bank, and over Scatari Bank; Geol. Surv., Canada, Paper 62-6 (1963).

(M. E. B.)

60. PROJECT: LABORATORY DEVELOPMENT OF LOW FREQUENCY INDUCED POLARIZATION EQUIPMENT

PERSONNEL: L. S. Collett, R. A. Ahrens, and C. Gauvreau

Construction of low frequency induced polarization equipment was undertaken during 1962. This equipment is to be used for groundwater exploration. The apparatus will deliver 1 ampere into the ground over a frequency range from 0.1 cps to 30 cps. It is designed to measure the in-phase and out-of-phase electrical components of the membrane polarization of clays.

The equipment consists of four parts: a transmitter, a comparator network, a receiver, and associated power supplies. A low frequency function generator modulates a carrier signal in the transmitter. This signal is amplified and demodulated at the output. To protect the high-capacity, low-voltage capacitors in the comparator circuit, a protection circuit had to be incorporated in the design.

Circuit analysis over the low frequency range was carried out in the design stages to ensure linearity in the modulation of the carrier, amplification and demodulation. The construction is complete except for the receiver. Laboratory tests have been done on the completed individual units.

(L. S. C.)

61. PROJECT: SCALE MODEL AND LABORATORY MEASUREMENTS ON ROCK SPECIMENS

PERSONNEL: L. S. Collett

In the scale model measurements, a large wooden tank, 15' x 15' x 4', has now been installed in a hut in Gatineau Park, where power line and radio interference is at a minimum. The track for the carriage that will support the transmitter and receiver coils has been installed. Accessory equipment and coils are expected to be ready to commence measurements during the summer of 1963.

For laboratory measurements of resistivity and induced polarization studies, most of the accessory equipment has been acquired. Holders for rock specimens have been made. A method to handle unconsolidated material such as clay has been designed and is in the process of being constructed.

This program is intended to study the effect of conductivity and dielectric constant of earth materials on the mutual coupling between coils in the case of scale model measurements. The measurements on rock specimens and unconsolidated earth materials are designed to investigate the mechanism of electrode and membrane polarization effects.

(L. S. C.)

62. PROJECT: CONSTRUCTION OF A PORTABLE GAMMA-RAY SPECTROMETER

PERSONNEL: R. Doig

A portable gamma-ray spectrometer with three variable-width channels has been designed and is being built at McGill University for the Geological Survey. The instrument will be used for field investigations of natural gamma-ray spectra of rocks with the object of evaluating the content of uranium, thorium, and potassium. One channel has been completed and tested. The remaining two channels are under construction.

63. PROJECT: EVALUATION OF AEROMAGNETIC AND PHOTOGEOLOGIC METHODS AS AIDS IN THE REGIONAL GEOLOGIC MAPPING OF GRENVILLE-TYPE ROCKS

PERSONNEL: A. F. Gregory, D. T. Anderson, K. H. Owens, and E. Roy

This project was initiated late in 1962 to study a large area in western Quebec. Preliminary library research and administrative work was completed. D. T. Anderson started compiling a composite geological map, at a scale of 1 inch to 4 miles, based on the available geological mapping at larger scales. A common legend was established to group and correlate the various rock units in the legends of the detailed mapping. Consideration was also given to the best means of preparing composite aeromagnetic maps, at a scale of 1 inch to 4 miles, from the various surveys in the area of interest.

(A. F. G.)

64. PROJECT: SHIP MAGNETOMETER AND CONTINUOUS SUB-BOTTOM PROFILE RECONNAISSANCE OF HUDSON BAY

PERSONNEL: R. J. Hood, Margaret E. Bower, and D. Reveler

A total of 6,500 nautical miles of ship magnetometer records and 225 nautical miles of continuous sub-bottom profiles had been obtained in Hudson Bay during the 1961 summer cruise of the M. V. Theta, which was under charter to the Oceanographic Research Division of the Department of Mines and Technical Surveys. The instruments used were the G. S. C. proton precession magnetometer and a sparker-type seismic recorder.

The sparker profiles shed some light on the extent of the Palaeozoic sediments in the bay and indicate a Palaeozoic-Proterozoic contact about 20 miles west of the Belcher Islands. In the Belchers themselves, an anticlinal structure is indicated along the central part of Omarolluk Sound with tightly folded synclines on either side.

A quantitative interpretation of the ship magnetometer records shows that, in general, the depths to basement are least around the margin of the bay with the greatest calculated depths occurring in the central part of the bay to the northeast of Churchill. Depths of 10,000 feet were interpreted. This thickness of sediments is rather more than had hitherto been expected, but much of it may include Proterozoic and possibily Cambrian sediments.

(P. J. H.)

65. PROJECT: DEVELOPMENT OF AN ASTATIC-TYPE MAGNETOMETER

PERSONNEL: A. Larochelle

A limited amount of time was spent on this project during the past year. Improvements were made to the optic lever system and work is in progress for one automatic sample positioning system. No results are available as yet as to the limit of resolution of this instrument.

(A. L.)

66. PROJECT: DEVELOPMENT OF A SPINNER MAGNETOMETER

PERSONNEL: A. Larochelle, R.A. Ahrens, and H.W.C. Knapp

Construction of an air-driven turbine spinner magnetometer was completed during the course of this year. Calibration of the instrument reveals a sensitivity of the order of 10^{-7} c.g.s. u./cc., which is adequate for most palaeomagnetic measurements. The instrument operates at a nominal frequency of 255 c.p.s. and used 1-inch cubes as samples. A written account of the theory and design of this instrument will be submitted shortly for publication by the Geological Survey.

(A.L.)

67. PROJECT: RECENT PUBLICATIONS BY GEOLOGICAL SURVEY PERSONNEL OF PALAEOMAGNETIC DATA FROM CANADIAN ROCKS

PERSONNEL: A. Larochelle

During 1962, two Geological Survey bulletins containing palaeomagnetic data on Canadian rocks were published, two other bulletins were in press, and a report of an investigation on the differential rotation of the Lewis thrust plate was published in a geological journal.

Ref.: Black, R.F.: Palaeomagnetism of the Purcell Series; Geol. Surv., Canada, Bull. 84 (in press).

Du Bois, P.M.: Palaeomagnetism and Correlation of Keweenawan Rocks; Geol. Surv., Canada, Bull. 71 (1962).

Larochelle, A.: Palaeomagnetism of the Monteregion Hills; Geol. Surv., Canada, Bull. 79 (1962).

Norris, D.K. and Black, R.F.: Palaeomagnetism and Differential Rotation in the Lewis Thrust Sheet; Jour. Alberta Soc. Pet. Geol., vol. 10, pp. 13-21 (1962).

Sopher, S.R.: Palaeomagnetism of the Sudbury Intrusive; Geol. Surv., Canada, Bull. 90 (in press).

(A.L.)

68. PROJECT: PALAEOMAGNETIC MEASUREMENTS OF DIABASE DYKE ROCKS THROUGHOUT CANADA

PERSONNEL: A. Larochelle, W. F. Fahrig, and E. Gaucher

Of the 500 oriented specimens collected from diabase dykes and sills throughout Canada, 20 were examined so far. These specimens were collected in the vicinity of Isachsen on Ellef Ringnes Island and their age is known to be Cretaceous. Preliminary results indicate that their directions of magnetization are internally and externally consistent and that they are not affected by the tabular shape of the bodies from which they were collected. A pole position computed from these directions of magnetization is in full agreement with the pole position indicated by other Cretaceous rocks from far distant localities in North America.

(A. L.)

69. PROJECT: AEROMAGNETIC GEOLOGICAL INTERPRETATION

PERSONNEL: A. S. MacLaren, K. H. Owens, and E. Roy

Two maps in 5 colour tones with marginal notes on interpretation, Wholdaia Lake and Beaverhill Lake, in the Northwest Territories, were published on a scale of 1 inch to 4 miles.

An aeromagnetic-geologic interpretive map and preliminary report of the Roads to Resources area, Northwestern Ontario, was prepared on a scale of 1 inch to 8 miles. Many square miles of unknown volcanic rocks were interpreted from the magnetic data. Major structures and faults show up distinctly as well as areas of intrusive rocks ranging in composition from granite to serpentinite.

Magnetic susceptibility and specific gravity determinations from this area have been made on 7,500 rock samples. The data were placed on I. B. M. punch cards with other petrographic and geochemical data. Coefficients of correlation between magnetic susceptibility and gravity values and the geochemistry for each rock type are being calculated on the computer.

(A. S. MacL.)

70. PROJECT: SHIP MAGNETOMETERS

PERSONNEL: L. S. Collett, P. Sawatzky, W. J. Stauffer, and A. Dicaire

New construction

During 1962 an additional magnetometer was constructed for the use of the Bedford Institute of Oceanography. Spare chassis were also constructed for the two older units, which had been used on board the "Kapuskasing" and "Baffin".

Improvements and modifications

Several improvements were incorporated in the new units. Solid state clamping diodes and zener diodes replaced the older types of vacuum tube diodes and voltage regulators. The use of these components resulted in the saving of space and reduced power requirements.

The sensing head or "fish" was completely re-designed so that distilled water instead of kerosene could be used in the sensing head as the proton source. This made it possible to increase the "read" time and thus improve the accuracy of the magnetometers to the point where they are capable of measuring magnetic field changes of less than a gamma.

A dual channel Sanborn recorder was tried for the third unit in lieu of the Westronics. This required some re-design of the programming and the digital to analogue circuits. After this was done, this recorder proved to be quite satisfactory.

(P. S.)

71. PROJECT: MAGNETOMETER INSTALLATION IN A HELICOPTER

PERSONNEL: P. Sawatzky, S. Washkurak, H. W. Knapp, A. Dicaire, and W. J. Stauffer

Equipment was built to fit under the seat of a Bell 47J-2 helicopter. The two heaviest items were a radio altimeter (APN-1) and a Mark VII camera. The actual magnetometer equipment together with the sensing head weighed only about 25 pounds. A special programmer and amplifier were built that were shielded against engine and VHF radio interference.

Transistorized power supplies, operating at a switching frequency of from 1,600 cps to 1,800 cps, were used to operate the magnetometer and the radio that was used to telemeter the magnetic field information to the ground.

A pulse integrator that synchronized the camera and magnetometer was built for the aircraft; it also controlled the ground station equipment, keeping everything in step. Another circuit that worked in conjunction with the pulse integrator was incorporated with the ground station equipment.

A special unit that removed the effect of diurnal magnetic variations from the values telemetered from the survey aircraft was designed and built for the ground station. This meant that the old method of compensating or correcting the survey data for diurnal magnetic drift could be eliminated. Each reading, before it was recorded at the ground station, was corrected automatically.

(P. S.)

72. PROJECT: MAGNETOMETER INSTALLATION IN A SMALL FIXED-WING AIRCRAFT

PERSONNEL: P. Sawatzky, S. Washkurak, H. W. Knapp, A. Dicaire, and W. J. Stauffer

As the weight problem is less acute in a Beaver aircraft than in a helicopter, a telemetering magnetometer was constructed that was also capable of recording the magnetic field data on board the aircraft. Much of the equipment was transistorized to reduce the weight and power requirements.

Instead of the sensing head being towed, it was mounted in a "stinger" that had been designed for the Beaver. This eliminated tow-cable problems encountered at higher speeds.

To maintain a constant signal amplitude in spite of heading, and reduce the effects of pitch and roll, a special sensing element was wound by hand in our laboratory. After the installation in the Beaver was complete, detailed checks showed that the total heading effects were less than 5 gammas.

Special high-gain directional antennas were built to improve the telemetering range. In order that complete coverage in the mountains might be obtained, a radio link was installed in a second light aircraft (Cessna 180).

Flight path recovery in the mountains proved to be something of a problem and it has been proposed that further work should be done on this phase of the survey, possibly using wider angle lenses in the camera.

During the survey it was found that the multi-contact relays used in the programming circuits wore out rather faster than normal. A new circuit was designed and tested to eliminate this fault.

(P. S.)

GEOCHEMISTRY, ISOTOPE AND NUCLEAR GEOLOGY

73. PROJECT: PREPARATION OF SYNTHETIC MIXTURES OF MINERALS FOR INFRARED TESTS

PERSONNEL: S. Abbey, H.R. Steacy, W.H. Champ, and E. Schiller

Specimens of the purest available quartz, albite, microcline, and muscovite were ground to the usual fineness for chemical analysis. Portions of each were weighed out to give three mixtures of compositions characteristic of granite, quartz monzonite, and granodiorite. After thorough mixing, portions of the mixtures were ground exceedingly fine, as were also portions of each pure mineral and of a rock sample for which modal and normal analysis were available. Part of each finely ground material was sent to each of four manufacturers of infrared spectrometers, who had offered to attempt to determine the mineralogical composition of the mixtures and the rock by using the pure minerals as reference standards.

Results from one manufacturer were entirely unsatisfactory, since they did not treat the samples in the manner requested. A second manufacturer provided a detailed report, at least half of the results on which were good. The data is being studied with a view to improving the remaining results. The other two manufacturers have not yet reported.

(S.A.)

74. PROJECT: LEAD AND SULPHUR ISOTOPE GEOLOGY OF KENO AND GALENA HILLS, YUKON TERRITORY

PERSONNEL: R.W. Boyle, R.D. Stevens, and R.K. Wanless

The lead isotopic analyses of 150 samples of galena and other lead minerals from the region have been completed. All of the samples studied have anomalous lead isotope abundance ratios, indicating the addition of excess radiogenic lead. The isotopic ratios fall into two main groups. One group, comprising about 75% of the samples, is confined within small limits whereas the majority of the remaining samples have accumulated varying, large concentrations of radiogenic lead.

The lead isotope data is to be combined with the results of the sulphur isotope studies. All sulphides have been converted to SO_2 and the first isotopic analyses (25) have been completed.

(R.K.W.)

75. PROJECT: DIRECT-READING SPECTROCHEMICAL LABORATORY

PERSONNEL: E.M. Cameron and Mrs. T.D. Dawes

In recent years it has become apparent that progress in many areas of pure and applied geochemistry is dependent on the development of rapid analytical techniques capable of producing large numbers of precise analyses of rocks. A direct-reading optical spectrometer was obtained to fulfil this need for a number of elements of geochemical interest.

Since this instrument was installed in December 1961 a method has been developed for the rapid analysis of Si, Al, Fe, Ca, Mg, Mn, Ti, and Na. The rock samples are fused with lithium tetraborate and strontium carbonate and are briquetted with graphite, before being excited in a high voltage spark. Similar techniques for the analysis of certain trace elements are presently being investigated.

(E.M.C.)

76. PROJECT: MAJOR-ELEMENT CONTENT, GRANITIC ROCKS, NORTHWESTERN ONTARIO

PERSONNEL: E.M. Cameron, R.F. Emslie, R.H.C. Holman, and Mrs. T.D. Dawes.

The major-element content of several hundred samples of granitic rocks, collected during the "Roads to Resources" project in northwestern Ontario, were analysed late in 1962. These analyses were made using newly developed direct-reading spectrochemical techniques, which are both rapid and precise.

The project was undertaken to provide information on the genesis of the various granitic rocks within the area studied and also to evaluate the use of rapid chemical analyses as a tool in mapping granitic areas.

(E.M.C.)

77. PROJECT: OPERATION OF HIGH PRESSURE APPARATUS

PERSONNEL: K.L. Currie

During 1962 the apparatus was assembled and successfully tested at design pressure and temperature of 50,000 psi and 650°C. Sealing difficulties were encountered in certain

pressure ranges and modifications of the sealing rings have been made. Experiments on quartz and albite solubility are in progress.

Specimens for experimentation were collected from the Crow Lake dome, a granitic body in the Grenville structural province. Initial chemical results indicate that this is a favourable location for determination of the role of water in granite formation.

Construction of apparatus to reach 150,000 psi and 600°C, using the present apparatus as a first stage is now under way.

(K. L. C.)

78. PROJECT: RADIOCARBON DATING

PERSONNEL: W. Dyck, R.K. Wanless, and others

Carbon 14 measurements completed during 1962 with the 2-litre counter provided 64 radiocarbon ages of samples the majority of which were collected by officers of Geological Survey of Canada. Most of these ages have been submitted for publication in Radiocarbon, vol. 5, 1963.

Twenty-one C-14 measurements were performed on samples of known age and are a part of two research projects initiated in 1961 and 1962.

One of these projects has as its objective a study of the variation of the C-14 content of terrestial plants with time and involves the C-14 analysis of tree rings of known age and annual growth of present day plants. Analyses to date show that the C-14 concentration in tree rings during the past 1,100 years has not varied by more than ±2.5%. 1961 and 1962 maple leaves from the Ottawa area have a C-14 concentration of 22% and 33%, respectively above that of the pre-thermonuclear bomb testing era.

The second project deals with the C-14 concentrations of shallow-water sea shells of known age from Canadian shores[1]. Shells collected before the advent of thermonuclear explosions have a C-14 content of approximately 1% below that of terrestial plants, whereas shells collected since show an increase in the C-14 concentration of 1% to 2%.

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[1]Most of the samples involved were collected and/or selected by W. Blake Jr.

In addition to the routine analyses, an all-metal filling line, a 5-litre radiocarbon counter, and a matched set of electronics were assembled and tested. The background count of this arrangement was found to be 3.0 c/min., 3.7 c/min., and 4.4 c/min. at 1, 2, and 3 atmospheres of CO_2, respectively, and the modern wood count 33 c/min/atm. CO_2. Calculations show that this counter will permit the extension of the present age limit of 40,000 yrs. to 47,000 yrs.

(W.D.)

79. PROJECT: GEOCHEMISTRY OF THE CANADIAN SHIELD - REPORT OF PROGRESS

PERSONNEL: K.E. Eade, W.F. Fahrig, and J.A. Maxwell

The object of this study is: (1) to determine the major and minor element composition of the Canadian Shield; (2) to determine the composition of individual cratonic segments of the Shield so that they can be compared, and geochemical evolutionary trends evaluated; and (3) to relate element abundance to lithology within each segment in order to gain increased knowledge of primary lithology and tectonic events.

Composite samples representing roughtly 150,000 square miles have been prepared and are ready to be sent forward for chemical analysis. The composites were derived from several thousand individual hand specimens.

(W.F.F.)

80. PROJECT: MOBILE SPECTROGRAPHIC LABORATORY

PERSONNEL: R.H.C. Holman, P.J. Lavergne, and C.C. Durham

The construction of a specially designed mobile spectrographic laboratory was completed. The unit is mounted in a modified house trailer (24' x 8') and can be easily hauled by road with a truck. Essential spectrographic equipment includes a 1.5 metre Jarrell-Ash grating spectrograph, a D.C. arc source, a photo-processor and an A.R.L. densitometer/comparator. Power is obtained from the domestic hydro-electric supply available along nearly all roads navigable with the unit. Water is pumped from a nearby well, lake, or stream. At the close of the season the spectrographic equipment is taken into the laboratory in Ottawa for use during the winter; the spectrograph is mounted on a movable stand to facilitate this operation. During field trials in the summer of 1962 several technical problems were solved and the mobile laboratory is now fully operational for the

routine semi-quantitative determination of some twenty trace elements in rocks. The unit is intended to provide spectrochemical data with the minimum delay while field programs are underway, so that sampling may be more efficiently planned during geochemical studies.

(R. H. C. H.)

81. PROJECT: THE CHEMICAL AND SPECTROGRAPHIC ANALYSIS OF ROCKS AND MINERALS

PERSONNEL: J. A. Maxwell and staff of the Analytical Chemistry Section

This project covers the regular work of the Section, which in 1962 resulted in the analysis of 2,908 samples, involving 10,571 chemical determinations and 26,353 spectrographic determinations. It also covers the investigation, adaptation, and development of new methods and techniques required to facilitate the work of the Section, among which, in 1962, were the following items:

1. a colorimetric method for traces of thorium in rocks;

2. titrimetric and colorimetric methods for small amounts of sulphur in rocks, especially in basic and ultrabasic varieties;

3. adaptation of a colorimetric method for titanium;

4. adaptation of an extraction-colorimetric method for small amounts of aluminium in the presence of large amounts of iron and titanium;

5. extension of the general quantitative spectrographic procedure for minor and trace constituents to cover some 40 elements in aluminosilicates, basic and ultrabasic rocks, iron ores and limestones;

6. improvement of the general semiquantitative spectrographic procedure to cover about 50 elements in almost any material to the 0.01% level;

7. the construction of a dual apparatus for the determination of CO_2 in rocks;

8. the construction of an apparatus for the determination of water by the Penfield method;

Development work is continuing on a micro-combustion method for the determination of CO_2 and H_2O, the flame-photometric determination of aluminium, the pyrolytic-colorimetric determination of small amounts of fluorine, and the quantitative spectrographic analysis of trace elements in specific minerals at the lowest possible limits of determination. An investigation is also continuing into the potential use of infrared spectroscopy in the mineralogical analysis of rocks.

(J. A. M.)

82. PROJECT: INVESTIGATION OF POSSIBLE VARIATIONS IN SAMPLE COMPOSITION AS A RESULT OF SAMPLE PREPARATION

PERSONNEL: J. A. Maxwell and S. Courville

Three different types of rocks were chosen for this experiment, a diabase, a granite, and a limestone.

The bulk samples, each weighing approximately 20 to 30 pounds, were reduced to chips of about 1/4" diameter in the sample preparation room. The samples were screened and quartered in the chemistry laboratory and then were returned to the sample preparation room to be processed as ordinary samples. Each sample was separated into five portions, four of which comprised the quartered 1/4" diameter material, and the fifth the fines, which were separated before quartering the sample.

Analytical work on the limestone samples is nearly complete and work will start soon on the diabase and granite. Unforeseen analytical requirements have increased the amount of work required and the length of time needed to bring the project to an adequate conclusion, but it is hoped to complete the project early in 1963.

Arising out of the analytical work on the limestone has been the need for a better method of determination of aluminium in low concentration. Two very different techniques were applied to verify the Al_2O_3 values obtained by difference - a flame photometric method and a colorimetric method employing alizarin Red. The flame photometric method will be useful in other aspects of the work of the laboratory as well.

(S. C.)

83. PROJECT: PREPARATION OF AN ULTRABASIC ROCK STANDARD FOR ANALYTICAL USE

PERSONNEL: J. A. Maxwell, W. H. Champ, C. H. Smith, and staff of chemical and spectrographic laboratories

There is a need in our laboratories for a reference sample of ultrabasic rock in connection with the analytical work of the Upper Mantle Project. Such reference material having a well-established composition (including major, minor, and trace elements) would be of great value in the testing of new methods for their application to the analysis of similar material, and to the checking of current analytical work, not only in Survey laboratories but also in other laboratories engaged in similar work. It was decided that the Survey would obtain about 200 pounds of suitable material, would crush, grind, and homogenize it, and would retain about 20% of it, the remainder to be turned over to the Non-Metallic Standards Committee of the Canadian Association for Applied Spectroscopy, for analysis, certification, and distribution, similar to the way in which this committee is handling the syenite and sulphide standards now in process of certification.

A sample of about 200 pounds of picrite from the Muskox intrusion has been collected by D. C. Findlay and processing of this material will start early in 1963.

(J. A. M.)

84. PROJECT: A CRITICAL EVALUATION OF THE GRAVIMETRIC, TITRIMETRIC, AND COLORIMETRIC METHODS FOR DETERMINATION OF SMALL AMOUNTS OF TOTAL SULPHUR

PERSONNEL: J. B. Sen Gupta

With a view to developing a fast and accurate method of determining small amounts of total sulphur in a large number of rock samples, the existing methods developed in the past half century by various researchers were critically reviewed and 103 references were cited. It was concluded that the conventional barium sulphate precipitation method is unsuitable because of incompleteness of precipitation and interferences from foreign ions. Direct or indirect determination of sulphur by volumetric or colorimetric methods using various reagents such as barium chloride and chromate, lead nitrate, ethylenediamine tetra-acetic acid (EDTA), benzidine, 4-amino-4'-chlorodiphenyl, thorium borate amaranth dye, barium chloranilate, barium molybdate-thioglycollic acid, and others are considerably influenced by the presence of foreign ions, especially chromate, phosphate, silicate, and fluoride, which if present will also interfere by giving high or low results.

Combustion with vanadium pentoxide in a tube at 900-950°C. in a current of nitrogen and subsequent reduction of sulphur trioxide to dioxide by hot copper and determination of sulphur dioxide by iodate-iodide titrimetric or p-rosaniline hydrochloride colorimetric method appeared to be a promising one, though reported in the literature only for determination of materials other than rocks. This method was successfully applied in our laboratories after suitable modification for determination of traces of sulphur in acidic, basic, and ultrabasic rocks with rapidity, high precision, and accuracy.

A paper on this project is being prepared for publication in 1963.

(J.G.S.G.)

85. PROJECT: AGE DETERMINATIONS OF ROCKS AND MINERALS

PERSONNEL: R.K. Wanless, R.J. Traill, J.C. Paris, S.C. Robinson, J.A. Lowdon, J.H.Y. Rimsaite, G.R. Lachance, R.D. Stevens, W.D. Loveridge, and J.K. Van Peteghem

Potassium-Argon Age Determinations

K-Ar age measurements have been continued on a routine basis. To date, a total of 636 samples have been processed (603 of these being priority samples) and the results have been published or are to be published in the following papers:

G.S.C. Paper	No. of Determinations
60-17	98
61-17	152
62-17	206
63-17	147
	603
Experimental Determinations	33
Total	636

Rubidium-Strontium Age Determinations

The experimental techniques required to process mineral concentrates and whole rock samples for Rb/Sr age measurements have been tested. Enriched rubidium and strontium isotope solutions used for the isotope dilution determination of the concentration of these elements have been prepared and calibrated. Ion exchange columns for the separation of the

rubidium and strontium fractions have been set up. Isotope analyses are carried out on a solid source mass spectrometer equipped with an electron multiplier. A three-filament source assembly is used for all Sr analyses in order to minimize the contribution of Rb^{87} to the Sr^{87} ion current. Contamination levels are monitored by processing all samples in duplicate using different samples-to-spike ratios for each fraction.

A preliminary study based on the Rb/Sr ratio in whole rock and mineral concentrates from various phases of the White Creek Batholith in S. E. British Columbia is nearing completion. It is hoped that the results, combined with K-Ar age measurements on the same rocks, may be of assistance in interpreting the age relationships between the various phases of the Batholith.

U-Pb, Th-Pb Age Determinations

During the early stages of development of isotopic studies in the G. S. C. laboratories all lead samples were converted to a gas, lead tetramethyl, and were analyzed on a gas source mass spectrometer. This method is dependent on relatively large samples (5 to 10 mgm.) and consequently its application is limited. Much smaller samples (from 1 to 10 micrograms) may, however, be analyzed by employing solid source mass spectrometric techniques. With this increased sensitivity, the problem of lead contamination originating in chemical reagents, glassware, laboratory air, etc. becomes a serious one and special precautions must be taken to reduce the contribution to negligible proportions. To facilitate this phase of the work a laboratory has been equipped with an electrostatic air purification system, plastic plumbing fixtures have been substituted for all fixtures containing lead, and the walls and ceiling have been painted with tygon paint. Special precautions have been taken to purify all reagents to render them free of lead contamination.

Plans are being made to apply these techniques to the determination of age based on the U-Pb and Th-Pb ratios in zircons.

(R. K. W.)

86. PROJECT: ISOTOPE CHEMISTRY OF SULPHUR IN ROCKS AND MINERALS

PERSONNEL: R.K. Wanless, R.W. Boyle, and R.D. Stevens

Four minor sulphur isotope studies, essentially of a reconnaissance nature, have been completed. These include studies of the sulphides from the Sullivan Mine, Kimberley, B.C. for G.B. Leech; sulphides from the Blind River region of Ontario for S.M. Roscoe; sulphides in radioactive deposits in the Bancroft area for S.C. Robinson; and a preliminary survey of the sulphides from various iron deposits in Canada for G.A. Gross.

(R.K.W.)

87. PROJECT: ISOTOPIC STUDIES OF CANADIAN ORE LEADS

PERSONNEL: R.K. Wanless, G.B. Leech, R.W. Boyle, and R.D. Stevens

This project was completed with preparation of a paper published in the Buddington Volume of the Geological Society of America, 1962.

Ref.: Leech, G.B. and Wanless, R.K.: Lead Isotope and Potassium-Argon Studies in the East Kootenay District of British Columbia; in Petrologic Studies: a Volume in Honor of A.F. Buddington; Geol. Soc. America, Buddington Volume (1962).

(R.K.W.)

88. PROJECT: ADSORPTION STUDIES

PERSONNEL: R.A. Washington

Studies were carried out of the variation with pH of adsorption of Co by quartz and feldspar, using Co^{60} tracer. Little or no adsorption took place on either mineral from solutions having pH < 3. From solutions having higher pH, the adsorption increased with pH to a maximum (at pH 6 to 6.5) of ca. 0.5 γ/g. for quartz (-250+325 mesh) and 1.5 γ/g. for feldspar (-250+325 mesh). The adsorption apparently decreases at pH values greater than 6.5, possibly because the Co begins to precipitate as a colloidal hydrous oxide or basic salt. A peculiar feature of the adsorption (which is usually, but not always reproducible) is a marked decrease in adsorption at a pH of ca. 5.5, relative to higher and lower pH values. Before an interpretation of these observations can be attempted, further experiments will be necessary, including establishment of an adequate experimental method for measuring the surface area of the substrata.

Attempts to measure the adsorption of Zn failed because of a lack of sensitivity and accuracy of the counting technique for the Zn^{65} used as a tracer, and for other reasons. These experiments will be repeated after improvements have been made in the experimental procedures.

(R. A. W.)

89. PROJECT: PRELIMINARY STUDY OF NEUTRON ACTIVIATION ANALYSIS

PERSONNEL: R. A. Washington

A preliminary study has been made of the analysis of Cd in rocks of the Keno Hill area by neutron activation. The results indicate that the sensitivity is better than that of the spectrographic method by an order of magnitude or more. Further improvements in the technique are being developed, including a method for more complete sample attack and a better procedure for chemical yield determination. Extension of the method to include other elements (e.g. gold, rare earths, etc.) is also planned.

(R. A. W.)

MINERALOGY AND PETROLOGY

90. PROJECT: STUDY OF SULPHIDES AND OXIDES IN THE MUSKOX INTRUSION AND RELATED ROCKS

PERSONNEL: J.A. Chamberlain

The purpose is to study the occurrence and distribution of sulphide and oxide phases in the Muskox Intrusion, and related rocks, with the object of determining the genesis of the phases relative to the history of the entire igneous body.

The project was begun in March, 1962, and was about half-completed by year's end. In general, the three stages listed below define the scope of the work.

1. Megascopic examination of samples (completed)
2. Microscopic examination of polished sections (half-completed)
3. Interpretation of results (not begun)

All specimens of the Muskox Intrusion and related rocks collected by C. H. Smith have been examined for visible sulphides. This resulted in the selection of over 400 sulphide-bearing samples from which slices have been sawn preparatory to making polished sections. By year's end, some 250 polished sections had been prepared by the ore polishing facilities of the Mines Branch and studied in the Survey's new metallogenic laboratory. No interpretation of results or conclusions are justified at the present time.

(J.A.C.)

91. PROJECT: GEOLOGICAL SURVEY'S REFERENCE ROCK AND THIN SECTION COLLECTION

PERSONNEL: K.R. Dawson

The objective is to set up in the Petrology Laboratory a suite of hand specimens and thin sections to illustrate the occurrence of rock-forming minerals and the textural features of rocks. The project was authorized to operate on a continuing basis.

The growth of the collection has been slow and it now consists of a few trays of hand specimens with fewer thin sections. Additions are made as specimens become available from a variety of sources. The collection has yet to be catalogued.

(K.R.D.)

92. PROJECT: GEOLOGICAL SURVEY'S METEORITE COLLECTION

PERSONNEL: K. R. Dawson

This project, which arises primarily from the Canadian Meteorite Collection, has some of the responsibilities of a curator and some additional activities arising from the Survey's interest in meteorites. The responsibilities include: maintenance of the catalogue of acquisitions; purchase of new Canadian falls; negotiation for exchange of specimens; requests for specimens for meteorite research; maintenance of photographic records; preparation of papers on undescribed Canadian falls; and eventually preparation of travelling displays. The additional activities involve identification of "pseudometeorites" and attempts to identify and recover "UFO" (unidentified flying objects).

In 1962 several newspaper articles on meteorite recovery and the sighting of two spectacular fireballs increased public interest in the subject. A total of 140 pseudometeorites were submitted for identification and one meteorite, a specimen of the Dresden, Ontario chondrite, was recovered.

The large size of the Abee enstatite chondrite has served as a valuable barter medium, which has made several exchanges possible during the year. As a result specimens of the Bonita Springs, Concho, Henbury, Labryinth Lake, Ramsdorf, and Canon Diable were added to the collection.

Sightings of fireballs were reported: near North Bay, Ontario; Port aux Basques, Newfoundland; Bathurst, New Brunswick; and Vancouver and Kamloops, British Columbia. These reports were evaluated and some steps were taken to determine the likelihood of a meteorite recovery. Stories were published in local newspapers to encourage submission of reports. Survey officers in the field made on-the-spot enquiries and information was forwarded to members of the National Subcommittee on Meteorites for action.

(K. R. D.)

93. PROJECT: GEOLOGICAL SURVEY'S PETROLOGICAL COLLECTIONS

PERSONNEL: K. R. Dawson

This project consists of the retention in open storage of suites of hand specimens representative of all areas of Canada. An average of 80 specimens per "square" degree is

suggested, but the number will vary depending upon the complexity of the geology. Areal collections will serve as reference purposes and future geochemical and petrographical investigations.

Suites have been collected from a total of 133 unit areas since 1958. This approximates 5 per cent of the country and an annual growth of 2 per cent. This rate is less than the rate of mapping of the country by the Geological Survey. Consequently, the slow rate of growth is viewed with some concern.

A total of five collections were received in 1962, representing areas in Cape Breton, N. S.; Bonavista, Nfld.; File Lake, Man.; Caribou Lake, Ont.; and Fort George-Great Whale River, Quebec.

(K. R. D.)

94. PROJECT: GEOMETRICS

PERSONNEL: K. R. Dawson

Development work is continuing on the geological and geochemical applications of trend surface analyses. Data collected for the studies of the Preissac-Lacorne and Anstruther batholiths were used for trend surface calculation and evaluation. The silicon, aluminum, sodium, and potassium from 76 chemical analyses scattered across the exposures of the Preissac-Lacorne batholith were used for this purpose. Contoured figures have been drafted and the evaluation of the results have been partly completed. Similar work is envisaged for gravimetric and aeromagnetic data on the Anstruther batholith.

The logic for the calculation of CIPW norms was prepared and submitted to the Departmental Data Processing personnel, who proceeded to compile a program for use on the IBM 1620 computer. As a result norm calculations can now be made at the rate of 360 per hour. Chemical analyses have been submitted to the Petrology Laboratory, where they were transcribed to IBM forms for punching. It is expected eventually that the analytical report forms will go directly to the punch operator for the production of input cards. The results obtained include a machine listing of the analyses along with the calculated norm.

(K. R. D.)

95. PROJECT: BROCHURE ON METEORITES

PERSONNEL: K. R. Dawson

A small non-technical brochure is being prepared to assist the public in the tentative separation of "pseudo-meteorites" from meteorites. It will be illustrated with a number of black and white photographs and brief non-technical captions dealing with the most apparent characteristics of meteorites. The booklet should be available in 1963.

(K. R. D.)

96. PROJECT: PRELIMINARY REPORT ON INVESTIGATIONS OF THE COMPOSITIONS OF OLIVINE AND PLAGIOCLASE IN THE MICHIKAMAU ANORTHOSITE, LABRADOR

PERSONNEL: R. F. Emslie

The Michikamau Anorthosite, which is currently under investigation is, in the main, well-exposed with excellently preserved primary precipitate minerals comprising plagioclase, olivine, orthopyroxene, clinopyroxene, and iron-titanium opaque oxides. The intrusion is layered and structural mapping will provide a basis for the mineralogical investigation and interpretation.

The range and manner of variation of the compositions of olivine and plagioclase are to be investigated through a "stratigraphic" thickness of some 25,000 feet in the layered anorthositic intrusion.

Olivine compositions are being determined by an X-ray powder method developed by J. L. Jambor in the laboratories of the Geological Survey. Plagioclase compositions will be sought by the method of fusion and refractive index of the glass.

This project is part of a more comprehensive study of anorthosite intrusions. The aim of the larger study is to examine in detail the mineralogy of a number of anorthositic intrusions in the eastern Shield with a view toward making quantitative interpretations of the physico-chemical conditions governing the development of the parent magmas and the history of their crystallization. Special regard will be paid to the factors controlling the formation of the important iron-titanium oxide deposits.

(R. F. E.)

97. PROJECT: RARE-MINERAL STUDIES

PERSONNEL: J.L. Jambor

Routine identification of minerals submitted by field geologists has led to the discovery of several new species. Among these are two cobalt sulphates collected in the Walton, Nova Scotia area by R.W. Boyle. The minerals are $CoSO_4 . 4H_2O$ and the monoclinic polymorph of $CoSO_4 . 6H_2O$. Reports describing these minerals are in preparation.

A white chalky mineral submitted by A. Y. Smith is a new basic zinc carbonate differing from hydrozincite. Synthesis was accomplished by corrosion of metallic zinc in hot water. A number of additional artificial zinc carbonates were also prepared and one was found to be identical to a mineral collected at Galena Hill, Y.T. This new species has the composition $5ZnO . 2CO_2 . 4H_2O$.

A specimen collected in the Yukon several years ago and submitted by Dr. Mulligan appears to be a polymorph of aurichalcite. Optical study of aurichalcites from numerous localities shows that the Cu/Zn ratio can be roughly determined by the variation in refractive indices.

No opportunity was available for further study of the 5 to 8 new sulphosalts discovered at Madoc, Ontario (2 of which were reported in Geol. Surv. Paper 62-30, p. 17, 1962). It is hoped that detailed single crystal studies will be carried out when a new X-ray unit becomes available.

(J.L.J)

98. PROJECT: APPLICATIONS OF X-RAY SPECTROGRAPHY

PERSONNEL: G.R. Lachance

During 1962, a preliminary investigation was carried out on the determination of rubidium and strontium in rocks and micas in relation to "age determination".

For the past two years, use has been made of the X-ray spectrochemical method to determine the range of the Rb and Sr in rocks and micas prior to isotope dilution work. The approximately 40 samples that have been quantitatively analyzed by the isotope dilution method were subjected to a more detailed X-ray analysis in order to determine the reliability of the latter under more favourable conditions. The problem in this case is two fold: a) because the Rb and Sr concentrations are fairly low (0-1,000 p.p.m.) some difficulties are encountered in the

determination of the net intensities of the characteristic lines of these two elements; b) because the rocks and micas vary in general composition, some difficulties are encountered in the determination of the correction to be applied in order to allow for the varying mass absorption coefficient.

The investigation has reached the stage where by plotting the gross counts/second intensities of background and characteristic lines, it is possible to obtain reliable net intensities. There is an indication that the intensity of the background may be used to determine the value of a general correction for varying matrix effects. Work will continue during 1963 as more samples become available.

(G. R. L.)

99. PROJECT: PLAGIOCLASE STUDIES - UPPER MANTLE PROJECT

PERSONNEL: G. Pouliot

The occurrence of various phase transformations in the feldspars has suggested the possible use of these minerals as indications of the thermal history of feldspar-bearing rocks. As part of the Upper Mantle Project, a systematic study of the feldspars from the Muskox Intrusion was initiated in May of 1962, to investigate the X-ray and optical methods of feldspar determination, to apply these methods to the study of structural and compositional variations in the Muskox Intrusion, and to aid in the interpretation of the cooling history of the intrusion.

The determination of plagioclase composition by the fusion method and by a modification of the Tsuboi method has indicated that unless the plagioclase sample is unaltered and free of impurity, the fusion method is susceptible to errors of considerable magnitude. These restrictions make the fusion method applicable to selected specimens only.

The structural state of the plagioclase was obtained from diffractometer powder patterns by measuring the separations $2\theta\,(1\bar{1}1) - 2\theta\,(20\bar{1})$ and $2\theta\,(220) + 2\theta\,(131) - 4\theta\,(1\bar{3}1)$. Both these separations agree in showing that plagioclase from the Muskox Intrusion is structurally intermediate between high and low modifications and is comparable in state to plagioclase of hypabyssal and volcanic environments. There are indications of higher structural states near the margins of the intrusion; these variations are however, small. With additional chemical standards, it is planned to develop a determinative curve, typical for the state and the chemical range An_{60} - An_{90} of plagioclase from the intrusion.

A suite of 40 specimens of alkali feldspars from the granophyre and other rocks from the upper border group have been investigated to date by X-ray diffraction methods. Seven of the specimens have been chemically analyzed. Because of interference between the quartz $(10\bar{1}0)$ reflection and the $(20\bar{1})$ reflection of potash-rich feldspars, the (400) spacing of heat-treated samples has been used to construct a curve for the determination of the ratio $Or/_{Ab + An + Or}$ Mol. per cent. This curve is applicable to the compositional range found in the intrusion, namely, Or_{80}- Or_{98}, and permits an accuracy of the order of $\pm$ 2 mol. per cent.

(G. P.)

100. PROJECT: RESEARCH STUDIES OF ROCK-FORMING FRESH MICAS

PERSONNEL: J. Y. H. Rimsaite

Optical, X-ray diffraction, DTA and TGB analyses, as well as specific gravity and specific magnetic susceptibility measurements were carried out on 34 chemically analysed micas. Fourteen working curves were prepared in order to study the relationship between the physical properties of micas and their chemical composition. The approximate interrelation of physical properties and the effect of ferrous iron on the properties of pure Mg - OH - phlogopite are presented in Table I (below). Properties of the muscovite, which contains 7% of total octahedral iron, are given for comparison.

The effect of different ions on the physical properties of pure Mg - OH mica are as follows:

1. Al raises the refractive indices and the specific gravity but lowers the intensity ratio (004)/(005) and reduces the spacing $^{d}(010)$;

2. F lowers the ratio I(004)/I(005) and the refractive indices and also reduces the spacing $^{d}(010)$;

3. $Fe^{'''}$ and Ti raise the refractive indices; and

4. $Fe^{'''}$ produces the green colour of mica, Ti the reddish colour.

The relationship between the colour of mica and the proportion of the colouring ions has been established. A report on the physical properties of fresh micas is being prepared, as is a report on the occurrence and paragenetic relations of micas. Micas exhibiting unusual structural and physical properties have

Table I. The approximate interrelation of physical properties and the effect of ferrous iron on the properties of pure Mg phlogopite

(Properties of muscovite (M) are marked with arrows for comparison).

% ∑ oct. Fe	0	10	20	30	40	50	60	70	80	90
Weight % Fe as FeO	0	8		16	20	24	28	32		
DTA oxid. T°	800				720			620		
TGB dehydr. T°	1200			1150 (masked by oxidation)				650	1400	
	↓ M= 800									
Mgn. Susc. emu/g x 10^6		16			40			80		
	M=	↓ 8								
Mgn. Susc. (Frantz amps.)		0.48	0.40		0.30		0.25	0.21	0.20	
	↓ M=0.76	↓ 0.66								
	M=2.87 ↑									
Sp.G.	2.74		2.90		3.00	3.10	3.20		3.30	
d(010)Å	9.20		9.23	9.25		9.28	(vary 9.25 - 9.22)			
	↓ M=9.03									
I(004)/I(005)	0.32	0.50		0.75-1.00			1.50	2.00	2.50	
	↓ M=	0.20								
	M= ↑	1.56								
RI α	1.535	1.540		0.560		1.580		1.600		1.620
	M= ↑	1.598								
RI γ	1.570		1.600		1.630			1.660		1.690

been selected for further studies. Data on physical properties of micas that are fired to the temperatures below and above exothermic and endothermic reactions are being assembled. Hydrated, dehydrated, and in general altered micas have been selected for further research studies.

(J. Y. H. R.)

HYDROGEOLOGY

101. PROJECT: GROUNDWATER LEVELS IN CANADA

PERSONNEL: I. C. Brown and R. G. Pearce

This programme was started in 1961 with the objective of setting up and maintaining a Canada-wide network of observation wells, in cooperation with provincial groundwater agencies, to provide long term records of groundwater fluctuations in areas not affected by large scale pumping. Such a network will supplement existing meteorological and stream gauging networks.

In 1962 discussions were held with groundwater agencies in Manitoba, Saskatchewan, Alberta, and British Columbia, and a well numbering-system and filing-system based on drainage basins were instituted. Some difficulty was experienced in locating suitable existing wells, as most wells large enough to accommodate a recorder are in continuous use. It is apparent that it will be necessary to construct wells specifically for this purpose and as a result of the excellent cooperation between provincial agencies and the Geological Survey, arrangements are being made to install observation wells as funds permit. A total of 45 observation wells are now being read on a year round basis in all provinces except Newfoundland. The results will be published when records merit.

(I. C. B.)

102. PROJECT: MODEL STUDIES APPLIED TO GROUNDWATER INVESTIGATIONS

PERSONNEL: R. O. van Everdingen

This program was started in November 1962 with the objective of setting up an analog model laboratory eventually to be used in solution of problems arising out of groundwater and engineering geology studies. The more immediate objective is to set up the laboratory and explore the capabilities, limitations, and economy of various methods and equipment.

The project started with a study of available literature to give a general review of model study methods. Continuous conductor electric analog models, using Teledeltos paper, have been constructed to test the capabilities of the method and general instrumentation is being developed. These models are based on the analogy between the electric field in a continuous homogenous conductor and the groundwater flow field in continuous homogenous aquifers. Studies on actual field problems were started by the end of the year.

FUELS

103. PROJECT: SPORE STUDY OF UPPER PALAEOZOIC SEDIMENTS ON PRINCE EDWARD ISLAND AND IN NEW BRUNSWICK

PERSONNEL: M. S. Barss, P. A. Hacquebard, and R. D. Howie

In 1962 additional samples were studied, bringing the total number of samples to 48. The results of this investigation have been submitted for publication in a Geological Survey Paper. These results in summary are: 1) contrary to previous evidence (later revealed as due to contamination of rotary drill cuttings) there are no Cretaceous sediments in western Prince Edward Island; 2) fossil spores definitely prove the existence of Permian beds in eastern Prince Edward Island; and 3) between Minto in New Brunswick and western Prince Edward Island there is a complete sequence of Upper Pennsylvanian rocks ranging in age from Westphalian C to Stephanian inclusive.

Ref.: Barss, M. S., Hacquebard, P. A., and Howie, R. D.: Palynology and Stratigraphy of the Upper Palaeozoic Sediments of the Maritime Provinces; Geol. Surv., Canada, Paper 63-3 (1963).

(M. S. B.)

104. PROJECT: SPORE ANALYSES ON A SAMPLE FROM AXEL HEIBERG ISLAND, CANADIAN ARCTIC

PERSONNEL: M. S. Barss and G. Playford

The results of this study have been submitted to the Geological Survey for publication in its Paper Series. The age of the sample was determined to be Mississippian (Visean).

Ref.: Playford, G. and Barss, M. S.: Upper Mississippian Microflora from Axel Heiberg Island; Geol. Surv., Canada, Paper 62-36 (1963).

(M. S. B.)

105. PROJECT: GEOLOGY AND PETROLEUM POTENTIALITIES OF NORTHERN CANADA

PERSONNEL: R. J. W. Douglas, D. K. Norris, R. Thorsteinsson, and E. T. Tozer

This project involves the assessment of the significant features of the geology of the sedimentary rocks of northern Canada that bear on the potentialities of the region as a productive petroleum province. A paper on this subject has been prepared for presentation at the 6th World Petroleum Congress, in Frankfurt, West Germany, in June, 1963.

(R. J. W. D.)

106. PROJECT: PETROGRAPHIC EXAMINATION OF COKING-COAL BLENDS FROM MICHEL, BRITISH COLUMBIA

PERSONNEL: A. R. Cameron and P. A. Hacquebard

In June, 10 column and channel samples were collected from the "A" Balmer, No. 1 seams of the Michel area. In addition, two 900 lb. samples of megascopically dissimilar benches in the Balmer seam were collected for carbonization tests in the 500 lb. coke oven at the Mines Branch. Each of these 900 lb. samples was screened into nine size fractions in order to determine possible petrographic segregation according to particle size. These fractions were then recombined for the coking tests, which have been carried out. The resulting cokes showed some differences in physical properties especially in the tumbler test, as expressed by the stability factor. Linear expansion of these two coals, as determined in the sole-heated oven, also differed. Maceral analyses of the nine fractions showed differences between the fractions, but comparison of the overall maceral composition of the two bulk samples showed little difference.

(A. R. C.)

107. PROJECT: REVIEW ARTICLE ON 'INDUSTRIAL APPLICATIONS OF COAL PETROGRAPHY'

PERSONNEL: A. R. Cameron, P. A. Hacquebard, J. A. Harrison

Some additional time was spent in literature research leading to the completion of this manuscript for publication.

(A. R. C.)

108. PROJECT: COMMONWEALTH COMMITTEE ON FUEL RESEARCH PROJECT ON EXCHANGE OF FOREIGN COALS FOR PETROGRAPHIC ANALYSES

PERSONNEL: P. A. Hacquebard and T. F. Birmingham

The final interim reports on the comparative studies of coals from South Africa, New Zealand and India were received in June. A series of graphs were plotted showing the variations in the 60 analyses that were prepared by five different coal petrology laboratories on the 30 different coals studied. These graphs reveal general agreement of the maceral analyses, but considerable variation in the microlithotype data. In view of these discrepancies, Hacquebard put forward certain suggestions for the continuation of this project.

(P. A. H.)

109. PROJECT: RESEARCH ON THE PETROGRAPHY AND SPORE ANALYSIS OF COAL

PERSONNEL: P. A. Hacquebard, A. R. Cameron, J. R. Donaldson, T. F. Birmingham, and M. S. Barss

The results, for the year 1962 in the various sub-projects included under this title are summarized below:

Petrography

1. Petrographic Investigation of Sub-bituminous coals of the Edmonton Formation of Alberta.

Certain problems relative to the preparation of microscopic specimens of these low-rank, high-moisture coals have been overcome by using resinous compounds as a mounting medium. This process binds the friable coals together and prevents the escape of their moisture. Three columns have been completed. These were collected in Rosedale, Carbon, and Drumheller. The Rosedale and Carbon columns are from different seams and it is encouraging to note distinct differences in their petrographic profiles. The Drumheller column is considered by some to be on the same seam as the Rosedale sample, namely the No. 1 seam. However, the petrographic profiles differ, with the Drumheller sample being duller. Other columns of the No. 1 seam may reveal whether or not these petrographic differences represent a certain pattern in facies changes, or if they support the possibility that the Rosedale and Drumheller samples are from different seams.

2. Petrographic Study of Major Coal Seams of the Springhill Coalfield, Nova Scotia.

This project was initiated in 1962 with the objective of trying out a petrographic correlation of the seams in the area south of Millers Corner. Most of the samples were taken from borehole cores and the petrographic compositions obtained were, of necessity, whole seam compositions, because it was no longer possible to examine the seams by benches or intervals. An encouraging success was achieved in that samples of the important No. 1 seam could, in many cases, be distinguished from those of the No. 3 seam when the compositions were plotted on ternary diagrams. Certain samples of intermediate composition still present difficulties in correlation, as do samples of seams other than the No. 1 and No. 3. A complete column of the No. 3 seam was obtained in the Syndicate Mine and petrographically analyzed. It was shown that the relatively high ash of this coal is concentrated in several distinct layers, which could probably be removed by a comparatively simple washing process.

3. Study of Facies Changes in the Harbour Seam, Sydney Coalfield, Nova Scotia.

This topic was the subject of a doctoral thesis, submitted to the Pennsylvania State University by A. R. Cameron. The author has completed revision of the original manuscript and has submitted it to the Editorial Staff for publication as a G. S. C. Bulletin.

4. An Examination of the Coking Coal Blends Used by The Steel Company of Canada Ltd.

This study was completed in 1962. Three coals, two of high volatile "A" and one of low volatile rank, were examined petrographically, along with blends prepared from them. The results may be summarized as follows: a) The study suggested that an increase in the content of dull components in the coal is accompanied by a decrease in after-shrinkage. b) It was indicated that maximum fluidity of the coal decreased with increase in the contents of dull components. c) The fragile and brittle components (vitrite and fusite) concentrated in the finer sizer of the coals involved.

Palynology

1. Spore Investigations of the Coal Seams of the Pictou Coalfield, Nova Scotia.

All samples pertaining to this study have been examined, but the final report remains to be written.

2. Spore Study of the Coal Seams of the Springhill Coalfield, Nova Scotia.

Because the spore analyses of the coals failed to show large enough differences between seams, recourse was had to petrography as a correlation device. A start was made on a study of the spore content of the roof shales of these coals in order to see if more useful analyses can be obtained and also to see if ecological differences between shales and coals can be determined.

3. Spore Study of Samples Submitted for Age Determinations.

Seven reports were compiled on samples submitted by G. S. C. personnel for age determinations. These were as follows. 1) and 2) Samples submitted by R. D. Howie from Moncton area, N. B. Age: Pictou (Lonchopteris zone) (2 reports). 3) Samples submitted by D. Benson from Lochaber map-area, N. S. Age: Horton. 4) Sample submitted by A. E. Schiller from the Guysborough map area, N. S. Age: Horton. 5) Samples submitted by P. Carr from the Moncton area, N. B. Age: Post-Morien, Morien, Mississippian, and possibly Devonian. 6) Sample submitted by M. Copeland from Parrsboro, N. S. Age: Riversdale. 7) Samples submitted by D. Kelley from Creignish Formation, N. S. Age: Horton (lower).

4. Spore Study of the Coal Horizons of New Brunswick.

Additional samples were macerated for this project and intermittent studies were carried out, depending upon the urgency of obtaining results on spore studies of samples submitted for age determination.

Other Activities

1. Springhill Coalfield.

In the early part of 1962 four new holes were drilled for the Nos. 3 and 1 seams in the area south of Miller's

Corner. Hacquebard and Donaldson suggested the locations for these holes and the information obtained from them has been used in revising seam contour maps. This work is carried on in cooperation with the Nova Scotia Department of Mines.

(P. A. H.)

110. PROJECT: MIOSPORES FROM THE MISSISSIPPIAN HORTON GROUP, EASTERN CANADA

PERSONNEL: G. Playford

Fifty-three species of small spores, assigned to twenty-eight existing genera are recorded from thirteen localities in the Horton Group. This group is a thick, non-marine sequence in Eastern Canada and is of early Mississippian age. Twenty-one species are described as new. One of these, Schopfites augustus n. sp., represents the first record of Schopfites Kosanke in rocks of pre-Westphalian age. It is shown that two distinct assemblages of miospores are present in the Horton Group, which, in its type area, comprises the Horton Bluff Formation and the conformably overlying Cheverie Formation. One of the microfloras appears to be characteristic of the Horton Bluff, whereas the other, younger assemblage has been encountered only in the type Cheverie. Stratigraphic implications of the microfloras are discussed, and the potential value of palynology in the resolution of Horton correlation problems is indicated. The Horton microfloras include certain species that occur in assemblages of comparable age from Russia, Britain, and Spitsbergen, but affiliations with previously described assemblages are not marked.

Ref.: Playford, G.: Miospores from the Mississippian Horton Group of Eastern Canada; Geol. Surv., Canada, Bull. (in press).

(G. P.)

GEOLOGY OF MINERAL DEPOSITS

111. PROJECT: STUDY OF SILICATES IN METAMORPHOSED IRON-FORMATION

PERSONNEL: K. L. Chakraborty and G. A. Gross

Iron-silicate minerals from metamorphosed iron-formations in the Wabush Lake and Mount Wright area of Labrador and Quebec were investigated to provide fundamental data on the cummingtonite-grunerite and anthophyllite-mangano anthophyllite series. Studies of optical, X-ray, and chemical data on a large suite of minerals were reported in a manuscript submitted for publication as a Geological Survey of Canada Bulletin.

(G. A. G.)

112. PROJECT: GEOLOGICAL RECORD OF IRON OCCURRENCES IN CANADA

PERSONNEL: G. A. Gross

Considerable geological data from office and field records were tabulated and processed for use in manuscripts submitted on the Geology of Iron in Canada. Current information from laboratory work and publications was contributed to records maintained on iron deposits in Canada.

(G. A. G.)

113. PROJECT: LABORATORY INVESTIGATION OF SNAKE RIVER IRON-FORMATION, YUKON TERRITORY

PERSONNEL: G. A. Gross

A suite of specimens from the Snake River iron-formation, Yukon Territory, was investigated to determine principal mineralogical and textural features. Further studies are in progress.

(G. A. G.)

114. PROJECT: SULPHUR ISOTOPES IN IRON DEPOSITS OF CANADA

PERSONNEL: G. A. Gross

Sulphur isotope data were reviewed from a preliminary examination of sulphide minerals in iron deposits in Canada.

(G. A. G.)

115. PROJECT: METALLOGENIC MAPS AND CONCEPTS

PERSONNEL: W. D. McCartney

The principal research effort was directed to initial work on the relation of mineral deposits to their regional geological environment, with emphasis on the tectonic development and related sedimentary, volcanic, and igneous history of the Appalachian region, a region representative of a single cycle of geosynclinal development in which the geological history is not unduly complex. Some metallogenic concepts, which are applicable in preliminary form and are worthy of further investigation, were reported by W. D. McCartney and R. R. Potter. These studies in selected regions should guide future metallogenic studies in larger areas, especially as the tectonic and revised geological maps of Canada near completion.

Less emphasis was placed on the compilation and interpretation of small-scale metallogenic maps of Canada, although a metallogenic map for manganese with an accompanying paper was submitted in December by W. D. McCartney and A. G. Johnston for publication by the Geological Survey. Two maps compiled by Johnston and McCartney showing chromite and manganese distribution in Canada were contributed to the North American subcommittee for the Metallogenic Map of the World.

Ref.: McCartney, W. D. and Potter, R. R.: Mineralization as Related to Structural Deformation, Igneous Activity and Sedimentation in Folded Geosynclines; Can. Min. J., vol. 83, No. 4, pp. 83-87 (1962).
McCartney, W. D.: Mineralization in Mobile Belts; Econ. Geol., vol. 57, pp. 1131-1132 (1962).
McCartney, W. D. and Johnston, A. G.: Metallogenic Map of Manganese in Canada; Geol. Surv., Canada, Map (in press).

(W. D. McC.)

116. PROJECT: BARITE AND FLUORITE IN CANADA

PERSONNEL: W. D. McCartney and B. Edmund

Laboratory research explored the possible relations in barite between composition variations, specific gravity and optical variations, geological environment, and temperature of formation as deduced from fluid inclusion and decrepitation measurements. The latter work was begun by B. Edmund as a seasonal employee and continued at the University of Toronto. Pure barite samples from a wide variety of deposits were submitted for trace element analysis and are to be compared with variations in the geological setting and, in particular, with the presence or absence of known sulphides associated with the barite deposit. A great many poorly exposed barite occurrences are known and if associated but hidden sulphide minerals prove to be reflected in the trace element content of barite, mineral exploration would be aided.

Most analytical results are not yet available, but strontium does not exceed 5.5 per cent in the 65 barite samples submitted. Despite the acceptance in all texts of a solid-solution series between barite and celestite, this is not proven in natural material nor well documented in the literature. Two phases of barite appear to be present in some barite crystals. A study of synthetic minerals ranging, if possible, from barite to celestite seems warranted.

These studies seek fruitful lines of research rather than an exhaustive treatment of one aspect of the barite problem.

(W. D. McC.)

117. PROJECT: METALLOGENIC STUDIES IN NORTHEASTERN ONTARIO AND WESTERN QUEBEC

PERSONNEL: S. M. Roscoe

In an effort to establish approaches to metallogenic studies in the shield, the distribution and character of mineral deposits in the southern part of the Superior (structural) province were considered within the context of the tectonic history of the region, as fragmentally indicated by available geological evidence and isotopic data. Four or five metallogenic epochs corresponding with orogenic periods can be postulated. Published lead isotope data, although scanty, support this and moreover fit established concepts that deposits of approximately the same age within the same area may have had significantly different histories. Analogies with deposits in more recent mobile belts, such as the Appalachian region under study by W. D. McCartney, may aid in

recognition of the most significant associated rocks and enable one to classify many deposits as early, middle, or late within a particular orogeny. Numerous samples were prepared for analyses and additional sampling of mineral deposits and associated rocks for elemental and isotopic analyses was planned.

(S. M. R.)

118. PROJECT: MINERAL STUDIES, HEATH STEELE ORE-BODIES, NEW BRUNSWICK

PERSONNEL: D. R. E. Whitmore

In connection with preparation for publication of a paper on the Heath Steele orebodies in New Brunswick a visit was made to the mine and further samples collected. Polished and thin sections are being prepared and studied. Completion of the study is expected by December 1963.

(D. R. E. W.)

GEOLOGICAL COMPILATIONS

119. PROJECT: GEOLOGICAL AIRPHOTOS OF CANADA

PERSONNEL: H. S. Bostock

Compilation of an annotated list of airphotos of geological and allied features in Canada, for publication, was commenced in 1962. Two hundred and twenty (plus) airphotos have now been collected, and cards have been made out for them. These cards with a few introductory and explanatory pages will form the manuscript of the paper for the first section of the catalogue. More than 150 have been gone over in 'editing' by the writer. In addition cards have been prepared for some 200 additional airphotos to be requisitioned before the author's final editing of the cards for the manuscript is done. The work of culling poor photos from among those recommended by other people has only started.

A general physiographic map of Canada is being prepared to show the major physiographic sub-divisions to which the photos refer.

(H. S. B.)

120. PROJECT: COMPILATION OF CANADIAN GEOLOGICAL MAPS ON 1:1,000,000 SCALE

PERSONNEL: A. H. Lang

Compilation of a series of geological maps of parts of Canada from all available data, on a scale of 1:1,000,000 and leading eventually to compilation of a new Geological Map of Canada on a scale of 1:5,000,000, was initiated in late 1960. During 1961, the following four maps were compiled (National Topographic Series number in parentheses): Assiniboine River (62); Carrot River (63); Churchill River (54); and South Saskatchewan River (72). In 1962 five more maps were compiled: Hay River (84); Clearwater River (74); Cochrane River (64); North Saskatchewan River (73); and Ekwan River (43). Compilation of six other maps was started.

121. PROJECT: OIL AND GAS MAPS FOR WESTERN CANADA

PERSONNEL: H. L. Martin, Violet M. McGuire, and Penny J. Wise

The ninth edition of Map 1039A (Alberta and Northeastern British Columbia Showing Oil and Gas Fields) was

completely revised. The base map was redrawn for greater accuracy and clarity, and pipeline details were added.

In addition, a study was initiated on the Mississippian system of southern Alberta which will lead to the preparation of a combined geological and oil and gas map for this area.

(H. L. M.)

122. PROJECT: COMPILATION OF CANADIAN ROCK AND MINERAL ANALYSES

PERSONNEL: J. A. Maxwell, K. R. Dawson, Margaret E. Tomilson, Dorothy M. E. Pocock, and Diane Tetreault

This project, which has been carried on chiefly as a summer project with the help of summer assistants, has as its goal the compilation and publication of analyses of Canadian rocks, minerals, and ores. Emphasis has been placed on the data to be found in the records of the Geological Survey for the period 1846 to 1955, but work has also been done on the data accumulated for the period 1956-1962, as well as on those contained in the records of other sources of such data.

The manuscript for the first part of this work, including over 1,300 complete and partial analyses, will be submitted for publication early in 1963. An additional feature is the inclusion of the norms of 289 rocks. The norm calculations were done by the Departmental Computer, using a programme compiled by Departmental officers.

(J. A. M.)

123. PROJECT: REFERENCE COLLECTION OF SMALL SPORES

PERSONNEL: D. C. McGregor

Compilation of a reference slide collection of spores and pollen of pre-Pleistocene age is being carried on as a continuing project. Particular emphasis is given to acquisition of assemblages of known age with which unknown samples may be compared. In 1962 exchange of material was effected with several sources on this continent and abroad. A photographic record has been, or will be, made of selected species from the material acquired in 1962.

(D. C. McG.)

124. PROJECT: CATALOGUE OF ONTARIO WELL CUTTINGS IN SAMPLE REPOSITORY, GEOLOGICAL SURVEY OF CANADA

PERSONNEL: B. V. Sanford

This project constitutes the compilation of wells drilled in Southwestern Ontario and pertinent data concerning each, for which sample cuttings are available in the Geological Survey of Canada repository. This collection contains between 4,500 and 5,000 complete sample cuts, and at present is the only library of Ontario sample cuttings available for public use.

(B. V. S.)

125. PROJECT: TECTONIC MAP OF CANADA

PERSONNEL: C. H. Stockwell and others

In 1958 work commenced on the preparation of a Tectonic Map of Canada for publication by the Geological Survey of Canada on the scale of 1:5,000,000. The map is being prepared jointly by the Geological Survey of Canada, the Geological Association of Canada, and the Alberta Society of Petroleum Geologists, under the chairmanship of C. H. Stockwell. Various committees and subcommittees have been formed and at least twenty-five geologists are actively engaged in the project. By the end of 1962 most basic information had been compiled; it will now be assembled, correlated, and prepared for publication. The map, when published, will serve as Canada's contribution toward the preparation of a world tectonic map to be compiled and published by the International Geological Congress.

MISCELLANEOUS

126. PROJECT: TESTING A DRILL FOR CORING FROZEN BOGS

PERSONNEL: O. L. Hughes

A 10 x 12 tent on a Jutland frame has been established on the surface of Mer Bleu peat bog, in order to induce frost penetration of the peat. Peat boring equipment will be tested when frost penetration is at a maximum, presumably about the end of February, 1963.

(O. L. H.)

127. PROJECT: EXPERIMENTAL MINE

PERSONNEL: E. B. Owen

The problem was to find a suitable location for an experimental mine in which personnel of Mines Branch, Dept. of Mines and Technical Surveys could conduct certain experiments relating to rock mechanics.

The site chosen was the north end of a north-trending ridge of Nepean sandstone located about 3 miles west of the community of Bells Corners, Ontario.

A topographic map, scale 1 inch to 200 feet, was prepared and the visible geologic structures mapped. A seismic reconnaissance survey was conducted by G. D. Hobson, Geophysics Division, Geological Survey of Canada, using a hammer seismograph model No. F. S. -2. The purpose of this survey was to determine the depth of weathering, the occurrence of any water-bearing horizons, and to attempt to contour the surface of the underlying Precambrian rocks. Subsequently eight diamond drill holes were put down to further investigate the quantity of the rock.

It was found the seismic information correlated extremely well with the results of the test borings. Also, the quality of the sandstone encountered was satisfactory for the purposes it will be used. All data obtained were compiled and included in an unpublished Geological Survey of Canada report.

(E. B. O.)

128. PROJECT: CATALOGUE OF GEOLOGICAL SURVEY OF CANADA PUBLICATIONS

PERSONNEL: H. M. A. Rice

A supplement to the Catalogue of Geological Survey of Canada Publications arranged according to the National Topographic System, covering the years 1961 and 1962, is in preparation.

129. PROJECT: PREPARATION OF PAPERS FOR ORAL PRESENTATION AND/OR PUBLICATION IN SCIENTIFIC JOURNALS

PERSONNEL: Staff of Geological Survey

In 1962, members of the Geological Survey presented twenty-four papers at scientific meetings, and authored forty-eight papers published in scientific journals. Several more papers were in press at the end of the year. These papers, based on office, laboratory, and/or field work, are in addition to the many maps and reports prepared during the year for publication by the Geological Survey.

INDEX OF PERSONNEL CITED

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