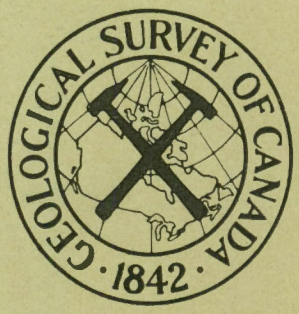

GEOLOGICAL
SURVEY
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CANADA

DEPARTMENT OF MINES
AND TECHNICAL SURVEYS

PAPER 66-4

ABSTRACTS OF PUBLICATIONS IN SCIENTIFIC JOURNALS BY OFFICERS OF THE GEOLOGICAL SURVEY OF CANADA, 1965

Compiled by S. E. Jenness

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ABSTRACTS OF PUBLICATIONS IN SCIENTIFIC JOURNALS BY OFFICERS OF THE GEOLOGICAL SURVEY OF CANADA, 1965

This report contains abstracts of 105 papers published by officers of the Geological Survey of Canada in scientific journals and books during the calendar year 1965. Most of these papers included abstracts, and these have been copied from the published texts; abstracts for the others were prepared either by the authors concerned or by the compiler, and are so indicated by the appropriate initials. These papers, together with the various Geological Survey memoirs, bulletins, papers, economic geology reports, miscellaneous reports, and maps listed in the Index of Publications of the Geological Survey of Canada (G.S.C. Paper 66-3) comprise the total published scientific output of the Geological Survey during 1965.

The abstracts are arranged alphabetically according to author.

Abbey, Sydney

DETERMINATION OF POTASSIUM, SODIUM AND CALCIUM IN FELDSPARS; Can. Mineralogist, vol. 8, Part 3, pp. 347-353, 1965.

A combined flame photometric method is described for the determination of potassium, sodium and calcium in feldspars. Magnesium is used to minimize variations in the depressant effect of aluminum on calcium emission resulting from deviations from stoichiometry. Standard solutions, approximating the compositions of the sample solutions, are prepared from pure reagents. An analysis can be done on as little as 10 milligrams of sample.

Agterberg, F.P.

COMPUTER ORIENTED ANALYSIS OF MINERAL DEPOSITS; Proc. Eighth Commonwealth Mining and Metallurgical Congress, Australia, 2nd Tech. Session, pp. 23-28, preprint No. 81, 1965.

In the past several years, high speed computers have become widely available. There is a marked increase in the application of more complicated computational schemes. The possibility of applying some methods of statistical mechanics and modern information theory to the field of mineral deposits is considered. A formula is derived which relates the variance of average concentration values for blocks of ore with their volume. The well known formula for the generating process of logarithmic frequency distributions has been generalized in two ways to make it applicable to other shaped frequency distributions and to meet the observed tendency of the logarithmic variance to be constant.

Agterberg, F.P.

FREQUENCY DISTRIBUTION OF TRACE ELEMENTS IN THE MUSKOX LAYERED INTRUSION; Proc. Sympos. on Computers in Mining and Exploration, Univ. Arizona, March 15-19, vol. 1, pp. G1-33, 1965.

Up to approximately 1,000 determinations for each of nine trace elements are statistically analyzed. Trends are present as systematic differences in concentration between rocks of different composition. Their effect on the frequency distributions is largely eliminated by the transformation $X' = X/\bar{X}$. Sub-groups for data of each trace element in individual rock types are compared to each other by χ^2-values based on information statistics. Some possibilities for the generating process for frequency distributions are simulated by experiments with random normal numbers. The principle of maximum entropy is tested for both data X' and transformed data $Y' = \ln(1+X')$.

(F.P.A.)

Agterberg, F.P.

THE TECHNIQUE OF SERIAL CORRELATION APPLIED TO CONTINUOUS SERIES OF ELEMENT CONCENTRATION VALUES IN HOMOGENEOUS ROCKS; J. Geol., vol. 73, pp. 142-154, 1965.

A technique of serial correlation is considered for chemical data on series of adjacent specimens from homogeneous mineral deposits and a critical independent sampling interval (I-interval) is evaluated. Values taken at a sampling interval larger than the I-interval are independent in a probability sense, whereas mutual specimen influence is appreciable for smaller sampling intervals.

I-intervals have been calculated for element concentration values from three examples. The I-intervals for weight percentages Zn, Ti, and MoS_2 in deposits of sphalerite, titaniferous magnetite, and molybdenite are 23 feet, 15 feet, and 0.5-2 feet, respectively. The examples are in the field of mineral deposits which are generally better sampled, but the theory may be applied to element concentration values in other continuous, homogeneous rocks showing random frequency distribution for a specified element.

The I-interval is the one-dimensional equivalent of the PRobable-INfluence CEll (prince), which indicates the sphere of influence of a certain value. The approximate size of the prince should be considered in sampling problems such as choosing specimen sizes and distances between the individual specimens.

Armstrong, J.E.

DAY 13 - SEPTEMBER 18; Intern. Assoc. Quat. Res. (INQUA), Guidebook for Field Conference J, Pacific Northwest, pp. 105-108, 1965.

Roadlog-type geological descriptions of the Quaternary features and deposits at 5 localities between Harrison Hot Springs, B.C. and the U.S. border are presented and are accompanied by 2 simplified stratigraphic sections.

(S.E.J.)

Armstrong, J.E., and Fulton, R.J.

DAY 12 - SEPTEMBER 17; Intern. Assoc. Quat. Res. (INQUA), Guidebook for Field Conference J, Pacific Northwest, pp. 98-105, 1965.

Roadlog-type geological descriptions of the Quaternary features and deposits at 9 localities between Kamloops and Harrison Hot Springs, B.C. are presented and are accompanied by 2 simplified stratigraphic sections.

(S.E.J.)

Armstrong, J.E., Crandell, Dwight R.,[1] Easterbrook, Donald J.,[2] and Noble, J.B.[3]

LATE PLEISTOCENE STRATIGRAPHY AND CHRONOLOGY IN SOUTHWESTERN BRITISH COLUMBIA AND NORTHWESTERN WASHINGTON; Bull. Geol. Soc. Am., vol. 76, pp. 321-330, 1965.

Six geologic-climate units are proposed for the late Pleistocene sequence in southwestern British Columbia and northwestern Washington. They include two major units, the Olympia Interglaciation and the Fraser Glaciation, and four subdivisions of the latter--the Evans Creek, Vashon, and Sumas Stades, and the Everson Interstade. The Olympia Interglaciation is a nonglacial episode that started at least 36,000 years B.P. and continued until the advance of Cordilleran glacier ice during the Fraser Glaciation. During the Evans Creek Stade, alpine glaciers formed in the mountains of western Washington and British Columbia while nonglacial sediments were still being deposited in the southern Puget Lowland. Further growth of glaciers in British Columbia resulted in the formation of the Cordilleran ice

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1 U.S. Geological Survey, Denver, Colorado.

2 Western Washington State College, Bellingham, Wash.

3 Washington State Division of Water Resources, Olympia, Wash.

sheet. This ice entered the northern end of the area after 25,000 years B.P. but did not reach the southern end until after 15,000 years B.P. The Vashon Stade of the Fraser Glaciation began with this advance of Cordilleran ice into the lowlands. It ended with the beginning of marine and glaciomarine conditions there, which commenced in the southern Puget Lowland about 13,500 years B.P. and in the Strait of Georgia about 13,000 years B.P. The episode represented by the marine conditions is called the Everson Interstade and lasted about 2,000 years, during which the sea contained much floating ice. The Interstade ended when the land rose with respect to the sea level forcing withdrawal of the sea and the disappearance of floating ice in most of northwestern Washington and southwestern British Columbia; in the eastern part of the Fraser Lowland this event coincided with the advance of a valley glacier during the Sumas Stade.

Babu, S.K., and Cameron, A.R.

THEORETICAL CONSIDERATIONS ON THE VALUE OF COAL PETROGRAPHY IN COKE STUDIES OF CHIRMIRI COAL (M.P.), INDIA; Current Sci. (India), vol. 34, No. 6, pp. 172-174, 1965.

The use of coal petrography, including reflectance measurements, as a control on coke quality is discussed. To illustrate the procedure several calculations of coke strength for specific Indian coals are presented. (A.R.C.)

Babu, S.K., and Cameron, A.R.

REFLECTANCE STUDY OF SOME OF THE INDIAN COALS; Current Sci. (India), vol. 34, No. 14, pp. 425-426, 1965.

Reflectance studies on coals from four Indian fields revealed increasing reflectance with depth. This increase of rank with depth supplemented similar conclusions based on chemical analyses by other authors. The study also showed an increase of rank from west to east. (A.R.C.)

Baragar, W.R.A., Goodwin, A.M., and Souther, J.G.

NOW KNOWN MORE DEPOSITS ARE OF VOLCANIC ORIGIN; Northern Miner, Ann. Rev. Number, Nov. 25, pp. 73, 74, 80, 1965.

The close relationship of several major metalliferous fields (Bathurst, Noranda, Porcupine) to volcanism has recently been recognized and others will probably be recognized in the future. In the Stikine area, B.C. of the Cordilleran region, a close spatial relationship exists between several deposits and volcanism, for copper deposits are associated with Triassic volcanic rocks, and molybdenum and antimony-gold-silver deposits appear related to a Late Cretaceous–Early Tertiary igneous activity, including volcanic rocks. In the northwestern part of the Canadian Shield, copper deposits are directly affiliated with the Coppermine River flows and copper-nickel deposits with the basic Muskox complex, and many gold deposits are closely associated with volcanic rocks of the Yellowknife Group. In the Superior province most of the gold, base-metal, and iron deposits occur in

Archaean greenstone belts,which include extensive volcanic units. Examples are the gold deposits in the Porcupine-Kirkland Lake-Noranda greenstone belt, iron and gold in the Michipicoten greenstone belt, and gold in the Birch-Uchi Lakes belt in northwestern Ontario. In many cases the valuable minerals and their volcanic hosts probably represent consanguineous products of common magmatic parentage. Future volcanic studies may provide a clearer understanding of ore-forming processes and hence substantially aid long-term mineral exploration.

(S.E.J.)

Bhattacharyya, B.K.

TWO-DIMENSIONAL HARMONIC ANALYSIS AS A TOOL FOR MAGNETIC INTERPRETATION; Geophysics, vol. 30, pp. 829-857, 1965.

The total magnetic field values over an area can be represented exactly by a double Fourier series expansion. In this analysis, such an expansion is used to evaluate very accurately the fields continued downward and upward from the plane of observation and the vertical derivatives of the total field. This harmonic expansion of the anomalous total field makes it possible to calculate, with exceptional accuracy, the field reduced to the magnetic pole and its second derivative. The results of the calculations are free from the effect of the inclination of the earth's main geomagnetic field and that of the polarization vector, at all magnetic latitudes and for all possible directions of polarization. In order to determine the influence of remanence on the above field, a number of anomalies caused by rectangular block-type bodies with known polarization are reduced to the magnetic pole, correcting only for the obliquity of the earth's normal field. It is concluded from a study of these anomalies that the interpretation of magnetic data based on the assumption of rock magnetization due solely to induction in the earth's field may yield erroneous results, particularly when remanence is important.

Bhattacharyya, B.K., and Morley, L.W.

THE DELINEATION OF DEEP CRUSTAL MAGNETIC BODIES FROM TOTAL FIELD AEROMAGNETIC ANOMALIES; J. Geomagnetism and Geoelectricity; vol. 17, pp. 237-252, 1965.

Studies were made of accurate, total field aeromagnetic data of excellent uniformity over an area in N.W. Ontario extending from 48°45'N to 53°N latitude and from 86°W to 94°W longitude. The rocks in this area are of early Precambrian age (Archaean era). The regional effects from the data were removed. The residual values were then analytically filtered to obtain the total field stripped of its near-surface, high amplitude components. Eighty-five individual anomalies were selected and analyzed to determine the horizontal dimensions and the depths to the tops and bottoms of the causative bodies and the magnitude and direction of total polarization vectors associated with the bodies. The bodies were assumed to be vertical rectangular prisms of arbitrary polarization. A brief summary of the method used is presented.

The horizontal dimensions of the bodies vary from 0.8 km (.5 mile) to 5.1 kms (3.2 miles). The depths to the top of the bodies in the

filtered aeromagnetic map are found to be in the range 4.8 kms (3 miles) to 8 kms (5 miles) from the surface of the ground. The depths to the bottom of the bodies are between 17.7 kms (11 miles) and 24 kms (15 miles) for most of the anomalies, with a mean depth of 20 kms (12.4 miles), which is interpreted as the mean depth to the Curie point geotherm. The horizontal vectors of the polarizations are subparallel to the magnetic lineation of the filtered aeromagnetic map. An interesting and surprising result of this analysis is the detection of the presence of alternatingly normal and reverse polarization roughly in the East-West direction. The mean inclination and declination for normal polarizations are 67.6° and 258.7° respectively whereas those for reverse polarizations are −67.9° and 81.3° respectively. The consistency in the directions of magnetization in the two clusters for normal and reverse polarization indicates strongly the absence of any dominant component of magnetization parallel to the present field. On the basis that the magnetizations are permanent and the reversals are due to field or self-reversal, the calculated pole position for the rocks of Archaean era is found to be at a latitude of 31.5°N and a longitude of 136.9°W. The intensity of magnetization of the bodies lies within a wide range from .0006 to .349 cgs emu with the average of .055 cgs emu.

Blake, Weston Jr., Olsson, Ingrid U.,[1] and Środoń, Andrzej[2]

A RADIOCARBON-DATED PEAT DEPOSIT NEAR HORNSUND, VESTSPITSBERGEN, AND ITS BEARING ON THE PROBLEM OF LAND UPLIFT; Norsk Polarinstitutt, Arbok 1963, pp. 173-180, Oslo, 1965.

A radiocarbon age determination shows that the basal peat in a bog 12 m above sea-level near Hornsund is 1390 ± 70 years old. The peat, at 55–60 cm depth, apparently did not start to accumulate until after the site had emerged from the sea. Uplift at a rate of less than 1 m per century, rather than the 2.3 m per century for the last 350 years that previously has been suggested for this area, would suffice to have raised the bog to its present elevation.

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[1] Institute of Physics, Uppsala University, Uppsala, Sweden.
[2] Institute of Botany, Polish Academy of Sciences, Krakow, Poland.

Blake, Weston Jr.

THE LATE PLEISTOCENE CHRONOLOGY OF NORDAUSTLANDET, SPITSBERGEN; (abst.), Vorträge des Fridtjof-Nansen-Gedächtnis-Symposions über Spitzbergen, Ergebnisse der Stauferland-Expedition 1959/60, Heft 3; Franz Steiner Verlag, Wiesbaden, p. 29, 1965.

Radiocarbon datings of 30 samples of driftwood, shells, whale bones, and peat in the Murchisonfjorden–Lady Franklinfjorden area, Nordaustlandet, Spitsbergen, provide the basis for a glacial chronology of

the last 40,000 years.

Raised beaches occur up to approximately 100 meters above sea level in a narrow coastal zone. Dated shells collected from the higher beaches (77-44 meters), but probably originating in the underlying till, indicate that the area was at least partly ice-free 40,000 or more years ago. Wood and shells below 44 meters show that the coastal areas have been ice-free for the last 10,000 years. The absence of material between 40,000 and 10,000 years of age can probably be related to a more extensive ice cover during that period.

Pumice believe to have originated in Iceland is widespread on the lower beaches. The uppermost pumice, plus abundant driftwood, occurs on a broad beach which, because of differential uplift, rises from 5 meters at the outer coast to 10 meters in the inner parts of the fjords. Dated driftwood and whale bones show that this beach is less than 7,000 years old, and the pumice is tentatively correlated with pumice in Norway and Denmark dated at 4,000 years B.P. Thus this beach formed in the Hypsithermal Interval (Tapes Sea). Little or no uplift of the land is occurring now.

A study of lichens from the edge of Vestfonna southeast of Murchisonfjorden indicates that the main body of this ice-cap has not advanced beyond its present position in at least 2,000 years, although several of its outlet glaciers have fluctuated considerably in recent centuries.

Bolton, Thomas E.

PRE-GUELPH, SILURIAN FORMATIONS OF THE NIAGARA PENINSULA, ONTARIO; Mich. Basin Geol. Soc., Guidebook, pp. 55-71, 1965.

The Lower and Middle Silurian formations exposed in the Niagara Escarpment between Niagara River and Hamilton, Ontario, include rocks of both New York State and southwestern Ontario-Michigan sedimentary provinces. Any theories advanced for the interrelationship of these provinces should consider the field data available in the Niagara Peninsula region.

Bostock, Hewitt H.

CLEARWATER LAKE VOLCANIC COMPLEX, QUEBEC, CANADA; (abst.), Geol. Soc. Am., Program, Ann. Meeting, Nov. 4-6, 1965, Kansas City, Missouri, pp. 13-14, 1965.

Clearwater Lake, Quebec, consists of two circular basins 19 and 16 miles across. A concentric ring of islands 10 miles across and central shoals lie in the larger, much shallower west lake.

Precambrian rocks are overlain by Ordovician marble on the islands. These rocks are intruded by a volcanic sequence progressing from friable argillized breccia through coherent breccia to quartz latite. The K-Ar age of the latter is about 300 m.y. Emplacement of serpentine-chlorite veins and maskelynitization of Precambrian rocks on the central shoals were roughly synchronous with emplacement of friable breccia. Argillization of

country rocks accompanied emplacement of friable breccia early in the sequence, whereas high-temperature alterations of country rock (partial fusion, recrystallization, and formation of spurrite) accompanied the later intrusions.

The average volcanic rock is 1 per cent higher in K_2O than the average Precambrian rock of the Clearwater area. Compositional means for nickel, total iron, and magnesia for the two rock groups are similar. The composition of the volcanic rocks, and progression from low- to high-temperature alteration and volcanic products are inconsistent with origin by meteorite impact.

The basins are explained as collapse features resulting from exhaust of volatiles from a magma chamber. Early near-surface explosion of gases produced maskelynite and opened fractures penetrating to the chamber at depth. Adiabatic expansion of gases in major conduits resulted in argillization of early breccias at the surface. Continued release of hot volatiles produced small volumes of very hot quartz-latite magma.

Boyle, R.W.

THE GEOCHEMISTRY OF CADMIUM IN THE LEAD-ZINC-SILVER DEPOSITS OF THE KENO HILL AREA, YUKON, CANADA; Akad. Sci. U.S.S.R., A.P. Vinogradov vol. (in Russian), pp. 220-231, 1965.

The principal primary cadmium-bearing minerals in the Keno Hill lead-zinc-silver lodes are sphalerite (0.71-1.16% Cd) and freibergite (0.05-0.2% Cd). Galena may contain up to 200 ppm Cd, and traces are found in chalcopyrite, jamesonite, boulangerite, and pyrite. Cadmium replaces zinc in sphalerite, copper in freibergite, and probably lead in the galena.

The main supergene cadmium-bearing mineral is hawleyite, isometric CdS. Small amounts of cadmium are found in supergene sphalerite, native zinc, pyrargyrite, limonite, wad, smithsonite, beudantite, bindheimite, jarosite, and anglesite. In these minerals cadmium shows a close association with zinc, lead, and antimony.

The oxidized zones of most lodes are depleted in cadmium. In this respect the element behaves like zinc.

(R.W.B.)

Boyle, R.W.

THE GEOCHEMISTRY OF SILVER IN THE KENO HILL-GALENA AREA, YUKON, CANADA; Akad. Sci. U.S.S.R., Vernadsky mem. vol. (Russian with English summary), pp. 326-340, 1965.

In the country rocks of the Keno Hill area silver is present in the largest amounts in the graphitic sediments (0.50 ppm) and in the lowest amounts in granitic rocks (<0.10 ppm). In all rock types the element is concentrated principally in the accessory sulphides, particularly in pyrite and chalcopyrite.

In the hypogene lode minerals silver is greatly enriched in freibergite, galena, and chalcopyrite. Small amounts are present in boulangerite and jamesonite, and traces occur in pyrite, arsenopyrite, sphalerite, and other minerals.

During the course of mineralization only trace amounts of silver were precipitated during the first stage in the cassiterite, wolframite, and quartz veins and in the scheelite skarn. Some silver was precipitated together with gold in the second stage quartz-pyrite-arsenopyrite veins. The elements accompanying silver in this stage were Si, Fe, As, S, Au and very minor amounts of Pb, Zn, Sb. The greatest quantities of silver were precipitated during the third and final stage of hypogene mineralization which resulted in the formation of the siderite-galena-sphalerite-freibergite lodes. In these silver is closely associated with Pb, Sb, and Cu. Other accompanying elements and compounds are Mn, Zn, Cd, Fe, CO_3, and S.

During the oxidation of the lodes silver has followed a number of courses depending upon the oxidation-reduction potential, the p^H, the presence in solution of various constituents particularly iron, manganese, and antimony, and the presence of primary sulphides. In the oxidized zones the principal silver-bearing minerals formed were jarosite and native silver. In addition to these much silver was incorporated in minerals such as bindheimite, beudantite, anglesite, limonite, and wad. The silver-bearing minerals formed in the zone of reduction are pyrargyrite, native silver, and small amounts of acanthite.

Only infinitesimal amounts of silver are present in the ground and surface waters of the area, a fact attesting to the low mobility of the element where dissolved iron and manganese are present in abundance and where carbonates (mainly siderite) play a large part in neutralizing the acid oxidizing solutions.

Small amounts of silver are retained in the residual soils in the vicinity of the lodes. This silver is present in a variety of forms, in native gold, in oxidized nodules of galena and freibergite, and in numerous secondary minerals especially beudantite, anglesite, limonite, and wad.

(R.W.B.)

Boyle, R.W.

THE GEOCHEMISTRY OF ARSENIC, KENO HILL-GALENA HILL AREA, YUKON, CANADA; Mining and Metallurgical Inst. India, Dr. D.N. Wadia commemorative vol., pp. 757-770, 1965.

In the country rocks of the Keno Hill-Galena Hill area, arsenic occurs in the greatest abundance in the graphitic argillites, schists, and phyllites. Pyrite carries the bulk of the arsenic in these rocks.

Arsenic is concentrated in arsenopyrite in the second stage of mineralization of the area. In the third stage siderite-galena-sphalerite-pyrite lodes small amounts of arsenic occur in pyrite and freibergite.

Oxidation of the lodes has led to the formation of scorodite, beudantite, and pharmacosiderite. These minerals are the result of a series

of complex oxidation, hydrolytic, co-precipitation, and adsorption reactions.

The oxidized zones of some veins are slightly enriched in arsenic; others are depleted. The zones of reduction exhibit a small enrichment in arsenic where marcasite, secondary pyrite, and pyrargyrite are abundant.

Brown, I.C.

LES EAUX SOUTERRAINES, RESSOURCES INEXPLOITÉES; Le Jeune Scientifique, vol. 10, No. 1, pp. 2-7, No. 2, pp. 32-34, 1965.

Affirmer que les eaux souterraines constituent une ressource inexploitée peut paraître ridicule à ceux qui tirent des puits leur approvisionnement en eau; mais ceux-là connaissent-ils la quantité d'eau qu'ils peuvent extraire de la terre, la durée maximale du pompage à un certain débit, savent-ils comment l'eau parvient au puits, d'où elle vient, pourquoi elle est douce ou dure? Si de telles questions demeurent sans réponse, les vastes réserves d'eaux souterraines du Canada ne peuvent pas être utilisées à leur pleine valeur; et actuellement, les renseignements disponibles en ce domaine ne portent que sur un nombre limité de puits et de nappes aquifères.

Burk, C.F. Jr.

SILURIAN STRATIGRAPHY OF GASPÉ PENINSULA, QUEBEC (A REPLY TO DISCUSSION AND COMMENTS ON GRAPTOLITES); Bull. Am. Assoc. Petrol. Geologists, vol. 49, No. 12, pp. 2305-2316, 1965.

Included with response to discussions by A.J. Boucot and W.B.N. Berry (A.A.P.G. vol. 49, pp. 2295-2305, 1965) of the writer's paper under this title (A.A.P.G. vol. 48, pp. 437-464, 1964) are three compilations bearing on Silurian stratigraphic problems in Gaspé Peninsula. Table I is a comparison of lithologic descriptions by various geologists of strata assigned by the writer to the St. Léon Formation. Figure 1 is a compilation of fossil identifications from strata in northeast Gaspé variously interpreted as Silurian or Lower Devonian. Finally, Figure 2 compares three interpretations of Silurian and Lower Devonian stratigraphic relationships in northeast Gaspé Peninsula.

(C.F.B.)

Cameron, E.M.

GEOCHEMISTRY OF SLAVE POINT FORMATION, WESTERN CANADA; (abst.), Geol. Soc. Am., Program, Ann. Meeting, Nov. 4-6, 1965, Kansas City, Missouri, p. 26, 1965.

Drill cuttings and core from 100 wells were used to sample the Slave Point Formation over 40,000 square miles of northern British Columbia and Alberta. The formation, composed of relatively pure and uniform

limestones, and having an irregular western margin with a shale basin, is the uppermost unit of a Middle Devonian carbonate-evaporite sequence. Along the margin with the basin stromatoporoid reefs developed which have, in places, been dolomitized. The frequently vuggy dolomite contains natural gas in several fields.

Analyses by direct-reading emission spectrometry were made for 10 elements. Because of the uniformity of the limestone, regional variation is subtle, and interpretation demands a knowledge of sampling efficiency. Study of within-station variance, contamination of drill cuttings by cavings and other material, and the selective recovery of different lithologies as cuttings indicate that sampling efficiency is better for those elements held in solid solution in the carbonate than for elements contained in terrigenous material or secondary, noncarbonate minerals.

Magnesium and strontium held in the calcite of the limestone decrease in amount toward the reef margin and the dolomitized areas. Within the reef limestone and dolomite, high zinc values and high Si/Al ratios are common, caused by the secondary deposition of quartz and sphalerite. These different geochemical features are interpreted to be the result of leaching and migration accomplished by fluids that were more active in the permeable reef strata than in the tight nonreef limestones.

Cameron, E.M.

APPLICATION OF GEOCHEMISTRY TO STRATIGRAPHIC PROBLEMS IN LOWER CRETACEOUS OF WESTERN CANADA; Bull. Am. Assoc. Petrol. Geologists, vol. 49, pp. 62-80, 1965.

The detrital sediments that form the Lower Cretaceous series of the Interior Plains of Western Canada were sampled at close vertical intervals in fourteen widely spaced sections in Alberta and western Saskatchewan. The soda and potash contents of these samples were determined and then corrected to a carbonate-free basis.

"Chemical logs" are plotted for each section and show that throughout the area studied the series can be separated into three stratigraphic divisions, each of distinctive soda content. The lower division is poor in soda. The middle division is principally composed of sediments that are rich in sodic igneous detritus, and which interfinger with low-soda strata in the eastern part of the area. The upper soda division consists of sediments that have a low to intermediate soda content.

Samples of different grain size, such as sand and shale, share a distinctively similar soda content if they come from the same division or sediment suite. Thus chemical contacts may be traced from section to section without being affected by the lateral facies changes from sand to shale that are so common in the Lower Cretaceous. The potash content of the series is controlled by grain size variations to a much greater extent than soda, and thus this oxide is much less useful for stratigraphic correlation. Correlations made on the basis of the chemical data are related to the different stratigraphic units into which the series has been divided in different parts of the area.

Compositional variation between the sediment suites is ascribed principally to varying provenance, rather than to influences within the depositional basin. Plots showing regional chemical variation within the middle division indicate a western derivation for the highly sodic detritus and an eastern derivation for the soda-poor sediments, with the two suites mixing in eastern Alberta and western Saskatchewan. The upper division shales show a consistent decrease in potash and an increase in soda away from the presumed western shoreline of the time.

Chemical methods of correlating detrital sediments appear to be useful, particularly when applied to shales or to mixed assemblages that include shales. The rapid development of more efficient methods of analyzing rocks makes the application of geochemical methods to stratigraphic studies increasingly attractive.

Chamberlain, J.A., and Delabio, R.N.

MACKINAWITE AND VALLERIITE IN THE MUSKOX INTRUSION; Am. Mineralogist, vol. 50, pp. 682-695, 1965.

Mackinawite and valleriite have been observed in the dunites and pyroxenites of the central layered series of the Muskox intrusion, Northwest Territories, Canada. New electron probe measurements and X-ray powder diffraction data are presented which compare closely with those given by earlier workers. Certain optical and physical properties that were found to be helpful in distinguishing the two minerals in polished section are tabulated. Mackinawite occurs as a replacement in pentlandite and is invariably associated with this mineral in serpentine-bearing rocks. Valleriite occurs in serpentine where it may replace secondary magnetite and, unlike mackinawite, is not usually associated with other sulfides. Mackinawite formed before valleriite and various lines of evidence suggest that both minerals formed at sub-magmatic temperatures during, and as a result of, the serpentinization process.

Chamberlain, J.A., McLeod, C.R., Traill, R.J., and Lachance, G.R.

NATIVE METALS IN THE MUSKOX INTRUSION; Can. J. Earth Sci., vol. 2, pp. 188-215, 1965.

The following native metals have been identified in the Muskox intrusion: native iron, native nickel–iron (awaruite), native cobalt–iron (wairauite), and native copper. Mineral distributions and textures indicate that the native metals formed more or less contemporaneously, during the period of serpentinization of the host dunites and related rocks.

Conditions during serpentinization must have been more reducing in the central and lower parts of the layered series than in the margins and upper parts of the intrusion. This is indicated by the fact that most native metals are abundant in the central regions and are essentially lacking elsewhere, even in strongly serpentinized zones. This zoning suggests that reducing conditions may have been generated internally, possibly as a result of the serpentinization process itself. The composition of the primary

olivine of forsterite$_{80-88}$ together with the presence of abundant secondary magnetite in equivalent serpentinites indicates that a redox reaction, olivine + water = serpentine + magnetite + hydrogen, contributed to the development of a progressively more reducing, or hydrogen-rich, fluid phase.

Natural phase relations indicate that each native metal formed primarily in situ as a result of the decomposition of specific earlier formed minerals that had become unstable in the reducing environment. Native iron appears to have been formed by the reduction of magnetite; awaruite by the reduction of pentlandite; wairauite by the reduction of an unknown phase, possibly cobalt pentlandite or cobaltian pyrite; and native copper by the reduction of chalcopyrite. The feasibility of most of these reactions was confirmed by experimental studies carried out in systems open to moist hydrogen.

Clayton, Lee,[1] Laird, Wilson, M.,[1] Klassen, R.W., and Kupsch, W.O.[2]

INTERSECTING MINOR LINEATIONS ON LAKE AGASSIZ PLAIN; J. Geol., vol. 73, pp. 652-656, 1965.

Intersecting minor ridges on the plain of glacial Lake Agassiz were probably pushed up by floating lake ice and apparently are not primarily the result of permafrost, wave action and running water, or a fracture pattern in the underlying bedrock, as previously suggested. Associated intersecting minor grooves were also formed by dragging lake ice. They are essentially identical to grooves forming in Great Slave Lake in recent times.

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[1] North Dakota Geological Survey.
[2] University of Saskatchewan.

Cobban, W.A.[1] and Jeletzky, J.A.

A NEW SCAPHITE FROM THE CAMPANIAN ROCKS OF THE WESTERN INTERIOR OF NORTH AMERICA; J. Paleontol., vol. 39, pp. 794-801, 1965.

Scaphites gilli, n. sp., a densely ribbed latterally compressed ammonite is described from Wyoming, Colorado, South Dakota, and Montana, in the United States, and Manitoba and Saskatchewan in Canada. The species is assigned to Hoploscaphites Nowak, 1912, which is herein treated as a subgenus of Scaphites Parkinson, 1811. Scaphites (Hoploscaphites gilli is closely related to the fine-ribbed European scaphites usually referred to as Scaphites roemeri d'Orbigny. In terms of the standard stages of the Upper Cretaceous, S. (H).) gilli occurs in the middle of the upper Campanian. The species first appears in the Western Interior of the United States in the middle of the range zone of Baculites perplexus, and ranges on up through the range zones of Baculites gregoryensis, B. scotti, Didymoceras nebrascense, and D. stevensoni.

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[1] U.S. Geological Survey.

Collett, L.S.

AIRBORNE RESISTIVITY SURVEYS USEFUL FOR OVERBURDEN TESTS; Northern Miner, Ann. Rev. Number, Nov. 25, p. 68, 1965.

In 1965 the Geological Survey commenced an experimental program to study the electrical properties of soils and surficial deposits to determine if any electromagnetic method could differentiate between clays, tills, sands, and gravels. A rapid reconnaissance study using an induced pulse transient (INPUT) system was made flying at 500 feet, with flight lines at 1 mile intervals, over the Winkler area, Manitoba. The airborne results agreed closely with those of a ground DC resistivity survey. Three other areas were also flown in 1965. Despite certain limitations the method is able to detect quickly sand and gravel beds with thicknesses of a few tens of feet lying beneath clay and till deposits up to 75 feet thick and should prove invaluable to both groundwater and Pleistocene geologists.

(S.E.J.)

Craig, B.G., and Fyles, J.G.

QUATERNARY OF ARCTIC CANADA; in Anthropegen Period in Arctic and Subarctic; Trans. Scientific Research Institute of the Geology of the Arctic, State Geological Committee, U.S.S.R., Moscow, vol. 143, pp. 5-33 (Russian with English summary), 1965.

In Arctic Canada as in the more southerly parts of the country, the Pleistocene epoch involved a succession of glacial and interglacial intervals. Interglacial and pre-Glacial deposits occur in the northwestern part of the region. The early Pleistocene and (?) late Tertiary Beaufort Formation, consisting of wood-bearing gravel, sand, and silt, occupy the Arctic coastal plain. High terrace deposits on western Ellesmere Island and eastern Axel Heiberg Island include wood-bearing sediments possibly equivalent to the Beaufort Formation as well as younger materials that are tentatively considered to be interglacial. Plant-bearing deposits inferred to be interglacial occur on Banks Island, on Bathurst Island, and are widespread on the coastal plain in the Mackenzie Delta area.

Most of Arctic Canada was ice covered at the climax of the last (classical Wisconsin) glaciation. At this stage the Laurentide continental ice sheet covered the northern continental mainland east of the Cordillera and extended across the adjoining Arctic Islands and the Parry Channel. The mountainous northeastern islands supported a complex of ice-caps and glaciers which coalesced with large glacier tongues in the depressions (straits) between these islands and between the lower islands to the northwest. Although glacial features are inconspicuous on these northwestern islands, all have yielded some evidence of glaciation and many appear to have supported locally-centered glaciers or ice-caps. Although substantial parts of the Yukon have never been glaciated, no extensive unglaciated areas have yet been clearly defined on the Arctic Islands.

The last climax and early retreat of the Laurentide ice-sheet took place at about the same time in Arctic Canada as in southern Canada and

the northern United States. In the northwestern part of its area the margin of the ice-sheet withdrew southeast and east from its maximum stand and ultimately retreated into the 'barren grounds' west of Hudson Bay. In the northeast on Baffin Island the margin of the ice-sheet retreated southwestward leaving behind extensive moraines, but the total distance retreated was only a few kilometres. As deglaciation progressed, the sea penetrated through Hudson Strait into Hudson Bay and Foxe Basin, and the ice-sheet separated into isolated remnants east and west of Hudson Bay and on Baffin Island. The last ice-sheet remnants west (and probably east) of Hudson Bay may have disappeared as early as 7,000 years ago, but substantial remnants remained on Baffin Island considerably later.

Raised marine features, formed during and since deglaciation, occur throughout most of Arctic Canada, although coastal drowning has taken place during the same interval both on the western mainland and western islands. The level of the highest post-glacial marine features increases in altitude, in a general way, from the outer coasts of Arctic Canada towards the interior across a zone a few kilometres to 800 kilometres in width; beyond this border zone (in the interior) the marine limit varies in level from place to place but does not increase further in altitude. Marine shells and shell fragments above the marine limit on various Arctic islands are believed to have been carried into their present locations by glacier ice. In some areas of appreciable uplift, radiocarbon dates inferred to relate to successive levels of the seashore provide evidence that rapid emergence was in progress at the time of ice retreat, that most emergence took place within a few thousand years of ice retreat, and that subsequent uplift has been slow. Some areas have emerged significantly during the last 2,000 years or so (and probably still are rising), but others have emerged little if at all during recent centuries. Moreover, the western mainland coast both east and west of Mackenzie River may possibly have subsided relative to the sea during the last few hundred years.

(B.G.C. and J.G.F.)

Currie, K.L.

THE GEOLOGY OF THE NEW QUEBEC CRATER; Can. J. Earth Sci., vol. 2, pp. 141-160, 1965.

The New Quebec Crater is a circular depression in the acid Archaean gneisses of northern Quebec, about 2 miles in diameter and 1,300 feet deep. The crater is roughly bowl-shaped, with a prominent rim elevated 300 to 500 feet above the surrounding barrens. The rim structure is a relatively recent deformation resulting in systematic outward dip of rock sheeting, and radial distribution of other curviplanar structural elements. Rocks of the rim are strongly mineralized with epidote and hematite, and are altered to sericite. These minerals are not found in the same rock units outside the rim. Glaciation of the rim appears to have removed little or no material. No evidence of impact was found.

The crater may have arisen either by extraterrestrial impact or by volcano-tectonic collapse. The impact theory is implausible because of absence of distinctive criteria of shock and failure to explain the characteristic structure and mineralization of the crater. The volcano-tectonic hypothesis explains the structural and petrographic evidence but appeals to a

type of volcanism not presently observed in active volcanic areas. Geophysical measurements are not likely to resolve the dilemma. The diagnostic evidence lies in the rocks hidden beneath the crater, concealed by 800 feet of water.

Currie, K.L.

ANALOGUES OF LUNAR CRATERS ON THE CANADIAN SHIELD; Ann. N.Y. Acad. Sci., vol. 123, Article 122, pp. 915-940, 1965.

Canadian craters occur along a great welt on the craton raised since late Palaeozoic time. The site of the craters is determined by local structural features, usually faults older than or contemporaneous with the crater. The crater is formed by uparching from below followed by collapse. This cycle may be repeated in the larger craters. Hydrothermal activity is always prominent during the formation of the crater, and true volcanic activity occurs in the largest craters. The continental distribution of craters shows that their root cause must be deep seated, presumably connected with events in the mantle. The nature of these events is at present unknown. The location of the craters on uplifted ground, the association of hydrothermal activity with the craters, and the occurrence of volcanism in the craters, suggests that an upwelling of volatile-rich material from the mantle is involved. Like all volcanism, cratonic craters probably represent a comparatively trivial by-product of the degassing of the earth. Their unique form is a product of environment, not of root cause.

(K.L.C.)

Currie, K.L.

VARIATIONS IN THE HAFNIUM-ZIRCONIUM RATIO OF GRANITIC ROCKS FROM EASTERN ONTARIO: PART II, THE CROW LAKE DOME; (abst.), Can. Mineralogist, vol. 8, Part 3, p. 396, 1965.

The Hf/Zr ratio of the Crow Lake quartz monzonite is 0.022 with a mean deviation of 0.0014. Just outside the boundaries of the mass the ratio falls to about 0.018, then rises to a sharp peak exceeding 0.030. The height and location of this peak are practically independent of rock type, but often occur in unusually basic gneisses. Passing outward, the Hf/Zr ratio decreases slowly from a maximum to values between 0.025 and 0.030. This pattern is interpreted to show migration of material from the surrounding metamorphic envelope into the granitic mass. Differential solubility of Hf and Zr is inadequate to explain this result, but a combination of vapour diffusion and differential solubility could yield the observed pattern.

Cumming, L.M.

TECTONICS AND STRATIGRAPHY OF THE WEST COAST OF NEWFOUNDLAND; (abst.), Geol. Soc. Am., Program, Ann. Meeting Nov. 4-6, 1965, Kansas City, Missouri, pp. 39-40, 1965.

The dominant structural unit of western Newfoundland is the Anticosti-Strait of Belle Isle Platform which is characterized by Lower

Paleozoic carbonate deposits resting upon a Grenville crystalline basement. In western Newfoundland, the southeastern margin of the platform lies beneath an Ordovician klippe consisting of eugeosynclinal and ultramafic rocks.

The relationship between platform carbonates and klippe is displayed on Port au Port Peninsula. There, klippe rocks of the Humber Arm Group (shale, sandstone, conglomeratic sandstone, limestone conglomerate, chert, wildflysch, and minor pillowed basalt) lie upon platform carbonate and are overlain by younger platform carbonate. The structural succession from east to west across Port au Port Bay is as follows: platform carbonate–St. George Formation (Cambrian-Ordovician) and Table Head Formation (Middle Ordovician); klippe rocks–Humber Arm Group (Lower Ordovician); the younger platform carbonate–Long Point Formation (Middle Ordovician); and sandy Clam Bank Formation.

At Port au Choix, the St. George dolomite is petroliferous and to the south is capped by Table Head shales. Offshore, the St. George Formation is probably overlain by several thousand feet of Table Head and younger strata. Lead and zinc sulphides occur in dolomite breccias in the platform carbonates. The deposits 7 miles northeast of Daniels Harbour are stratigraphically confined to the upper part of the St. George Formation.

In southwestern Newfoundland, the platform also forms the northwest margin of a late Paleozoic fold belt. Flat-lying Carboniferous limestone, sandstone, and gypsum-anhydrite lie on the platform around the head of St. George Bay and on Port au Port Peninsula.

Donaldson, J.A., and Jackson, G.D.

ARCHAEAN SEDIMENTARY ROCKS OF NORTH SPIRIT LAKE AREA, NORTHWESTERN ONTARIO; Can. J. Earth Sci., vol. 2, pp. 622-647, 1965.

Archaean sedimentary rocks of the North Spirit Lake area show little evidence of having been derived predominantly from associated Archaean volcanic rocks. Instead, compositions of the sediments reflect significant sedimentary and (or) granitoid provenance. A remarkably high content of clastic quartz in thick units of sandstone and conglomerate suggests either reworking of older quartzose sediments, or reduction of the labile constituents in quartz-rich granitoid rocks through prolonged weathering and rigorous transport. Observations for other sedimentary sequences in the region between Red Lake and Lansdowne House suggest that the North Spirit sediments are not unique in the Superior Province. Quartzose sandstones commonly are regarded as atypical of the Archaean, but such rocks are abundant in northwestern Ontario. Frameworks of many Archaean greywackes actually are richer in quartz than typical greywackes from numerous Proterozoic and Phanerozoic sequences.

The concept of rapidly rising volcanic arcs as the sole source of Archaean sedimentary detritus is rejected for the North Spirit area. The volcanics, rather than representing relicts of protocontinents, probably record events removed from initial volcanism in the history of the earth by

one or more orogenic cycles. Major unconformities may therefore exist not only between sedimentary and volcanic units, but also between these units and older granitoid rocks.

Dreimanis, A.,[1] Terasmae, J., and McKenzie, G.D.[1]

THE PORT TALBOT INTERSTADIAL OF THE WISCONSIN GLACIATION; Intern. Assoc. Quat. Res. (INQUA), VII Intern. Congress, General Sessions, Abstracts, p. 108, 1965.

Recent test borings at the type locality of Port Talbot Interstadial deposits in southwestern Ontario indicate that this interval which preceded the Main Wisconsin Glaciation, was considerably longer than previously assumed. It comprised two relatively warm episodes, in which northern boreal forest species predominated, separated by a glacial readvance that reached Lake Erie from the north. During this readvance varved clays and stratified lacustrine sediments, probably equivalent to the Dunwich Drift, were deposited in Erie basin.

The two warmer episodes (with sub-arctic and boreal climate) and one cold episode (sub-arctic or arctic climate) are represented by 60 to 80 feet of lacustrine deposits found in the Port Talbot sequence. They are underlain by Bradtville Drift, deposited by an Early Wisconsin Glacial advance from the northeast.

No C-14 dates are available for the earlier relatively warm episode, Port Talbot I. It is represented by greenish, slightly calcareous, allochthonous clay which contains weathering products of till (montmorillonite, chlorite, partly weathered feldspars, and vivianite). The second relatively warm episode, Port Talbot II, with C-14 dates ranging from 35,600 to 47,690 years, and represented by dolomite-rich lacustrine deposits, gyttja, and peat, corresponds to the formerly defined Port Talbot interstadial.

Further new evidence suggests that the Port Talbot Interval may include also the materials of the age of Plum Point and thereby might extend through the period from at least 48,000 to about 24,000 years B.P.

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[1] University of Western Ontario.

Dyck, W., Fyles, J.G., and Blake, W. Jr.

GEOLOGICAL SURVEY OF CANADA, RADIOCARBON DATES IV; Radiocarbon, vol. 7, pp. 24-46, 1965. (Also reprinted as Geol. Surv. Can. Paper 65-4.)

Seventy-seven radiocarbon age determinations made by the Geological Survey of Canada Carbon-14 Dating Laboratory between December 1963 and November 1964 are presented. They are on specimens from the following parts of Canada: Quebec (3); Ontario (7); Manitoba (4); Alberta (4); British Columbia (25); Yukon (3); N.W.T. (1); and Arctic Islands (30). The

construction and testing of a new 5-litre counter is described and some aspects of sample preparation and contamination are discussed.

(S.E.J.)

Easterbrook, D.J.[1] and Armstrong, J.E.

DAY 10 – SEPTEMBER 15; in Intern. Assoc. Quat. Res. (INQUA), Guidebook for Field Conference J, Pacific Northwest, pp. 75-87, 1965.

The Quaternary features and surficial deposits seen at 13 localities from Bellingham, Washington, to Manning Park, British Columbia, are briefly described in roadlog fashion. The account is accompanied by 3 maps, 1 cross-section, 2 stratigraphic sections, and 1 correlation chart.

(S.E.J.)

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[1] Western Washington State College, Bellingham, Wash.

Emslie, Ronald F.

THE MICHIKAMAU ANORTHOSITIC INTRUSION, LABRADOR; Can. J. Earth Sci., vol. 2, pp. 385-399, 1965.

The Michikamau Intrusion is a large, unmetamorphosed anorthositic mass lying within the broad belt of anorthositic bodies extending from southeastern Ontario to Labrador. Potassium–argon biotite dates place the time of crystallization of the intrusion at approximately 1,400 million years ago.

The main rock units of the intrusion are leucotroctolite, anorthosite, and leucogabbro; essential minerals are plagioclase, olivine, clinopyroxene, and orthopyroxene. The bulk of the plagioclase falls in the range An_{52}–An_{62} and olivine in the range Fo_{60}–Fo_{70}. The rocks are remarkably fresh and free from secondary alteration products.

A number of features characteristic of large, layered basic plutons are present in the Michikamau Intrusion. The chilled margin has the composition of olivine basalt. However, the bulk composition of the mass is highly feldspathic, thus leading to the proposition that the basaltic liquid was heavily charged with plagioclase crystals. Cumulate structures and textures indicate that bottom accumulation of crystals may have played an important part in the solidification and differentiation of the intrusion.

The course of differentiation of the magma was toward extreme iron enrichment with the development of ferrous-rich dioritic, granodioritic, and syenitic rocks as end products. It is unlikely that water played an important role in the crystallization of the intrusion.

Emslie, Ronald F.

SOME ASPECTS OF THE CRYSTALLIZATION AND DIFFERENTIATION OF THE MICHIKAMAU ANORTHOSITIC INTRUSION, LABRADOR, CANADA; (abst.), Geol. Soc. Am. Program, Ann. Meeting, Nov. 4-6, 1965, Kansas City, Missouri, p. 50, 1965.

The Michikamau intrusion underlies about 800 square miles in west-central Labrador. The Grenville Front is approximately 30 miles south of the intrusion, and no significant post crystallization metamorphism of the pluton has been recognized. Biotite from the intrusion yielded a K-Ar age of 1400 m.y.

The major rock units of the intrusion from older to younger are: plagioclase-rich troctolite, anorthosite, leucogabbro, and a group of ferrous-rich diorite, syenite, and quartz monzonite rocks. The most striking feature of the differentiation process is strong iron enrichment of the late members.

Plagioclase-rich troctolite comprises 60 to 70 per cent of the exposed rocks of the Michikamau intrusion. Rhythmic layering and igneous lamination are widespread in the troctolitic-rocks. Rhythmic layering is usually subtly developed, but some localities have layers of strongly contrasting mineral constitution. The bulk of the plagioclase in troctolite falls within the An_{50} to An_{60} range and is associated with olivine of Fo_{58} to Fo_{70} composition. Augite and hypersthene occur chiefly as interstitial and poikilitic crystals. A fine-grained marginal facies of olivine basalt composition is present at the contact between troctolite and wall-rock gneisses and is believed to represent the chilled parent liquid. The great bulk of plagioclase-rich rocks would therefore require either that the basaltic liquid was heavily charged with plagioclase crystals at the time of intrusion or that continued introduction of fresh magma maintained the liquid at a composition corresponding to the plagioclase-olivine phase field boundary for a long period.

Fahrig, W.F., Gaucher, E.H., and Larochelle, A.

PALAEOMAGNETISM OF DIABASE DYKES OF THE CANADIAN SHIELD; Can. J. Earth Sci., vol. 2, pp. 278-298, 1965.

Some areas of the Canadian Shield are profusely intruded by swarms of subparallel basaltic dykes. These typically have a diabasic texture and formerly were considered to be strictly the intrusive equivalents of tholeiitic flood basalt.

About 650 oriented samples were collected from about 25 dyke swarms and preliminary palaeomagnetic data from six of them are presented here. The Mackenzie swarm has a K-Ar age of 1,295 million years, occurs throughout the western Canadian Shield, and is the most extensive swarm of basic dykes known anywhere in the world. The other swarms are the Molson dykes (1,445 m.y.) in northeastern Manitoba, the Marathon dykes (1,810 m.y.) just north of Lake Superior, the Sudbury dykes (1,285 m.y.) of southeastern

Ontario, the Matachewan dykes (2,485 m.y.) of western Quebec and north-eastern Ontario, and the Abitibi dykes (1,230 m.y.), which occur from Sault Ste. Marie, Ontario, to Lake Mistassini, Quebec.

The palaeomagnetic virtual pole positions of six swarms were derived from the mean of their measured remanent magnetization directions. These directions of magnetization were determined from the samples after they were magnetically washed in an a-c. field of 80 or 130 oersteds. The reasons for the dispersion within the individual swarms are discussed. The pole positions of the Sudbury and Mackenzie dykes are almost identical and the two swarms are the same age within the limits of analytical uncertainty. However, basalt of the Sudbury swarm is alkalic and more undersaturated than basalt of the Mackenzie dykes.

No evidence was found to contradict the usual assumption that unaltered basic igneous rocks of this type acquire and generally retain a stable magnetization which was parallel with the earth's magnetic field at the time of the dyke intrusion.

Findlay, D.C., and Smith, C.H.

REVIEW, DRILLING FOR SCIENTIFIC PURPOSES IN CANADA; Tectonophysics, vol. 2, No. 4, pp. 247-257, 1965.

This paper discusses the development of drilling projects carried out for scientific purposes, particularly their present and future roles in upper mantle studies. Drilling projects that are currently underway or that have been completed in Canada in the fields of meteorite crater investigations, heat-flow studies, and studies of ultramafic intrusions, are briefly described. A recently completed drilling program on a large ultramafic–mafic layered intrusion in northern Canada – the Muskox Drilling Project – is used as an example to illustrate factors involved in the design and execution of a drilling project. Experience gained from the Muskox Project provides a basis for anticipating factors that will be involved in planning and completing deep drilling programs of the future.

Fulton, R.J.

SILT DEPOSITION IN LATE GLACIAL LAKES OF SOUTHERN BRITISH COLUMBIA; Intern. Assoc. Quat. Res. (INQUA), VII Intern. Congress, General Session, Abstracts, p. 154, 1965.

The extensive late glacial silt deposits of the major valleys of the Interior System of the Canadian Cordillera hold an important position in the deglaciation of the area. This study is limited to the silt of the South Thompson Valley. If all major silt deposits accumulated under roughly similar conditions as suggested, generalizations of this study may be applied to silt deposition in other valleys.

The South Thompson Valley is a steep-walled valley flanked by rolling uplands. During deglaciation the ice downwasted leaving ice tongues in the main valleys. Silt was deposited in Lake Thompson, an eastward

draining glacial lake formed in the South Thompson Valley between an ice tongue retreating to the west and one receding to the east.

Silt up to 500 feet thick is exposed along the 36 mile length of the South Thompson Valley. Lower portions of the silt are marked by varves up to 250 inches thick which grade upwards into varves 1 inch thick. In places the stratification has been modified by slumping due to collapse during the melting of buried ice, drag of floating ice and simple gravity movements.

The main generalizations of this study which may apply to similar silt deposits are: (1) Silt was deposited in glacial lakes; (2) Varves are thick in lower parts of the deposit, grading thinner upwards; (3) Much of the silt was derived from meltwater erosion of glacial till; (4) Maximum deposition occurred as the ice receded from adjacent uplands.

Fulton, R.J.

SILT DEPOSITION IN LATE-GLACIAL LAKES OF SOUTHERN BRITISH COLUMBIA; Am. J. Sci., vol. 263, pp. 553-570, 1965.

The extensive late-glacial silt deposits of the major valleys of the Interior System of the Canadian Cordillera hold an important position in the deglaciation of the area. This study is limited to the silt of the South Thompson Valley. If all major silt deposits accumulated under roughly similar conditions as suggested, generalizations of this study may be applied to silt deposition in other valleys.

The South Thompson Valley is a steep-walled valley flanked by rolling uplands. During deglaciation the ice downwasted leaving ice tongues in the main valleys. Silt was deposited in Lake Thompson, an eastward draining glacial lake formed in the South Thompson Valley between an ice tongue retreating to the west and one receding to the east.

Silt up to 500 feet thick is exposed along the 36-mile length of the South Thompson Valley. Lower portions of the silt are marked by varves as much as 250 inches thick, which grade upward into varves about one inch thick. In places the stratification has been modified by slumping due to collapse during the melting of buried ice, drag of floating ice, and simple gravity movements.

The main generalizations of this study which may apply to similar silt deposits are: (1) silt was deposited in glacial lakes; (2) varves are thick in lower parts of the deposit, grading thinner upward; (3) much of the silt was derived from meltwater erosion of till; (4) maximum deposition occurred as the ice receded from adjacent uplands.

Fulton, R.J., and Armstrong, J.E.

DAY 11 - SEPTEMBER 16; in Intern. Assoc. Quat. Res. (INQUA), Guidebook for Field Conference J, Pacific Northwest, pp. 87-98, 1965.

Roadlog-type geological descriptions of the Quaternary features and deposits at 8 localities between Manning Park and Kamloops, B.C., are

presented, and are accompanied by 1 map, 1 stratigraphic section, and 1 pollen diagram.

(S.E.J.)

Fyles, J.G., and Blake, W. Jr.

GLACIATION OF THE NORTHWESTERN CANADIAN ARCTIC ISLANDS; Intern. Assoc. Quat. Res. (INQUA), VII Intern. Congress, General Session, Abstracts, p. 156, 1965.

Recent studies indicate that most of the northwestern Canadian Arctic islands have been ice-covered during the last glaciation (approximately equivalent to the classical Wisconsin). Unglaciated areas are much less extensive than indicated on the "Glacial Map of Canada" (1958).

The continental (Laurentide) ice impinged on eastern Banks Island and left a terminal moraine on southern Melville Island. Evidence for locally-centered glaciation exists on Bathurst, Melville, and Prince Patrick Islands. All the other islands exhibit some traces of glaciation; e.g., till, erratics, drumlins, eskers, meltwater channels, or moraines.

The altitude of the highest marine features displays considerable local and regional variation. It is greatest in northeastern Bathurst Island (140 m) and slight along coasts bordering the Beaufort Sea (10 m or less). These variations presumably reflect differences in both ice thickness and in time of ice retreat.

Radiocarbon-dated marine shells indicate that northwesternmost Victoria Island became ice-free ca. 12,000 years ago. The oldest dates obtained north of the Parry Channel are 11,000 years for shells from both eastern Prince Patrick Island and southwestern Melville Island. Shells on the distal (NW) side of the moraine along southern Melville Island are 10,300 years old. Several dates show that much of coastal Bathurst Island was ice-free by 9,700 years B.P., as was Byam Martin Island.

Ice from the islands and from the Laurentide ice sheet coalesced and filled the inter-island channels, but the relationships between ice from these various sources remain undetermined.

Gaucher, Edwin H.S.

QUANTITATIVE INTERPRETATION OF THE "MONTAGNE DU SORCIER" MAGNETIC ANOMALY, CHIBOUGAMAU, QUEBEC; Geophysics, vol. 30, pp. 762-782, 1965.

A sill of serpentinized dunite, called magnetite serpentinite, outcrops on the south flank of the "Montagne du Sorcier" in Chibougamau, Province of Quebec. This sill is associated with an oval-shaped mass of anorthosite in the Precambrian rocks of that locality. The sill contains about 20 per cent of magnetite by volume (24 per cent Fe) with one per cent of TiO_2. It extends for two miles in an east-west direction, dips 80°N, and is about 500 feet thick. The magnetic anomaly associated with this sill is

unusual as it shows a magnetic low south of the magnetic high.

Measurements of the susceptibility and of the remanent magnetization of 73 oriented cores (281 specimens) indicate that the remanent magnetization (0.034 emu) is in the same direction as the present earth's magnetic field and therefore in the same direction as the induced magnetization (0.053 emu), and thus suggest that the shape of the anomaly could be explained by the topography of the mountain. Additional evidence such as the direction of magnetization of an adjoining talc rock layer suggests that the alignment of the remanent magnetization and of the present earth's field is due to a viscous realignment of the remanent magnetization.

In the rocks studied, the relation between the susceptibility K and the proportion of the magnetite by volume X can be expressed as follows:

$$K = 0.03X + X^2.$$

The sill presents a certain economic interest as a possible iron ore deposit.

Goodwin, A.M.

MINERALIZED VOLCANIC COMPLEXES IN THE PORCUPINE-KIRKLAND LAKE-NORANDA REGION, CANADA; Econ. Geol., vol. 60, pp. 955-971, 1965.

Mineralized volcanic complexes at Porcupine, Kirland Lake, and Noranda display: (1) similar generalized stratigraphic successions, each 20,000 to 40,000 feet thick, in which mafic flows grade up through intermediate flows and fragmentals to predominantly felsic pyroclastic rocks and associated clastic sediments; (2) domical structures in varying stages of development and preservation; and (3) metal concentrations characteristically associated with the upper stratigraphic zones. Volcanic complexes in development are related by inference to cycles of magmatic differentiation in the parent magma.

The large majority of mineral deposits in the region are concentrated in the three volcanic complexes. Copper, zinc, silver and gold predominate at Noranda. Gold and silver are present at Kirkland Lake and Porcupine; the latter, in addition, contains copper and zinc. Despite possible later migrations of metals to more favorable sites, original metallization is viewed as an integral part of the growth and development of the complexes rather than as a later, independent, superimposed feature. Volcanic complexes of contrasting rock and metal associations are ascribed to contrasting source magmas.

Goodwin, A.M.

ARCHEAN VOLCANISM: PATTERNS AND PROBLEMS; (abst.), Geol. Soc. Am., Program, Ann. Meeting Nov. 4-6, 1965, Kansas City, Missouri, pp. 64-65, 1965.

Archean volcanism is well recorded in numerous greenstone belts of the Canadian Shield. Archean volcanic piles display common sequential

trends from early, predominantly mafic effusion to later, predominantly felsic extrusion. The typical Archean greenstone belt contains one or more mafic-felsic volcanic trends aggregating 25,000–35,000 feet in stratigraphic thickness.

Archean volcanic piles comprise in the order of 50 per cent basalt flows, 30 per cent andesite-dacite-rhyolite pyroclastic rocks and flows, and 10 per cent each of sedimentary and intrusive rocks. The dominant Archean basalt, probably of direct parental derivation, is of general tholeiitic character, as follows: SiO_2–48.8; Al_2O_3–15.3; Fe_2O_3–2.4; FeO–9.1; MgO–5.5; CaO–8.0; Na_2O–2.3; K_2O–0.6; TiO_2–1.1; H_2O–3.4; CO_2–2.7 per cent. Associated felsic differentiates are similar in chemical composition to Pacific suite rocks of the andesite-dacite-rhyolite association. Archean volcanic rocks are thus indicated to correspond chemically to modern volcanic rocks resting upon the continents and in orogenic belts marginal to continental masses. The Archean volcanic rocks, by inference, had a similar continental, as opposed to oceanic, origin.

Problems connected with Archean volcanic studies are briefly reviewed. They include, in addition to the highly folded, intruded, and otherwise relict state of the volcanic piles, the mutual presence of low-Al_2O_3 (13-14 per cent) and high-Al_2O_3 (14-17 per cent) basalts; postextrusion, chemical alteration of the volcanic rocks involving selective removal (SiO_2, alkalies, etc.) and addition (CO_2, H_2O, etc.) of chemical constituents; and the presence locally of alkalic-suite volcanic rocks.

Goodwin, A.M.

VOLCANISM AND GOLD DEPOSITION IN THE BIRCH–UCHI LAKES AREA; Bull. Can. Inst. Min. Metallurgy, vol. 58, No. 635, pp. 304-314, 1965.

Detailed stratigraphic studies in the Birch–Uchi Lakes area have shown that the volcanic components are arranged in superimposed sequences, or cycles. Each cycle displays a progression from predominantly mafic effusives below to predominantly felsic extrusives above. Sedimentary rocks are preferentially associated with the felsic extrusives. Two volcanic cycles are represented.

The average stratigraphic thickness of the volcanic rocks present is 31,000 feet. The original volcanic pile was probably in the order of 40,000 feet thick. The present lithologic composition is estimated to be: mafic volcanic rocks, 60 per cent; felsic volcanic rocks, 27 per cent; sedimentary rocks, 10 per cent; and others, 3 per cent.

Gold occurrences are preferentially distributed with respect to the volcanic succession. Of fifty recorded occurrences, thirty-nine are located in the upper felsic division of the lower volcanic cycle; forty are associated with closely interbanded dacite-rhyolite pyroclastic rocks, andesitic lavas and siliceous sediments. The gold-bearing quartz veins either lie at the contacts of enclosing lithologic units or occupy cross-cutting fractures in one or more adjacent units.

A common magmatic derivation for the gold and enclosing volcanic rocks is advocated. The preferential distribution of gold mineralization with respect to the volcanic succession may express related emplacement histories. Possible methods of gold emplacement are considered. Similar stratigraphic studies in other Archean volcanic belts are desirable.

Gregory, A.F.

ROCK COLORS, RADIOACTIVITY MEASURED IN AERIAL SURVEYS; Northern Miner, Ann. Rev. Number, Nov. 25, p. 67, 1965.

The Remote Sensing Section of the Geological Survey of Canada is currently conducting research on aerial colour photography and natural gamma radiation. Preliminary results have indicated that aerial colour photography is practical and superior to panchromatic photography where colour rather than texture of geological features is important. Research on gamma radiation has centred mainly on the fundamental processes of gamma-ray attenuation in rocks, air, and water, and ten major conclusions are listed. It is concluded that radiation detection techniques will dominate over geochemical or other direct exploration methods, particularly in pin-pointing discrete, exposed concentrations of uranium, thorium, and potassium.

(S.E.J.)

Gross, G.A.

ORIGIN OF PRECAMBRIAN IRON-FORMATIONS (DISCUSSION OF A PAPER BY H. LEPP AND S.S. GOLDICH, 1964); Econ. Geol., vol. 60, pp. 1063-1065, 1965.

The following criticisms to the statistical analysis of chemical data on iron-formations presented by Lepp and Goldich (1964) are offered: (1) their discussion of origin pertain only to cherty Precambrian iron-formations of the Lake Superior type and excludes post-Precambrian cherty iron-formations and Precambrian "minette type" iron-formations; (2) they relied heavily on chemical data and ignored geological evidence such as that for contemporaneous volcanism; (3) they did not present satisfactory evidence to show the validity of their assumption that iron and calcium were precipitated as carbonates and that silica subsequently replaced the calcium carbonate; and (4) their assumption that a relatively low oxygen content in the Precambrian atmosphere was a primary factor in controlling the composition of the iron-formations is not necessarily valid.

(S.E.J.)

Harrison, W.,[1] Malloy, R.J.,[2] Rusnak, Gene A.,[3] and Terasmae, J.

POSSIBLE LATE PLEISTOCENE UPLIFT CHESAPEAKE BAY ENTRANCE; J. Geol., vol. 73, pp. 201-229, 1965.

Paleontological and lithological studies of engineering borings and boring logs indicate that a buried, subaerial erosion surface of Pliocene (?)-Pleistocene age cuts across clastic sediments of pre-Yorktownian Miocene age in the subsurface and subbottom of the lower Chesapeake

Bay area. When the bore-hole data are coupled with the results of subbottom echo profiling and piledriving records, it is possible to construct accurate cross sections of the buried Miocene-Pleistocene contact. The cross sections show "lows" in the erosion surface that may be correlated with the buried channels of the Pleistocene Elizabeth, James, York, and Susquehanna river valleys. Probable channel depths below mean low water at control points are: 100 feet (Elizabeth River, beneath Tunnel No. 1), 155 feet (James River, at Hampton Roads Tunnel), 120 feet (York River, at Yorktown), 158 feet (Susquehanna River, off Cape Charles City), and 160 feet (Susquehanna River, at Fisherman Island, Cape Charles). The channel depths of what is believed to be the buried Susquehanna River valley are less than expected when placed on a curve showing the expectable gradients of that stream during the time of the most-recent, maximum lowering of sea level (ca. 18,000 years B.P.). The discrepancy suggests uplift of that channel of approximately 170 feet in about the last 18,000 years.

Pollen analysis and C^{14} dating of peats and shells immediately overlying the Miocene-Pleistocene contact indicate that the peats were deposited in brackish-water marshes or on boreal flood plains, probably only slightly above sea level, and that they were subsequently submerged and covered by estuarine sediments. The peats date between 10,340 and 15,280 years B.P., and occur at depths of 82–89 feet below mean low water. Because points for these age-depth values fall well above those used in developing curves of eustatic rise of sea level on relatively stable coasts, it seems possible that the peats may have been uplifted as much as 160 feet in the last 15,000 years.

Additional possible evidence of uplift within the last 1,900 years also is suggested by C^{14} dates on a peat and underlying shell bed cropping out on the seaward side of Hog Island on Virginia's eastern shore. The peat bed, assumed to have formed at about high tide, and the shell bed, deposited below low tide, now crop out some 5 feet above mean low water, and date from 1,170 to 1,900 years B.P., respectively.

Rates of uplift suggested by three localities of dated horizons indicate an average value of about 1.05 feet per century for the past 15,000 years, although the rate of uplift varied with time and actually involves a calculation for subsidence between 6,000 and 2,000 B.P. The rate of uplift seems to have approximated the rate of eustatic sea-level rise (about 2.8 feet per century), between 15,000 and about 8,000 B.P. Apparent reversal of crustal uplift between about 6,000 and 2,000 B.P., coupled with continued eustatic rise of sea level, allowed for extensive flooding of the Susquehanna valley lowland and eastern shore of Virginia.

Crustal uplift appears to have resumed between 2,000 B.P. and the present. The crustal-movement curve for the period 14,000–3,000 B.P. is remarkably similar to that found by Kaye and Barghoorn (1964) for the Boston area.

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[1] U.S. Coast and Geodetic Survey, Norfolk, Virginia.

[2] U.S. Coast and Geodetic Survey, Washington, D.C.

[3] U.S. Geological Survey, Menlo Park, California.

Harrison, W.,[1] Malloy, R.J.,[2] Rusnak, G.A.,[3] and Terasmae, J.

POSSIBLE LATE PLEISTOCENE UPLIFT, CHESAPEAKE BAY ENTRANCE, U.S.A.; Intern. Assoc. Quat. Res., VII Intern. Congress, General Sessions, Abstracts, p. 194, 1965.

Paleontological and lithological studies of bore-hole data, when coupled with the results of subbottom echo-profiling and pile-driving rates, permit construction of cross-sections of the buried Miocene-Pleistocene contact in the subbottom sediments. Pleistocene physiography revealed in these cross-sections shows a gradient reversal in the buried Susquehanna River valley. The gradient discrepancy suggests uplift of that channel of approximately 170 feet off Cape Charles, Virginia, in about the last 18,000 years.

Pollen analysis and C-14 dating of peats and shells immediately overlying the Miocene-Pleistocene contact, indicate that the peats were deposited on a boreal flood plain, probably only slightly above sea level, and that they were subsequently submerged and covered by estuarine sediments. The peats date between 10,340 and 15,280 years B.P., and occur at depths of 82 to 89 feet below MLW. Evidence presented indicates that the peats may have been uplifted as much as 160 feet in the last 15,000 years.

The rate of uplift seems to have approximated the rate of eustatic sea level rise (2.8 feet/century), between 15,000 and 8,000 B.P. Apparent reversal of crustal uplift between about 6,000 and 2,000 B.P., coupled with continued eustatic rise of sea level, allowed for extensive flooding of the Susquehanna Valley lowland, forming Chesapeake Bay. Crustal uplift appears to have resumed between 2,000 B.P. and the present. The crustal-movement curve for the period 14,000-3,000 B.P. is remarkably similar to that found by Kaye and Barghoorn (1964) for the Boston area.

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[1] U.S. Coast and Geodetic Survey, Norfolk, Virginia.

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[3] U.S. Geological Survey, Menlo Park, California.

Hood, Peter

GRADIENT MEASUREMENTS IN AEROMAGNETIC SURVEYING; Geophysics, vol. 30, pp. 891-902, 1965.

The recent development of highly sensitive magnetometers, such as the optical-pumping varieties, has made feasible the measurement of the first vertical derivative of the total field ($\partial\Delta T/\partial h$) in aeromagnetic surveys. This is accomplished by using two sensitive magnetometer heads separated by a constant vertical distance, and recording the difference in outputs. The effect of diurnal is thus eliminated in the resultant differential output, and this is an especially desirable feature in northern Canada where the diurnal variation is usually much greater than is found in more southerly magnetic

latitudes. Moreover, steeply dipping geological contacts in high-magnetic latitudes are outlined by the resultant zero-gradient contour. It is also possible to obtain the depth of burial of the contact from the graph of $(\partial\Delta T/\partial h)$ versus $(x\partial\Delta T/\partial x)$ where x is the horizontal distance measured from the contact. Similar quantitative interpretations may be made for the point pole and dipole. The data reduction necessary to produce a vertical-gradient map is much simpler than with the total-field case because no datum levelling is necessary. Since the aircraft track will be available from the main compilation it is only necessary to plot the resultant vertical-gradient values on the track map and contour. Thus, two maps will be obtained for little more than the price of one but with a greatly increased gain in geophysical information concerning the geometry of the causative bodies. Actually, a first-derivative map is difficult (and therefore costly) to produce by any other means. The measurement of the vertical gradient would appear to be the main advantage to using hundredth-gamma magnetometers in aeromagnetic surveys, since those types presently in service are sensitive enough for the effective delineation of total-field anomalies.

Hood, Peter

MINERAL EXPLORATION: TRENDS AND DEVELOPMENTS IN 1965; Can. Min. J., vol. 86, No. 2, pp. 140-150, 1965.

This article reviewed the following topics pertaining to 1964:

(1) New geophysical, geochemical, data recording, and compilation techniques.
(2) New airborne and ground instrumentation.
(3) New services offered by the survey companies.
(4) The important articles (57 references) on mineral exploration including research and case histories.
(5) An indication of the areas actively explored during the year.
(6) Anything else which appeared to be of interest to those engaged in exploration for mineral deposits.

(P.H.)

Hood, Peter and Godby, E.A.[1]

MAGNETIC PROFILE ACROSS THE GRAND BANKS AND FLEMISH CAP OFF NEWFOUNDLAND; Can. J. Earth Sci., vol. 2, pp. 85-92, 1965.

This paper describes an aeromagnetic profile from Prince Edward Island, through the Cabot Strait to the Tail of the Grand Banks of Newfoundland, and subsequently over the Flemish Cap. It is inferred that Burgeo Bank off the southwest coast of Newfoundland is possibly a granite intrusion of Devonian age. A distinct magnetic anomaly, approximately 400 gammas in amplitude, appears to be associated with the edge of the continental shelf at the Tail of the Bank. A series of sharp shallow-source magnetic anomalies was recorded over the Flemish Cap, and this feature appears to have a negatively polarized core whose long dimension is oriented in a NNW.-SSE. direction.

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[1] National Aeronautical Establishment, Nat. Res. Council, Ottawa, Canada.

Hood, Peter and McClure, D.J.

GRADIENT MEASUREMENTS IN GROUND MAGNETIC PROSPECTING; Geophysics, vol. 30, pp. 403-410, 1965.

The development of electronic magnetometers, i.e., the proton-precession and fluxgate instruments, for use in ground magnetic surveys has permitted the measurement of the first-vertical derivative of the total field, or of the vertical component of that field, with negligible addition to the total cost of the survey. The gain in information is, however, significant. Curves for the vertical gradient over a vertical contact, point pole, and finite dipole are presented. The vertical contact is outlined by the zero contour for the vertical gradient of the vertical component, and the depth of burial is half the horizontal distance between the positive and negative maxima. The depth of burial of the point pole and finite dipole is approximately equal to the horizontal distance between the negative half-maximum points on the vertical-gradient curves.

Hughes, O.L.

SURFICIAL GEOLOGY OF PART OF THE COCHRANE DISTRICT, ONTARIO, CANADA; Geol. Soc. Am., Spec. Paper 84, pp. 535-565, 1965.

The surficial deposits of Cochrane District consist mainly of three sheetlike stratigraphic units: lower till, which records regional glaciation during the Wisconsin stage, overlies Precambrian bedrock, and is overlain by mostly varved sediment of the Barlow–Ojibway Formation, which was deposited in glacial Lake Barlow–Ojibway during northward retreat of the ice margin. Till and associated glaciolacustrine sediments of the Cochrane Formation overlie the Barlow–Ojibway Formation in the northern part of the area, recording a late Wisconsin ice advance. Other deposits, of discontinuous distribution, include glaciofluvial deposits, mainly in the form of esker complexes, eolian deposits, fluviatile deposits, and organic deposits of widespread bogs.

It is inferred from radiocarbon dates from the area and from James Bay lowland that the late Wisconsin advance which deposited till of the Cochrane Formation attained its maximum advance at least 8,275 years ago.

About 900 of some 2,075 varves which comprise the varved clay unit of the Barlow–Ojibway Formation were measured. Varve diagrams prepared from the measurements agree well with diagrams made by Antevs (1925; 1928), confirming his counting and correlation of the varves. Agreement of the varve diagrams indicates that personal judgment in determining upper and lower limits of individual varves of the Barlow–Ojibway Formation does not affect seriously the measurements on which the diagrams are based.

Irvine, T.N.

CHROMIAN SPINEL AS A PETROGRAPHIC INDICATOR: PART 1. THEORY; Can. J. Earth Sci., vol. 2, pp. 648-672, 1965.

Previous investigators have shown that natural chromium-bearing spinel solid solutions adhere closely to the general formula $(Mg, Fe^{++})(Cr, Al, Fe^{+++})_2O_4$ and may therefore be graphically portrayed in a triangular prism, the length of which represents the ratio MgO/FeO, and the cross-section the relative proportions of Cr_2O_3, Al_2O_3, and Fe_2O_3. In this paper, theoretical expressions are derived whereby the prism may be "contoured" for conditions of isothermal-isobaric equilibrium according to (a) the spinel compositions that may coexist with olivine or pyroxene having specific MgO/FeO ratios; (b) the activity ratios of Cr/Al, Cr/Fe^{+++}, or Al/Fe^{+++} that obtain in the environments in which the spinel solid solutions form, and (c) the oxygen fugacities that accompany formation of spinel in systems containing olivine (forsterite–fayalite) and orthopyroxene (enstatite–ferrosilite). Rough "working" values for the thermochemical coefficients involved are estimated from limited calorimetric data and chemical analyses of spinel-olivine and spinel-orthopyroxene pairs.

Irvine, T.N.

SEDIMENTARY STRUCTURES IN IGNEOUS INTRUSIONS WITH PARTICULAR REFERENCE TO THE DUKE ISLAND ULTRAMAFIC COMPLEX; Soc. Econ. Paleontologists Mineralogists, Spec. Publ. No. 12, pp. 220-232, 1965.

Many igneous intrusions show layering formed by gravitational accumulation of crystals that is remarkably similar, both in variety and detail, to bedding in sedimentary rocks. Such layering occurs in most compositional types of intrusions but is especially common in mafic and ultramafic bodies. The examples considered specifically are from the Duke Island ultramafic complex in the Alaskan panhandle; the rocks are composed of olivine and clinopyroxene but, where layered, resemble graded-bedded turbidity current deposits.

The Duke Island complex comprises two major intrusions, and the layering which has been tilted and folded, has two ages–thus, layered blocks and fragments of olivine clinopyroxenite are included in stratified peridotite. The stratification is developed intermittently through a total section of about 2 miles thickness. Individual layers have been traced for 300 feet, and one continuously layered section is 1,500 feet thick and extends for 1,000 feet. Typical layers are 2 inches to 2 feet thick and are graded from grain sizes of 2–10 mm at their base to 0.1–1 mm at their top. The base of a graded layer is sharp; the top may coincide with the base of the next, but commonly passes into an intervening zone of thin laminae. Some layers of younger age resemble graded beds of slide conglomerate, their lower parts being largely olivine clinopyroxenite fragments. Other layering features are: loading and impact structures; scour-and-fill; local angular unconformities; streamlining over irregularities; slump structures; lateral grading; grain-size sorting similar to that in turbidite bedding; "sandstone" dikes; and "diagenetic" recrystallization.

The layering undoubtedly was formed by sedimentation from magmatic currents during extremely unstable conditions. The described phenomena illustrate that features of water-laid sediments can form in a greatly different environment in terms of the densities of the particles and transporting liquid, and the viscosity of the liquid.

Jambor, J.L., and Boyle, R.W.

MOORHOUSEITE AND APLOWITE, NEW COBALT MINERALS FROM WALTON, NOVA SCOTIA; Can. Mineralogist, vol. 8, Part 2, pp. 166-171, 1965.

Moorhouseite and aplowite are new supergene cobalt sulphate minerals from Walton, Nova Scotia. Moorhouseite, $CoSO_4.6H_2O$, is monoclinic with a = 10.0 Å, b = 7.2, c = 24.3, β = 98°22', Z = 8, S.G. 1.97 (meas.), 2.006 (calc.). X-ray spectrographic analysis gave Co:Ni:Mn:Cu: Fe:Zn = 100:45:21:9:6:1. The mineral has very small (-)2V, α = 1.470, γ = 1.496.

Aplowite, $CoSO_4.4H_2O$, is monoclinic with a = 5.94 Å, b = 13.56, c = 7.90, β = 90°30' calculated from the powder pattern; Z = 4, S.G. 2.33 (meas.), 2.359 (calc.). X-ray spectrographic analysis gave Co:Mn:Ni:Cu: Fe:Zn = 100:50:45:3:2:2. The refractive indices are 1.528 (min.), 1.536 (max.). Both aplowite and moorhouseite are pink, water-soluble, and give X-ray powder patterns identical to their synthetic equivalents.

Jambor, J.L., and Pouliot, G.

X-RAY CRYSTALLOGRAPHY OF AURICHALCITE AND HYDROZINCITE; Can. Mineralogist, vol. 8, Part 3, pp. 385-389, 1965.

Aurichalcite is orthorhombic, a = 27.2 Å, b = 6.61, c = 5.29, space group $B22_12$. The cell dimensions of hydrozincite have been confirmed and the X-ray powder pattern indexed. Anomalous diffraction spots on single crystal films of hydrozincite can be explained by twinning on (100).

(J.L.J.)

Kerr, J.W., and Christie, R.L.

TECTONIC HISTORY OF BOOTHIA UPLIFT AND CORNWALLIS FOLD BELT, ARCTIC CANADA; Bull. Am. Assoc. Petrol. Geologists, vol. 49, pp. 905-926, 1965.

The Boothia uplift is an elongate northerly extension of crystalline rocks of the Precambrian shield into the Canadian Arctic Archipelago. The structural grain of the crystalline rocks which comprise the uplift is northerly. This causes the uplift to have an over-all northerly trending elongate outline. Proterozoic to Upper Devonian sediments, which overlie and closely flank the Boothia uplift, form the Cornwallis fold belt. The structure of the Cornwallis fold belt is the result of movements of the underlying Boothia uplift, and for this reason the fold belt also has both a northerly structural

grain and outline. Together, the uplift and the fold belt extend at least 600 miles, striking diametrically across the Arctic lowlands and Franklinian miogeosyncline.

At various times since the Precambrian, the Boothia uplift has risen, lifting the Cornwallis fold belt with respect to flanking areas. Movements are dated from erosion surfaces and unconformities on the uplift and in the fold belt. In the southern part, the uplift is a simple arch, whereas in the northern, it is predominantly a horst, with a lesser amount of arching. Near-vertical faults bordering the Boothia uplift become high-angle reverse faults toward the surface, presumably the result of lateral spreading of the uplifted area. Such faulting commonly is exposed at the boundary of the uplift in the Arctic lowlands. However, in the much thicker, commonly incompetent succession of the miogeosyncline fold belt, structure is reflected as asymmetrical folding of the Cornwallis fold belt. Published model experiments with fine, dry sands, in which a horst-shaped block was uplifted, have steep reverse faults at the boundaries, and strongly resemble the northern part of the Boothia uplift.

A mobile belt encompassing the Boothia uplift and Cornwallis fold belt moved periodically, having six documented times of uplift relative to the flanking areas. These uplifts occured in (1) Precambrian, (2) pre-Middle Cambrian, (3) mid-Early Devonian, (4) late Early to early Middle Devonian, (5) mid-Late Devonian, and (6) Pennsylvanian or Early Permian times. Submergence following the mid-Early Devonian and the late Early to early Middle Devonian uplifts was the result of widespread regional submergence rather than relative depression of the mobile belt alone. The nature of the submergence which followed the other uplifts is unknown. Thus, in the geologic record, the Boothia uplift and Cornwallis fold belt have risen six times with respect to the flanking regions. However, although they were covered by sediments at various times and have narrow normal-faulted zones of down-dropped blocks, they do not appear to have sunk as a unit with respect to the flanking regions.

Kerr, J.W., McGregor, D.C., and McLaren, D.J.

AN UNCONFORMITY BETWEEN MIDDLE AND UPPER DEVONIAN ROCKS OF BATHURST ISLAND, WITH COMMENTS ON UPPER DEVONIAN FAUNAS AND MICROFLORAS OF THE PARRY ISLANDS; Bull. Can. Petrol. Geol., vol. 13, pp. 409-431, 1965.

The Griper Bay Formation is a widespread marine clastic deposit of Frasnian and Famennian ages, comprising mainly grey-green argillaceous quartz sandstones, and dark green siltstones and shales. Frasnian (early Late Devonian) fossils identified from the Griper Bay Formation include spores from Bathurst and Helena Islands, and marine invertebrates from Prince Patrick Island. Famennian (late Late Devonian) fossils from the formation include spores from Bathurst Island, and marine invertebrates from Bathurst, Cameron, Byam Martin and Melville Islands. On eastern Bathurst Island the Griper Bay Formation rests unconformably upon folded Middle Devonian and older rocks, indicating a hitherto unknown episode of deformation of the Boothia Uplift and the Cornwallis Fold Belt in Middle to Late Devonian time. The deformation was restricted to those

regions and dies out westward within the Griper Bay Formation on Bathurst Island; however, it probably provided a source for coarse pebble conglomerates in the formation on Helena Island and pebbly sandstones on Cameron and western Bathurst Islands.

Lachance, G.R.

X-RAY SPECTROGRAPHIC DETERMINATION OF POTASSIUM IN MICAS; Can. Spectr., vol. 10, No. 2, pp. 38-42, 1965.

Recent modification in X-ray spectrometric instrumentation, namely the introduction of vacuum path spectrometers and of detectors sensitive in the 3 A plus region of the X-ray spectrum, permit the determination of the lighter elements (i.e. Atomic No. 12-22). A method has been developed at the Geological Survey of Canada for the determination of potassium in micas used for the age determination of these minerals by the K/Ar method. The potassium concentration is approximately proportional to the intensity of the K alpha line of potassium after a mathematical correction is applied to compensate for the difference in absorption caused by variations in the iron content of the micas.

Larochelle, A., and Black, R.F.

THE DESIGN AND TESTING OF AN ALTERNATING-FIELD DEMAGNETIZING APPARATUS; Can. J. Earth Sci., vol. 2, pp. 684-696, 1965.

An apparatus used at the Geological Survey of Canada for magnetic cleaning purposes is described. With this apparatus viscous components of remanent magnetization were effectively removed from a group of uniformly magnetized specimens although an appreciable scattering in magnetization directions was observed after treatment at high peak field intensity. Tests were conducted to verify that the scattering was not inherent in the design of the apparatus.

Larochelle, A., Black, R.F., and Wanless, R.K.

PALAEOMAGNETISM OF THE ISACHSEN DIABASIC ROCKS; Nature, vol. 208, No. 5006, p. 179, 1965.

New whole-rock potassium/argon age determinations on two samples previously reported to be of Permian age (Larochelle and Black, Nature, vol. 198, p. 1260, 1963) have provided ages ranging from 102 to 110 m.y. and are now regarded as of Lower Cretaceous age. This new age agrees with the Cretaceous age previously determined from palaeomagnetic data, and the pole position derived from the mean palaeomagnetic direction of these rocks is considered a fairly reliable one for Lower Cretaceous time with respect to the North American Continent.

(S.E.J.)

Leech, G.B.

DISCUSSION OF "THE ROCKY MOUNTAIN TRENCH: A PROBLEM"; Can. J. Earth Sci., vol. 2, pp. 405-410, 1965.

This discussion of a paper by C.H. Crickmay (Can. J. Earth Sci., vol. 1, pp. 184-205) concerns the southernmost Canadian part of the Rocky Mountain Trench. The subjects considered are the thickness and activity of Pleistocene ice, the age and distribution of Tertiary sediments, the shape of the bedrock floor of the Trench, and the extent to which this shape reflects block-faulting and surficial processes.

Pleistocene ice in the Trench was about a mile deep and moved actively, rather than being thin and sluggish as Crickmay concluded. The unconsolidated Tertiary St. Eugene sediments owe their preservation from glacial erosion to their position in a bedrock depression transverse to the main ice movement. Their flora is Miocene, not Pliocene. The known tertiary sediments are probably only a small proportion of the total.

The bedrock floor of the Trench has pronounced relief, not only across its axis but along it, and the less consolidated cover is correspondingly varied in depth, instead of being a veneer upon a relatively flat bedrock surface. This was determined by gravity investigations (Garland and associates) and seismic investigations (Lamb and Smith) which showed that part of the bedrock floor of the Trench is well below sea-level.

Normal faults occur along the steep east edge of this part of the Trench and its floor, where exposed, is a structural continuation of the less abrupt west flank. This, together with the relief and depth of the floor, leads to the conclusion that this part of the Trench was initiated by block-faulting and is not simply an erosional valley, as Crickmay believes. Surficial processes, including much fluviatile deposition as well as erosion, modified a tectonic valley.

(G.B.L.)

Liberty, B.A.

MIDDLE ORDOVICIAN STRATIGRAPHY OF THE LAKE SIMCOE AREA, ONTARIO; Mich. Basin Geol. Soc., Guidebook, pp. 15-24, 1965.

Middle Ordovician strata are well-exposed in the Lake Simcoe area. They are typically limestone with some shale, and correlate with Black River-Trenton rocks of Michigan and western New York State. The lithostratigraphic terminology presented (Liberty, 1955; 1963; in press) is applicable throughout Central and Southwestern Ontario.

Liberty, B.A.

UPPER ORDOVICIAN STRATIGRAPHY OF THE TORONTO AREA; Mich. Basin Geol. Soc., Guidebook, pp. 43-53, 1965.

Upper Ordovician rocks in the Toronto area are typically shale with some beds of limestone and dolomite. They correlate with Edenian, Maysvillian, and Richmondian strata of Michigan and Western New York State. The lithostratigraphic subdivisions presented (Liberty, 1955, 1963, in press) are applicable throughout Central and Southwestern Ontario.

Loveridge, W.D., Wanless, R.K., Reesor, J.E., and Mursky, G.

RB/SR WHOLE ROCK AND MINERAL AGES OF THE WHITE CREEK BATHOLITH AND ASSOCIATED PRECAMBRIAN COUNTRY ROCKS OF THE KOOTENAY DISTRICT OF BRITISH COLUMBIA; (abst.), Trans. Am. Geophys. Union, vol. 46, p. 172, 1965.

Rb/Sr whole rock analyses have been carried out on material selected from the various compositional units of the White Creek batholith and the lower part of the upper unit of the adjacent Precambrian Aldridge Formation. Whole rock isochron ages have been obtained for the leucoquartz monzonite core of the batholith (110 m.y.) and the Aldridge country rock (475 m.y.), the initial Sr^{87}/Sr^{86} ratios being 0.725 and 0.729 respectively. However, the results do not define isochrons for the boundary and intermediate units of the body. Sr^{87}/Sr^{86} ratios for these rocks span the range from 0.706 to 0.714, in marked contrast to the higher initial ratio determined for the core rocks. Rb/Sr mineral ages for the batholithic rocks range from 70 to 95 m.y. compared with previously reported K/Ar ages of 18 to 82 m.y. The apparent age relationships will be discussed in terms of the chemical, mineralogical and structural relationships within the pluton.

(R.K.W.)

Lyster, H.N.C., and Bower, Margaret E.

SEMI-AUTOMATIC REDUCTION OF DATA FROM AN EXPERIMENTAL AIRBORNE MAGNETOMETER SURVEY; Nat. Res. Council Can., DME/NAE Quarterly Bull. No. 1965, vol. 2, pp. 39-46, 1965.

During April 1963 the Flight Research Section of the National Aeronautical Establishment with the assistance of the Geological Survey of Canada, and the Royal Canadian Air Force carried out an experimental airborne magnetometer survey of about 800 square miles in Southern Alberta. Semi-automatic techniques of data reduction were employed to produce an aeromagnetic map contoured at 10 gamma intervals. The primary purpose of this note is to report the methods used in reducing the data and preparing the aeromagnetic map.

(M.E.B.)

Macauley, G.,[1] Penner, D.G.,[2] Proctor, R.M., and Tisdall, W.H.[3]

CARBONIFEROUS; in Geological History of Western Canada, Alberta Soc. Petrol. Geologists, pp. 89-102, 1965.

Sediments of the Carboniferous Period are dominantly shallow-water marine deposits; biogenic carbonates dominate in the south whereas shale content increases northward to become the major lithology. The original depositional extent was probably far greater than the area of sedimentary rocks remaining today; part of the present Canadian Shield area was covered by sediments during Carboniferous deposition. Westerly thickening in the disturbed belt indicates an approach to the geosynclinal conditions postulated for the central Cordilleran area of British Columbia. Deposition appears to have been continuous throughout Mississippian into at least early Pennsylvanian time.

Carboniferous sedimentary rocks were erosionally truncated in a general northeasterly direction prior to deposition of Permian, of Triassic, of Jurassic, and of Cretaceous strata. Over 4,500 feet of Carboniferous section remains in the southern Canadian Rocky Mountains, and 5,500 feet of beds are preserved in the subsurface of the Peace River area of northern British Columbia. These deposits represent the Kinderhookian through Atokan interval. In southern Saskatchewan, over 1,900 feet of remaining sedimentary rocks represent an earliest Kinderhookian to early Chesterian interval. These thickest sequences are preserved in areas of lesser uplift, and the entire Carboniferous wedges by erosion to zero from these areas. The Carboniferous in Western Canada is apparently everywhere overlain unconformably by younger beds; consequently no complete Carboniferous sedimentary record is known. Depositional thickness variations cannot be recognized from the present distributional pattern of the total Carboniferous.

The Carboniferous is divisible into three major map-units which approximate time-stratigraphic units and reflect major phases of sedimentation. The lower map-unit is dominantly fine clastic; the middle map-unit is dominantly carbonate; and the upper map-unit is a coarse clastic sequence.

The lower map-unit, essentially Kinderhookian, comprises the Bakken-Souris Valley of Saskatchewan and the Exshaw-Banff of Alberta and northeastern British Columbia. A facies change from carbonate at the south to almost entirely shale at the north is coincident with a regional northerly depositional thickening of the map-unit.

The middle map-unit, Osagean-Meramecian in age, comprises the Mission Canyon-Charles of southern Saskatchewan, the Livingstone-Mount Head of southern Alberta, the Pekisko-Shunda-Turner Valley-Mount

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[1] Hudson's Bay Oil and Gas Co. Ltd., Calgary.

[2] Consulting geologist, Calgary.

[3] Sun Oil Co., Calgary.

Head of the south-central Alberta Plains and the Foothills, and the Pekisko-Shunda-Debolt of northern Alberta and British Columbia. Regional depositional thickness variations cannot be established as only small areas of the complete interval remain. Facies change from carbonate at the south to shale and lesser carbonate at the north. Distinct east-west lineaments can be mapped where carbonates abruptly disappear northward. Evaporites are present in the southern part of the map-area.

The upper map-unit, of Chesterian-Pennsylvanian age, is represented by a thin sliver of Big Snowy Group in Saskatchewan, by the Etherington-Tunnel Mountain-Kananaskis sequence in the southern Canadian Rocky Mountains and by the Stoddart in the Peace River area. Nowhere is an uneroded section known for this map-unit; present distribution is restricted to areas of small geographic extent. The lithology consists basically of clastics (sandstones and siltstones) with minor carbonates. Deposition may have been in a marine and/or a regressive continental environment.

MacKenzie, W.S.

UPPER DEVONIAN CARBONATES OF THE SOUTHESK CAIRN COMPLEX AND ASSOCIATED STRATA, EASTERN ROCKY MOUNTAINS FOOTHILLS, ALBERTA; Bull. Can. Petrol. Geol., vol. 13, pp. 457-481, 1965.

Upper Devonian carbonate bodies that are stratigraphically equivalent to oil-producing reefs in the Alberta subsurface outcrop in the Rocky Mountain Foothills between Mountain Park and Brazeau River. They are easily accessible and provide a valuable supplement to subsurface studies.

Late Devonian seas transgressing over a rugged Upper Cambrian erosion surface deposited argillaceous and siliceous lime muds over large areas; where the environment was favourable to organic life, bottom sediments became stabilized and carbonate bodies began to develop. Different rates of structural basin subsidence are reflected by the morphology of the carbonate bodies. For example, the Cairn Formation decreases progressively in areal extent upward, due presumably to relatively rigid subsidence, whereas the Southesk becomes more widespread in its upper horizons.

Silty beds common in the upper part of the Frasnian strata of both the carbonate and adjacent argillaceous facies are forerunners of a period of marine regression. The Frasnian Fairholme Group of formations is overlain by a disconformity with widespread evidence of erosion and nondeposition of the youngest Famennian sediment.

Marine plant and animal life played an important role in the accumulation of carbonate sediments, first, by the volumetric contribution of their calcareous skeletons to the sediment pile, and second, by stabilizing effect of their roots and the baffle action of their bodies on freshly deposited unconsolidated sediment and the water through which it settled. Dense lagoonal facies accumulated in the interior regions of carbonate deposition and these, by virtue of their association with porous marginal strata, are of value in the oil industry's continuing search for effective carbonate porosity and potentially productive beds. Porous beds no doubt occur surrounding areas of deeply buried dense lagoonal sediments immediately northeast of the

report-area. They may occur as well in association with similar and equally economically unattractive dense strata beneath the Alberta plains.

McCartney, W.D.

METALLOGENY AND GEOCHRONOLOGY, CANADIAN APPALACHIANS; (abst.), Geol. Soc. Am., Program, Ann. Meeting, Nov. 4-6, 1965, Kansas City, Missouri, pp. 102-103, 1965.

Geochronology in the Canadian Appalachians using paleontological and isotopic methods has led to relatively precise dating of Paleozoic events. Some ore deposits can be assigned absolute ages but most can be dated only with respect to their enclosing rocks. Despite this difficulty, deposits appear to conform to regional tectonic-stratigraphic patterns which are comparable to other post-Precambrian mobile belts. Syntheses of this type should aid exploration, classification, and genetic understanding of mineral deposits.

Massive, semiconcordant pyritic base-metal deposits of three types are restricted to pre-orogenic, mainly Ordovician volcanic (eugeosynclinal) host rocks, as are the ultramafic rocks containing chromite and associated nickeliferous gabbros. Gold-quartz; cassiterite-quartz and tungsten; molybdenum, beryllium, and lithium minerals as veins in sedimentary (mainly Ordovician) rocks appear for the first time associated with orogenic Devonian granitic intrusions. Post-orogenic igneous activity includes early Mississippian rhyolitic volcanism, seemingly related to one deposit that contains cassiterite, stannite, sphalerite, galena, and molybdenite. Deposits in Carboniferous sedimentary cover rocks seem to be controlled by paleogeographic and sedimentary environments. After accumulation of clastic beds, including a fossil placer gold deposit, the first post-orogenic marine limestones and overlying evaporites contain abundant combinations of barite, siderite, galena, sphalerite, fluorite, and separate manganese occurrences. The subsequent transition from marine to continental beds is a favorable site for cupriferous (red-bed) sandstones or galena-bearing sandstone; these are overlain by Pennsylvanian coal measures. Outpourings of Triassic "plateau" basalt with minor native copper terminated the orogenic cycle.

McGregor, D.C.

DEVONIAN SPORE SUCCESSION IN EASTERN GASPÉ, QUEBEC, CANADA; (abst.), Geol. Soc. Am., Program, Ann. Meeting, Nov. 4-6, 1965, Kansas City, Missouri, pp. 104-105, 1965.

Trilete spores occur through most of the thick and well-exposed section of Lower and Middle Devonian rocks of the Forillon Peninsula and Gaspé Bay, Quebec. Within this section, a major change in spore assemblage composition occurs in the Battery Point Formation.

The assemblage below this "break" (Gedinnian, Siegenian, and probably Emsian according to marine invertebrate fossils) comprises small, dominantly asaccate, radially ribbed, or finely ornamented spores, most of

which are different from any previously described. The younger assemblage (not dated by marine faunas) is characterized by larger, (?) saccate spores and spores with prominent bifurcate process, and is similar to assemblages described from the Middle Devonian (Eifelian and Givetian) of Scotland and the U.S.S.R.

Milne, J.E.S.,[1] and Howie, R.D.

DEVELOPMENTS IN EASTERN CANADA IN 1964; Bull. Am. Assoc. Petrol. Geologists, vol. 49, pp. 841-853, 1965.

In southwestern Ontario, exploration drilling decreased slightly from 93 tests in 1963 to 91 in 1964. However, development drilling reversed the declining trend of the past few years, increasing from 109 wells in 1963 to 125 in 1964. Combined exploration and development drilling not only resulted in an increase in the number of wells, but also in the average depth per well. This took place because of continued interest in the Cambrian. Offshore drilling decreased for the second consecutive year, from 35 wells in 1963 to 20 in 1964. For the first time in recent years there was no exploratory drilling on Lake Erie. Oil production in Ontario set a new record of 1,243,784 bbls., whereas gas production decreased to an estimated 14 BCF as a result of some fields being converted to gas storage.

Of the four oil and three gas discoveries in 1964, none appears to have added appreciably to the total oil and gas reserves, although further development drilling may prove the pools to be larger than indicated.

In the Hudson Bay lowlands, there are 54,773,326 acres under permit. Aeromagnetic and seismic surveys were conducted by combined Federal and Provincial governments. Industry activity appeared to be confined to evaluating the results of these surveys.

There was no development drilling in Quebec. Exploration consisted of 10 tests and 16 1/2 crew-months of field activity. No production was reported from the Pointe-du-Lac gas field during the year.

In the Maritime Provinces, there was no development drilling. One exploratory well was drilled in the Fox Harbour–Pugwash area of Nova Scotia. Oil production in New Brunswick continued to decline, but gas production for the second consecutive year showed a minor increase. Holdings on land were relatively stable; however, offshore acreage acquired to date now amounts to 69,115,823 acres, a considerable increase above 1963. Industry geophysical and geological field activity showed a slight increase from 6 to 7 months. Government and scientific institution surveys added 23 1/2 party-months to total activity.

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[1] Imperial Oil Limited

Milne, J.,[1] and Howie, R.

EASTERN CANADIAN EXPLORATION ACTIVITIES-EXPLORATION DRILLING DOWN AND DEVELOPMENT UP FOR 1964; Can. Petro Engineering, vol. 6, No. 3, pp. 29-30, 1965.

In southwestern Ontario, exploration drilling showed a slight decrease from 93 tests in 1963 to 91 in 1964. However, development drilling reversed the declining trend of the past few years to show an increase from 109 wells in 1963 to 125 in 1964. Combined exploration and development drilling not only increased in the number of wells, but also the average depth per well as a result of continued interest in the Cambrian. Offshore drilling decreased for the second consecutive year from 35 wells in 1963 to 20 in 1964. For the first time in recent years there was no exploratory drilling on Lake Erie. Oil production in Ontario set a new record of 1,243,784 bbls., whereas gas production decreased to an estimated 14 B.C.F. as a result of some fields being converted to gas storage.

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[1] Imperial Oil Limited.

Nassichuk, W.W., and Furnish, W.M.

CHRISTIOCERAS, A NEW PENNSYLVANIAN AMMONOID FROM THE CANADIAN ARCTIC; J. Paleontol. vol. 39, pp. 724-728, 1965.

Pennsylvanian ammonoids are now known from several localities on Melville, Axel Heiberg and Ellesmere Islands. They are particularly

abundant in small isolated carbonate bioherms in an unnamed formation in the vicinity of Hare Fiord, Ellesmere Island. From one of these bioherms at Hare Fiord, 13 ammonoid genera including the new Christioceras were recovered. Many species are remarkably similar to index species known from the Atokan Winslow Formation of Arkansas or are in a comparable stage of evolution. The suture of Christioceras is unique and moderately complex for Carboniferous ammonoids. The rapid modification of conch form and sutural development during ontogeny suggest that the subfamily Christioceratinae, is a hastily evolving stock of the Schistoceratidae.

(W.W.N.)

Norford, B.S.

ORDOVICIAN AND SILURIAN STRATIGRAPHY OF THE SOUTHERN ROCKY MOUNTAINS OF CANADA; (abst.) Geol. Soc. Am., Program, Ann. Meeting Nov. 4-6, 1965, Kansas City, Missouri, pp. 115-116, 1965.

Stratigraphic nomenclature is revised for Middle Ordovician, Upper Ordovician, and Silurian rocks of the southern Rocky Mountains of Canada. Lower Ordovician stratigraphy is briefly reviewed. The names Glenogle shales, Mount Wilson quartzite, and Skoki formation are retained. Coverage of the Beaverfoot formation is restricted to carbonate rocks and includes both Upper Ordovician and Lower Silurian strata. The terms Wonah quartzite and Brisco formation are considered obsolete. Four new rock units are proposed.

The common lithotopes suggest platform carbonates fringing the Canadian Shield in Late Ordovician and Early Silurian time and covering the whole of the southern Rocky Mountains. The eastern part of the mountains was the site of similar deposits in Middle Ordovician time, but miogeosynclinal shales and limestones accumulated farther southwest. The locus of facies change trends northwest and lies just west of the British Columbia-Alberta boundary.

Middle and Upper Silurian rocks are absent from the southern Rockies, and the basal Devonian rocks rest unconformably on Precambrian to Lower Silurian strata.

Faunal studies allow recognition of four brachiopod-coral-trilobite zones within the Beaverfoot formation and a conodont zone in the basal Beaverfoot and the uppermost Mount Wilson. Three brachiopod zones are present within the Skoki formation. Of these, the Anomalorthis and Orthidiella zones correlate with Whiterock zones in the Antelope Valley limestone of Nevada. A new brachiopod zone can be recognized near the base of the Skoki and is considered uppermost Canadian and may be in part equivalent to the Pseudocybele trilobite zone of Utah and Nevada.

Norford, B.S.

ORDOVICIAN-SILURIAN, PART II, CORDILLERA; in Geological History of Western Canada; Alberta Soc. Petrol. Geologists, pp. 42-48, 1965.

A geosyncline probably trended northwest in the Cordillera in Ordovician and Silurian time. Thick sequences of rocks are present in interior British Columbia and probably include Ordovician and Silurian strata, but most of these rocks are now metamorphosed and very little evidence of age is preserved.

Shelf carbonates dominate the Middle and Upper Ordovician and the Silurian of the Rocky Mountains, but the Lower Ordovician consists of limestones, argillaceous limestones, and shales that suggest somewhat deeper water. A similar facies persists at higher horizons in parts of the westernmost Rocky Mountains and in the northeast Cassiar Mountains. Graptolitic rocks are locally developed. Rocks deposited northeast of the belt of shelf carbonates have been largely removed by subsequent erosion, but the few remnants suggest shallow water deposition for much of this area, with at times restricted circulation.

The sub-Devonian unconformity is a major stratigraphic feature in the Rocky Mountains, and the local Ordovician and Silurian sequences reflect the depths to which erosion cut. Regional unconformities may also be present beneath the Upper Ordovician, and within the Lower Silurian.

Roscoe, S.M.

GEOCHEMICAL AND ISOTOPIC STUDIES, NORANDA & MATAGAMI AREAS; Bull. Can. Inst. Min. Metallurgy, vol. 58, No. 641, pp. 965-971, 1965.

Relationships of Noranda sulphide deposits to volcanic rocks are reviewed and chemical variations within the volcanic sequence are described. The assemblages of minor elements in the pyrites and pyrrhotites of the Noranda and Matagami deposits are similar and are characterized by a high content of cobalt, tin and other elements. Isotopic compositions of lead, other geochronological data and stratigraphically disposed zonal distributions of sulphides and minor elements indicate that the deposits were formed prior to folding and metamorphism. Lead isotope data indicate that the Matagami deposits, and several others, were probably formed about 2.95×10^9 years ago and that the Noranda deposits may be about 50 million years younger. The volcanic sequence at Noranda is younger than the thick sequences bordering it on the east and on the west. The relationships are consistent with the hypothesis that these strata-bound sulphide deposits are coeval with their associated volcanic rocks.

Rose, Edward R.

PYRITE NODULES OF THE TIMAGAMI COPPER-NICKEL DEPOSIT; Can. Mineralogist, vol. 8, Part 3, pp. 317-324, 1965.

Porous nodules composed essentially of cellular pyrite, noted by company geologists and collected by the writer from the chalcopyrite ore exposed in the open pit of the Temagami Mining Co. Limited on Timagami Island, are described. The nodules appear to occupy relatively smooth-walled cavities within massive chalcopyrite, from which they may be readily separated and removed in places almost intact. Platy ribs and seams of pyrite extend from the nodules into the enclosing mosaic of chalcopyrite crystals, within which they assume a delicate rhombohedral pattern, formed by an intersecting network of chains of minute pyrite cubes. The textural relationships described and illustrated suggest that the nodules may have been formed by recrystallization of pyrite-carbonate-silicate material that was engulfed by fluid magmatic chalcopyrite ore.

Ross, John V.,[1] and McGlynn, John C.

SNARE-YELLOWKNIFE RELATIONS, DISTRICT OF MACKENZIE, N.W.T., CANADA; Can. J. Earth Sci., vol. 2, pp. 118-130, 1965.

Within the District of Mackenzie, N.W.T., Canada, Snare Group rocks unconformably overlie Yellowknife Group; both groups of rocks are Precambrian in age. Snare deformation has modified the already deformed Yellowknife rocks and examples are given of Yellowknife "basement" response to the varying styles of Snare "cover" deformation.

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[1] University of British Columbia.

Rutter, Nathaniel W.

FOLIATION PATTERN OF GULKANA GLACIER, ALASKA RANGE, ALASKA; J. Glaciol., vol. 5, No. 41, pp. 711-718, 1965.

Gulkana Glacier, consisting of three major ice streams and two prominent ice falls, displays a complex foliation pattern. In the western ice stream, below Gabriel Ice Fall, the foliation is transverse, developing gradually down-glacier into a distinct series of nested arcs. The arcs are concave up-glacier with the foliation dipping steeply toward the inside of the arc. A similar pattern is displayed in the eastern ice stream but there the pattern is less distinct with the arcs evolving into a series of nested semi-arcs. The central ice stream is characterized by vertical layers of foliation with a longitudinal strike. Apparently, longitudinal foliation will form in areas with strong compression and shear caused by differential flow velocity such as where two ice streams unite. The foliation that ultimately displays

arcuate (or semi-arcuate) patterns originates principally at the base of an ice fall where strong longitudinal compression is present due to the decrease of gradient.

Rutter, Nathaniel W.

A LATE PLEISTOCENE? GLACIAL ADVANCE, BOW RIVER VALLEY, CANADIAN ROCKY MOUNTAINS, ALBERTA, CANADA; Intern. Assoc. Quat. Res. (INQUA), VII Intern. Congress, General Sessions, Abstracts, p. 405, 1965.

In the Bow River Valley, in the vicinity of Banff National Park, Canada, evidence indicates a relatively recent glacial advance, probably the last "significant" glacial event in the area.

The ice originated at the head of the Bow River Valley (elevation: ±2000 meters) and flowed for approximately 65 kilometers, as far as Eisenhower Junction (elevation: ±1400 meters). Cirques developed at a minimum elevation of about 1800 meters and supplied ice to tributary valleys, which in turn contributed ice to the main glacier when conditions permitted. The ice in the Bow River Valley near Eisenhower Junction reached a maximum thickness of approximately 450 meters.

Evidence for the advance includes end moraines consisting mainly of kame deposits, till deposits in the form of lateral and ground moraines, cirques, and glacial scouring on pre-existing glacial surfaces. Conclusions regarding the relative age and the youthfulness of this advance are based on the position and freshness of the end and lateral moraines, the drift sequence, the glacial scouring on older glacial surfaces, the development of the post-glacial Bow River, and the development of alluvial fans at the bases of the Bow River Valley walls. A maximum absolute age may be assigned to this advance after radiocarbon material collected for dating an older advance has been analyzed.

Airphoto interpretation and ground reconnaissance work indicate that this glacial event probably was not local, but extended throughout the main ranges of the Canadian Rocky Mountains from at least Jasper National Park to Crow's Nest Pass.

Sander, G.W.,[1] and Overton, A.

DEEP SEISMIC REFRACTION INVESTIGATION IN THE CANADIAN ARCTIC ARCHIPELAGO; Geophysics, vol. 30, pp. 87-96, 1965.

During 1962 and 1963, the Dominion Observatory conducted refraction seismic surveys in the islands north of the Canadian mainland. These surveys are part of a project of the Government of Canada to explore the Polar Continental Shelf. The operation consisted of three stationary

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[1] Polar Continental Shelf Project, Department of Mines and Technical Surveys, Ottawa.

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recording units and a shooting party which traversed the frozen sea in a tractor train. Three refraction-seismic profiles form a continuous section from the Canadian Shield through the Franklinian Geosyncline and the Sverdrup Basin to the Arctic Ocean. Post Devonian sediments in the Sverdrup Basin were found to be 10 km thick. The lower, basic portion of the crust is indicated by a velocity of 7.3 km/sec at a depth of 24 km and the base of the crust at 38 km.

Sangster, D.F.

COLLOFORM MAGNETITE IN A CONTACT METASOMATIC IRON DEPOSIT (Discussion of Paper by Stevenson and Jeffrey, 1964); Econ. Geol., vol. 60, pp. 824-826, 1965.

The assumption of Stevenson and Jeffrey (1964) that the colloform magnetite in the Merry Widow and Kingfisher deposits on Vancouver Island, B.C., was formed contemporaneously with the associated high-temperature skarn minerals is disputed. Evidence from these two deposits and three others in western British Columbia is presented to show that the magnetite could have been deposited later, presumably at lower temperatures as a primary mineral in a zone of brecciated non-colloform magnetite.

(S.E.J.)

Schiller, E.A., and Taylor, F.C.

SPESSARTITE-QUARTZ ROCKS (COTICULES) FROM NOVA SCOTIA; Am. Mineralogist, vol. 50, pp. 1477-1481, 1965.

Beds, lenses and nodules, composed chiefly of spessartite and quartz (coticules), occur at several widely separated localities in the non-carbonaceous parts of the Halifax Formation. They are present chiefly in rocks that have undergone regional metamorphism of greenschist grade but are also present, near granite plutons, with assemblages characteristic of the hornblende hornfels facies.

Chemical analysis of the garnet shows molecular per cent of end members: almandine 21.4, andradite 6.1, pyrope 4.7, spessartite 65.6, grossularite 2.2. RI = 1.805 $\pm$.005 and the cell edge is 11.613 Å. Trace elements present are V, Co, Cr, Cu and Sr.

Nova Scotia coticules are of sedimentary origin and are probably derived from chemically precipitated silica and manganese and small amounts of detrital clay particles. They are the product of greenschist regional metamorphism but are stable also into the hornblende hornfels facies range of contact metamorphism. The existence of a trace element assemblage characteristic of metasedimentary spessartite was not confirmed.

(F.C.T.)

Schmidt, Herta,[1] and McLaren, D.J.

PALEOZOIC RHYNCHONELLACEA; in Treatise on Intertebrate Paleontology, Part H, Brachiopoda, Geol. Soc. Am., pp. H552-H597, 1965.

Separation of Paleozoic from Mesozoic and Tertiary rhynchonellaceans is an arbitrary and artificial arrangement which for the present may be justified by the fact that the two groups have been studied from different points of view and seldom by the same workers. An additional factor is the scarcity of Lower and Middle Triassic rhynchonelloids. Paleozoic rhynchonellaceans currently are being subjected to a proliferation of genera, and there is no reason to suppose that this has ended. Recognition of the importance of detailed study of internal structures by means of a variety of techniques has resulted in the realization of the great complexity and abundance of forms in the superfamily, and this has not yet been fully exploited taxonomically.

Our present state of knowledge makes classification extremely difficult. Of 134 Paleozoic rhynchonellaceans here recognized (excluding homonyms and synonyms), 87 are definitely placed in 19 families or subfamilies and 47 are classed questionably in these groups or segregated as "Family Uncertain". Some of the family-group taxa are significant assemblages of related genera, whereas others merely represent a convenient, and presumably temporary, pigeonholing of morphologically similar forms. Difficulties in classification may arise from the methods used to examine interiors. Thus, while the study of internal structure by means of serial grinding techniques gives accurate information on interiors, it may nevertheless be difficult to interpret in terms of a shell interior examined in a different manner. Silicified specimens, internal molds, and prepared interiors differ in appearance and are not always easy to interpret in mutually intelligible terms.

There is still little agreement on the morphological features of most value in defining genera and higher taxa. Different features are stressed by different workers and synonyms will certainly be discovered when some existing genera are more fully known. Nevertheless, ultimate recognition of accurately defined genera holds promise of rigorous stratigraphic refinement. Features of external morphology used in grouping genera into families include: degree and type of ornament, shape of shell, beak and beak ridges, interarea, shape of fold and sulcus, form of commissure, and presence of marginal spines. Muscle impressions appear significant features in the interior of the pedicle valve and, in the brachial valve, all details of the cardinalia, shape and degree of development of hinge plates, septalium, median septum, and cardinal process are important characters.

In contrast to Mesozoic and Tertiary Rhynchonellacea, the form of the crura as yet has had little influence on classification of Paleozoic genera. In many genera the crura are unknown, although serial grinding often allows accurate observation of extremely delicate features. As far as now known, it seems that morphology of the crura is not as valuable in classification in Paleozoic rhynchonellaceans as in later forms.

(D.J.McL.)

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[1] Senckenbergische Naturforschende Gesellschaft, Frankfurt, Germany.

Sinclair, G. Winston

SOME MIDDLE ORDOVICIAN FOSSILS FROM CENTRAL ONTARIO; Mich. Basin Geol. Soc., Guidebook, pp. 37-42, 1965.

Some diagnostic fossils of Middle Ordovician age (Wilderness and Trentonian Stages) from Central Ontario are illustrated.

Sinclair, G. Winston

MEMORIAL TO ALICE EVELYN WILSON, 1881-1964; Proc. Geol. Assoc. Can., vol. 16, pp. 127-128, 1965.

Dr. Wilson, one of Canada's most respected geologists and palaeontologists, spent most of her life with the Geological Survey of Canada, mapping in detail the geology of Eastern Ontario and describing most of the lower Palaeozoic fossils found there. Her studies of Ordovician fossils also involved her with materials from as far afield as Baffinland and the Rocky Mountains. An enthusiastic person at all times, she had a devoted following of persons with whom she enjoyed sharing her knowledge and experiences, particularly among the young.

(S.E.J.)

Stalker, A. MacS.

PLEISTOCENE ICE SURFACE, CYPRESS HILLS AREA; Alberta Soc. Petrol. Geologists, 15th Ann. Field Conference Guidbook, Part 1, Cypress Hills Plateau, pp. 116-130, 1965.

During the period of maximum ice thickness, the surface of the strongest Pleistocene glacier that covered southern Alberta and southwestern Saskatchewan sloped downward to the south-southeast at a rate of about 13 feet to a mile. At this time, direction of the ice flow was in the same direction, or roughly parallel to the front of the Rocky Mountains to the west and the high land of Hudson Bay Divide to the south. The surface of the last major Wisconsin ice-sheet, at greatest extent and maximum thickness of this glacier, also sloped downward to the south-southeast, though at a significantly lower rate. The ice flowed in a similar direction. The flow-patterns changed markedly as the glaciers retreated and their surfaces lowered, however, and southwestward movement became predominant during latter stages of ice withdrawal from the prairies. The strongest Pleistocene glacier, at its maximum, had a general thickness of 1,500 to 2,500 feet in the region. The last major Wisconsin glacier, at its maximum, had a general thickness of 1,000 to 2,000 feet.

Stockwell, C.H.

STRUCTURAL TRENDS IN CANADIAN SHIELD; Bull. Am. Assoc. Petrol. Geologists; vol. 49, pp. 887-893, 1965.

A description of structures in the exposed Precambrian rocks of the Canadian shield may be of some assistance in understanding the basement structures beneath the surrounding Phanerozoic cover. The shield is divided

into a number of structural provinces and corresponding orogens. These differ from one another in age and, in each of the regions, structural trends are described in relation to the orogeny or orogenies responsible for their development. As a rule, the trends are so complex and intricate that they cannot be projected for useful distances beneath the surrounding cover. Locally, Precambrian fault scarps projected from the shield had an influence on depositional features in the overlying rocks. The orogens themselves form structural units of large size and, especially along their contacts with one another, possibly had some influence in controlling epeirogenic movements producing basins and "highs" in the cover.

Strimple, H.L.,[1] and Nassichuk, W.W.

CORRELATION NOTES ON THE UPPER WAPANUCKA LIMESTONE OF SOUTHEASTERN OKLAHOMA; Oklahoma Geol. Notes, vol. 25, No. 11, pp. 287-294, 1965.

The Wapanucka Limestone, which underlies the Atoka Formation and overlies the Caney Shale in Southeastern Oklahoma is discussed in terms of correlation and general historical development.

The discovery of the significantly restricted ammonoid, Axinolobus quinni McCaleb & Furnish in the upper Wapanucka Limestone allows a definitive correlation with typical Morrowan strata of Arkansas.

Axinolobus quinni is dealt with taxonomically and it is now known that the early volutions of this taxon are triangularly coiled. Among the Schistoceratidae then, only the Christioceratinae, represented by Christioceras Nassichuk & Furnish, lack triangular coils during all stages of development.

(W.W.N.)

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[1] University of Iowa.

Terasmae, J.

A REVIEW OF PALYNOLOGICAL STUDIES IN EASTERN MARITIME CANADA; Marine Sediments, vol. 1, No. 2, pp. 19-21, 1965.

The earliest palynological material on eastern Maritime Canada was published in 1930. Since then another eleven papers have appeared, pertaining to investigations in parts of eastern Quebec, Prince Edward Island, Nova Scotia and Cape Breton Island, Newfoundland, and Labrador. Currently palynological reports are being prepared for publication on deposits along the St. John River in New Brunswick, Cape Breton Island, Nova Scotia mainland, and Gaspé.

(S.E.J.)

Terasmae, J.

POSTGLACIAL CHRONOLOGY AND FOREST HISTORY IN THE NORTHERN LAKE HURON AND SUPERIOR REGION; Intern. Assoc. Quat. Res. (INQUA), VII Intern. Congress, General Sessions, Abstracts, p. 463, 1965.

Geochronological studies have indicated that the region immediately north of Lake Huron and Lake Superior was covered by the continental ice-sheet during the Valders substage. The following deglaciation some 10,000 years ago was accompanied by a complex sequence of ice-dammed lakes with rapidly changing levels, extents, and outlets. High shorelines north of Sault Ste. Marie at about 1,025 feet elevation indicate that Glacial Lake Algonquin extended into Lake Superior basin. The assumed Nipissing shoreline at Little Pic River, west of White River, Ontario, has been dated at about 5,900 years B.P. It is suggested that Glacial Lake Agassiz, west of Lake Superior, was in part contemporaneous with Glacial Lake Algonquin.

Species of arctic plants migrated into this region and reached the headwaters of rivers flowing north and northeast more than 9,000 years ago. The region was already occupied by boreal-forest vegetation some 9,000 years ago, and the arctic species were crowded out except in localities with rather unique ecological conditions, such as the rugged shore bluffs of Lake Superior, where they have survived to the present.

Some boreal species probably ranged north of their present distribution limits during the hypsithermal interval, which was followed by considerable areal expansion of muskeg. Forest fires have been a significant ecological factor in most of this region throughout postglacial time, as indicated in the Red Lake area by consistently high percentages of jack pine (Pinus banksiana) and birch (Betula) pollen.

Terasmae, J.

PROBLEMS OF QUATERNARY PALYNOLOGY IN THE CANADIAN ARCTIC; Intern. Assoc. Quat. Res. (INQUA), VII Intern. Congress, General Sessions, Abstracts, p. 464, 1965.

The basic differences of the geological, geographical, botanical and climatological aspects of the Canadian Arctic region and those of arctic U.S.S.R., Alaska and Scandinavia have to be clearly recognized within the general framework of reference in palynological investigations. Palynological studies made of Quaternary deposits in the Canadian Arctic have revealed numerous problems rather different in kind or magnitude from those commonly encountered in southern Canada. Pollen and spores are generally much less numerous per unit volume of sediment and often poorly preserved (with some exceptions), owing to low vegetation density and paucity of species with high pollen production in the arctic region. Difficulties of specific identification of pollen within such large families of plants as grasses, sedges and others are serious limitations particularly in arctic palynology. The rather large range of physiological tolerance to various ecological conditions of most arctic species further complicates paleoclimatological studies based on palynological data. The predominantly inorganic nature of sediments introduces other sources of error in the form of redeposited pollen.

Long-distance transport of pollen by wind is one of the important recognized sources of error in pollen analysis. The permafrost regime and its relationships to vegetation and sedimentology make paleo-ecological interpretations difficult, and complicate coring and sampling of sediments. Strong surface winds and adverse climatic conditions generally, coupled with large yearly and seasonal variations of climate, affect both pollen production and dispersal.

In spite of all these unfavourable and complicating factors, it has been possible to gather sufficient palynological evidence to cover most of the postglacial time in the arctic and to show the presence of past climatic changes, and furthermore, that such changes have been essentially contemporaneous with those farther south.

Although palynological studies have proved to be a useful tool in paleoecology and Quaternary chronology in the Canadian Arctic the use of supporting plant macrofossil studies is much more important in the arctic than in more southerly regions.

Terasmae, J., and Mott, R.J.

MODERN POLLEN DEPOSITION IN THE NICHICUN LAKE AREA, QUEBEC; Can. J. Botany, vol. 43, pp. 393-404, 1965.

Modern pollen content has been examined in 10 surface samples from the Nichicun Lake area, southwest of Schefferville, Quebec, and from three other localities in the same region. The pollen assemblages obtained reflect with fair reliability the regional characteristics of the northern boreal forest. Long-distance wind transport over several hundred miles is indicated by the presence of occasional ragweed and hardwood pollen grains from south of the boreal forest region. A morphological study of the black spruce pollen found indicates a rather wide range of variability, greater than that found in the pollen of black spruce south of this region.

Tozer, E.T.

UPPER TRIASSIC AMMONOID ZONES OF THE PEACE RIVER FOOTHILLS, BRITISH COLUMBIA, AND THEIR BEARING ON THE CLASSIFICATION OF THE NORIAN STAGE; Can. J. Earth Sci., vol. 2, pp. 216-226, 1965.

The Triassic section at Pardonet Hill, Peace River, British Columbia, has been studied in detail, resulting in a new interpretation of the structure and of the rock and faunal sequence. This work necessitates revision of the sequence of Upper Triassic ammonoid zones and some changes in the age assignments. The following sequence of Upper Triassic ammonoid beds and zones is now recognized in the Peace River Valley: (1) Discotropites; (2) Anatropites; (3) Mojsisovicsites kerri; (4) Malayites dawsoni; (5) Juvavites magnus; (6) Drepanites rutherfordi; (7) Himavatites columbianus; (8) Monotis subcircularis (Bivalve Zone); (9) Rhabdoceras suessi. Faunas 1 and 2 are Upper Karnian; 3 and 4 are classed as Lower Norian; 5, 6, and 7 as Middle Norian; 8 and 9 as Upper Norian. The Peace River succession suggests that the generally accepted standard for the Norian Stage, established in Austria, may be incorrect. In particular, the Austrian zones of

Cladiscites ruber and Sagenites giebeli are probably younger than the Cyrtopleurites bicrenatus Zone, not older, as formerly believed.

Trettin, H.P.

MIDDLE ORDOVICIAN TO MIDDLE SILURIAN CARBONATE CYCLE, BRODEUR PENINSULA, NORTHWESTERN BAFFIN ISLAND; Bull. Can. Petrol. Geol., vol. 13, pp. 155-180, 1965.

Three genetic assemblages of rock types are distinguished in the Middle Ordovician to Middle Silurian Brodeur Group of northwestern Baffin Island, which represent a protected shelf and shore environment with low supply of clastic sediments, and a hot climate: 1) Richly to predominantly sparsely fossiliferous cryptocrystalline limestone. 2) Thinly interstratified microcrystalline limestone and dolomite. The dolomite formed by replacement at the sediment-sea water contact, and the limestone by recrystallization of probably inorganically precipitated calcium carbonate. Recrystallization is more advanced than in 1), probably because of a lower content of carbonaceous impurities. 3) Strata of assemblage 2) brecciated and deformed by early solution of thinly interstratified evaporites with associated stromatolitic beds. The three assemblages, listed in the order of increasingly evaporitic conditions of origin, are all partly replaced by dolomite which formed in the subsurface, and contain some clastic impurities.

The lower 460 feet of the composite reference section (upper Middle Ordovician) is composed mainly of 2); the overlying 1,140 feet [upper Middle or lower Upper Ordovician to lower (?) Niagaran] mainly of 1); and the upper 1,340 feet [Niagaran and (?) younger] of numerous successions of 1), 2), and 3) with the latter two comprising more than two thirds of the unit. This sequence represents a transgressive-regressive cycle with the deepest submergence mainly in the Late Ordovician and Early Silurian. The Late Ordovician submergence followed a weak uplift in the middle part of the Middle Ordovician, and corresponds to the widest known Palaeozic advance of the Arctic seas. The cycle was probably terminated by positive movements which on adjacent Somerset Island culminated in the Early Devonian.

Webber, P.J.,[1] Terasmae, J., and Andrews, J.T.[2]

A STUDY OF LATE-QUATERNARY PLANT BEARING BEDS IN NORTH-CENTRAL BAFFIN ISLAND, CANADA; Intern. Assoc. Quat. Res., VII Intern. Congress, General Sessions, Abstracts, p. 496, 1965.

Geological, palynological, paleobotanical and sedimentological studies of the alluvial, plant bearing beds along the Isortoq River and at Flitaway Lake, near the northern end of Barnes Ice Cap on Baffin Island, have indicated that these beds are interglacial rather than interstadial in age.

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[1] Queen's University.

[2] Geographical Branch, Department of Mines and Technical Surveys.

The plant bearing sediments were folded by overriding ice from the east, and it is assumed that the deposits were not frozen at that time. C-14 dating indicates an age of more than 38,000 and 40,000 years for the folded Isortoq River sediments. Palynological and paleobotanical evidence indicates that the climate during this depositional episode was more favourable than the present; for example, birch (Betula) was growing in the Isortoq valley, whereas it now occurs only in the most protected and favourable localities in the southernmost Baffin Island, some 600 to 1000 km to the southward. The folding of the beds indicates that ice accumulation at the beginning of the glaciation occurred on the eastern interior plateau of Baffin Island, and the centre of ice dispersal later shifted westward to lie over the Foxe Basin as indicated by geomorphological evidence.

Williams, Gordon D.,[1] and Burk, C.F., Jr.

UPPER CRETACEOUS; in Geological History of Western Canada; Alberta Soc. Petrol. Geologists, pp. 169-189, 1965.

Upper Cretaceous rocks lie at the surface or beneath glacial drift over two-thirds to three-quarters of the western Canada sedimentary basin.

In the Plains and Foothills, a conformable sequence of marine and non-marine shale and sandstone deposited in and around a shallow interior sea represents all European stages from Cenomanian to Maestrichtian. Complete sections are preserved only where Tertiary deposits form a cover, as along the axis of the Alberta syncline, in the Swan Hills of Alberta, in the Cypress Hills of Alberta and Saskatchewan, in the Wood Mountain–Missouri Coteau region of Saskatchewan and in the Turtle Mountains of Manitoba. The rocks are mainly marine shale at the base and become sandy and continental upwards. Superimposed upon the vertical facies change is a lateral gradation from predominantly marine shale in the eastern Plains to marine and continental sandstone in the western Plains and Foothills. Facies variations indicate that coarse detritus was derived from a western source which was being strongly uplifted as the epoch drew to a close.

In the interior system of the Cordillera, a succession of coarse continental clastics and volcanic rocks was deposited in intermontane basins during much of Late Cretaceous time. Lower Cretaceous and Tertiary deposits are often included with Upper Cretaceous strata because of imprecise palaeontological dating and complex field relationships.

In the western system of the Cordillera thick marine and continental deposits were laid down during the latter half of the epoch, apparently by a "Pacific" sea which transgressed the western continental edge.

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[1] University of Alberta.

The Cordillera west of the Rocky Mountain Trench, in addition to providing sites for continental deposition, were probably the source terrain for coarse clastics which were deposited along the western margin of the interior sea.

Laramide structural tendencies may have originated as early as Turonian time, but the climax of the Laramide orogenic episode apparently took place in post-Cretaceous time.

Wright, G.M.

GEOLOGICAL SURVEY CONDUCTS CANADA-WIDE INVESTIGATIONS; Northern Miner, Ann. Rev. Number, Nov. 25, p. 79, 1965.

The 1965 field program of the Geological Survey of Canada included 112 full-season projects, many short-term studies, and six aeromagnetic surveys by contract. The 112 parties were distributed physiographically as follows: Arctic Islands (8); Cordillera (38); Western Plains (12); Precambrian Shield (32); Appalachia (17); and general (5). By function they consisted of the following: systematic reconnaissance and detailed bedrock studies (38); special bedrock problems (7); palaeontology (8); mineral deposits (13); glacial geology (16); engineering geology (2); groundwater (7); geochemistry (4); mineralogy and petrology (5); geophysics (8); and special studies (4). Some 70 graduate and 140 student assistants were employed to aid the Survey officers in carrying out this Canada-wide geological program. These field investigations are greatly assisted by the Survey's extensive laboratory service and research work. Together the Survey's field and laboratory activities make a solid contribution to both the mineral industry and the scientific community.

(S.E.J.)

Wright, G.M., and Duffell, S.

FEDERAL SURVEY STEPS UP PACE IN NORTHERN CANADIAN SHIELD; Northern Miner, Ann. Rev. Number, Nov. 25, pp. 45, 52, 1965.

Tremendous advances in geological knowledge have resulted from Geological Survey activities in the Canadian Shield north of latitude 52° since 1952. Use of light aircraft and helicopters for geological surveying has been the most important technical factor in aiding these advances. Since 1952 seven helicopter-supported operations have studied some 400,000 square miles of previously unmapped terrain north of latitude 60° west of Hudson Bay, and some 300,000 square miles in northern Quebec and Baffin Island. It is expected that future studies in these areas will be directed at detailed studies of small areas or of geological problems of regional significance. Such programs currently being undertaken include: (1) a study of the relationship of known mineral deposits to structures in the Yellowknife Group around Great Slave Lake;(2) stratigraphic and structural studies of the Goulbourn, Epworth, and Dubawnt Groups, which cover large areas north and northeast of Yellowknife;(3) investigation of the major geological boundary (front) between the Superior and Churchill tectonic provinces in central Manitoba

and the possible relationship of mineral deposits to such fronts; (4) detailed investigations of the recently discovered high-grade iron deposits in northern Baffin Island; (5) detailed studies of the extensive anorthositic bodies in the eastern Canadian Shield; (6) studies of the extent, ages, remnant magnetism, composition, and tectonic significance of diabase dyke swarms in the Canadian Shield; (7) investigation of the regional distribution of elements within the Canadian Shield, as a contribution to our understanding of the development of the earth's crust; and (8) studies of the ages and tectonic style of the recently recognized structural provinces within the Canadian Shield.

(S.E.J.)

AUTHOR INDEX