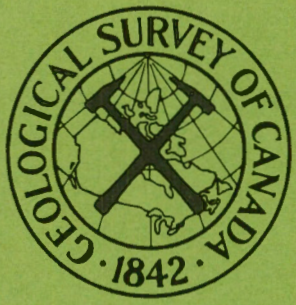

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 68-4

ABSTRACTS OF PUBLICATIONS IN SCIENTIFIC JOURNALS BY OFFICERS OF THE GEOLOGICAL SURVEY OF CANADA APRIL 1967 to MARCH 1968

Compiled by Dervorguilla Snowden

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ABSTRACTS OF PUBLICATIONS IN SCIENTIFIC JOURNALS BY OFFICERS OF THE GEOLOGICAL SURVEY OF CANADA, APRIL 1967 TO MARCH 1968

This report contains abstracts of 106 papers published by officers of the Geological Survey of Canada in scientific journals and books during the period 1 April, 1967 to 31 March, 1968. Most of these papers included abstracts, and these have been copied from the published texts; abstracts for the others were prepared by the authors concerned. The abstracts of the papers are arranged alphabetically according to the author.

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 68-3) comprise the total published output of the Geological Survey during this period.

Abbey, S.

'CAVEAT VENDOR' OR THE SCEPTICAL CHYMIST TALKS BACK; Chem. Can., vol. 19, No. 5, pp. 33-34, 1967.

Critical comment on the design, manufacture and distribution of laboratory supplies.

(S.A.)

Abbey, S.

THE DETERMINATION OF FELDSPARS BY FLAME PHOTOMETRY; Mineral. Mag., vol. 36, No. 277, pp. 143-144, 1967.

Draws readers' attention to a simpler solution to a problem described in an earlier paper in this journal.

(S.A.)

Agterberg, F.P.

APPLICATION OF TREND ANALYSIS IN THE EVALUATION OF THE WHALESBACK MINE, NEWFOUNDLAND; Can. Mining Met. Bull., vol. 60, p. 883, 1967.

This paper presents an application of methods of mathematical statistics using assay records from the Whalesback copper ore deposit near

Springdale, Newfoundland. The techniques of serial correlation and spectra analysis are applied to a series of copper concentration values. The nature of the small-scale fluctuations in ore concentration can be described by thes methods. The linear model of statistical theory is used for the evaluation of systematic patterns of the three-dimensional variation (trends) in the mining assays. The trends are established by the elimination of the effect of the sampling error and the more systematic small-scale fluctuations.

Agterberg, F.P.

COMPUTER TECHNIQUES IN GEOLOGY; Earth Sci. Rev., vol. 3, pp. 47-77, 1967.

The objectives of this paper are:

(1) A brief discussion of where and how computer techniques which are based on mathematical models can be used in geology.

(2) A summary of recent developments in computer techniques for geological problems.

(3) A more detailed discussion of some general, statistical techniques with applications to practical examples.

It is shown that methods of trend analysis for a single variable should be modified when (a) the residuals of the variable are autocorrelated, and (b) the computations are carried out using transformed data for the variable.

A technique of two-dimensional power spectrum analysis is employed for the quantitative description of periodicities in the arrangement of the grains for gabbroic rocks from the Muskox Layered Intrusion, Canada. Finally, the trend of a multivariate system (chemical data for the Yellowknife Volcanic Belt, Canada) is analyzed by using the multivariate Markov scheme method. Brief explanations for a number of non-geological terms that are used in the paper are given in an appendix.

Agterberg, F.P.

MATHEMATICAL MODELS IN ORE EVALUATION; Can. Operational Research Soc. J., vol. 5, No. 3, pp. 144-158, 1967.

Various mathematical models for the estimation of element concentration variations in ore deposits are briefly discussed. A signal-plus-noise model is derived from equations developed in statistical theory of communication. It results in an equation for the relationship between variance

of average grade and volume for blocks of ore which is tested for a practical example. It is also shown that the noise in observed data which is due to the sampling error can be eliminated from the record by the application of a filter.

Divers modèles mathématiques, conçus pour l'estimation des variations de concentration des éléments dans les gisements de minerai, sont d'abord brièvement discutés. Un modèle "signal + bruit" est obtenu à partir d'équations dérivées de la théorie statistique des communications. Il en résulte une nouvelle équation qui établit la relation entre la variance de la qualité moyenne d'un bloc de minerai et son volume; cette équation est alors éprouvée par un exemple pratique.

Il est de plus démontré que le bruit surimposé aux données d'observation, lequel est dû à une erreur d'échantillonnage, peut être éliminé de l'enregistrement par l'utilisation d'un filtre approprié.

Agterberg, F.P.

SYMPOSIUM ON MATHEMATICAL STATISTICS AND COMPUTER APPLICATIONS IN ORE VALUATION, JOHANNESBURG, MARCH 1966; Can. Mining Met. Bull., vol. 60, pp. 529-530, 1967.

This is a review of a number of papers presented in the Johannesburg Symposium of 1966 which have been published in book-form. Mathematical statistics and computers provide new tools for the location and evaluation of mineable blocks of ore in the Witwatersrand goldfields.

(F. P. A.)

Agterberg, F.P., Hills, L.V.[1] and Trettin, H.P.

PALEOCURRENT TREND ANALYSIS OF A DELTA IN THE BJORNE FORMATION (LOWER TRIASSIC) OF NORTHWESTERN MELVILLE ISLAND, ARCTIC ARCHIPELAGO; J. Sediment. Petrol., vol. 37, No. 3, pp. 852-862, 1967.

The Bjorne Formation represents the Early Triassic marginal facies of the upper Paleozoic to Tertiary Sverdrup Basin of the Canadian Artic Archipelago. On northwestern Melville Island, the formation forms a prograding fan-shaped delta characterized by concentric lithofacies. Paleocurrent indicators in 59 localities consist of the dip azimuths of planar foresets and the axes of spoon-shaped troughs with frequency distributions that can be approximated by the Gaussian normal model. The locality averages

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[1] University of Calgary, Alberta.

of the two features point in nearly the same directions, but the spread of the foreset dip-azimuths (average local variance 1,109 degrees) is wider than that of the trough axes (927 degrees). Trend analysis by the method of least squares is applied to locality averages for the combined features. The paleocurrent trends are evaluated for the linear polynomial equation and a graphical method is presented which can be extended to the cases of higher order polynomial equations.

Aitken, J.D.

CLASSIFICATION AND ENVIRONMENTAL SIGNIFICANCE OF CRYPTALGAL LIMESTONES AND DOLOMITES, WITH ILLUSTRATIONS FROM THE CAMBRIAN AND ORDOVICIAN OF SOUTHWESTERN ALBERTA; J. Sediment. Petrol., vol. 37, No. 4, pp. 1163-1178, 1967.

Designation of a carbonate rock as "algal" is not informative unless the fundamental distinction is made between carbonates composed wholly or partly of the remains of skeletal calcareous algae, and cryptalgal carbonates, in which the work of non-calcareous algae is largely inferred.

Some cryptalgal biolithites are not assignable to any of the established types of stromatolite. The adjective cryptalgalaminate is proposed for planar-laminated carbonate rocks bearing evidence of algal-mat activity, and the term thrombolite is proposed for non-laminated cryptalgal bodies characterized by a clotted fabric. Stromatolitic and cryptalgalaminate carbonate sediments appear to be restricted to the intertidal zone, but thrombolites and oncolites do not.

Description of some cryptalgal fragmental limestones and dolomites draws attention to the sediment-forming role of the non-calcareous algae, which in view of widespread emphasis on the sediment-binding role, has not been given sufficient attention.

Aitken, J.D., and Norford, B.S.

LOWER ORDOVICIAN SURVEY PEAK AND OUTRAM FORMATIONS, SOUTHERN ROCKY MOUNTAINS OF ALBERTA; Bull. Can. Petrol. Geol., vol. 15, No. 2, pp. 150-207, 1967.

The stratigraphic nomenclature of Canadian (Lower Ordovician) strata of the southern Rocky Mountains of Alberta is revised. The terms Mons Formation, Sarbach Formation, Robson Limestones, Goodsir Group, and Sarceen Series are discarded. Two new formations are proposed: the Survey Peak Formation and the overlying Outram Formation. The type

sections of both formations are at Mount Wilson, which can be considered the standard section for the Ordovician rocks of Alberta.

The Survey Peak Formation consists of calcareous shales and mudstones, siltstones, microcrystalline limestones, calcisiltites, limestone-pebble conglomerates, biocalcarenites, and cryptalgal limestones. Four informal members, basal silty, putty shale, middle, and upper massive, can be distinguished. All of these apparently originated on a shallow to very shallow, intermittently emergent sea bottom. The Survey Peak rests with abrupt but concordant contact upon the uppermost Cambrian Mistaya Formation or its equivalent in the Lynx Group. The formation can be recognized in the upper part of the McKay Group of adjacent British Columbia.

The Outram Formation includes dark-coloured shales, calcareous siltstones, calcisiltites, clotted, nodular, and laminated limestones, biocalcarenites, and limestone-pebble conglomerates. Chert is present as nodules, tracery, and irregular masses. Origin in moderately shallow, poorly aerated marine waters is suggested. The Outram has conformable and gradational contacts with the Survey Peak Formation below and the Skoki Formation above. The formation is coeval with the lowest part of the Glenogle Shales of southeastern British Columbia.

The Survey Peak, Outram and basal Skoki appear to represent a complete sequence through Canadian time. The trilobite zonation of the Survey Peak and Outram is remarkably similar to the zonation established in Utah and Nevada. The uppermost Cambrian Saukia Zone and Canadian Zones A, B, D, E, F, and G_1 can be recognized in the Survey Peak Formation, and Zones G_1, G_2, and J in the Outram Formation. Zones C, H, and I have not yet been detected in the southern Rocky Mountains.

Anderson, F.D.

STRUCTURAL STUDIES IN THE BAY D'ESPOIR GROUP, NEWFOUNDLAND; in Geology of the Atlantic region, Geol. Assoc. Can., Spec. Paper No. 4, pp. 193-200, 1967.

The Bay d'Espoir Group consists largely of slate and siltstone and their metamorphosed equivalents. The strata are Middle Ordovician(?) in age and best exposed around Bay d'Espoir in southern Newfoundland.

The group may be divided into four structural zones:

(1) A northern zone characterized by highly folded strata with a well developed axial plane cleavage. The axial planes strike northeast and dip 45 to 65 degrees northwest; the axes are nearly horizontal.

(2) A zone of more intensely folded strata with subhorizontal cleavage. The folds are generally shear folds; the axial planes commonly strike northeast and dip gently southeast, and their axes are nearly horizontal.

(3) A zone of relatively undisturbed strata with broad open folds.

(4) A southern zone of highly faulted and metamorphosed north-dipping strata.

Studies of meso- and mega-structures particularly in zone 2, show that the group has undergone several stages of deformation, the order of which has probably been: (1) folding; (2) development of subhorizontal cleavage; (3) folding; (4) faulting.

Aumento, F.

A SERPENTINE MINERAL SHOWING DIVERSE STRAIN-RELIEF MECHANISMS; Am. Mineralogist, vol. 52, pp. 1399-1413, 1967.

An unstable serpentine polymorph which exhibits the combined properties characteristic of a number of other known polymorphs is described. Macrocrystals of the mineral, from the Tilly Foster Mine, New York State, indicate that it is a six-layered monoclinic serpentine, with each successive layer displaced relative to its neighbours by $\pm a/3$ and $\pm b/3$ and, or, by a rotation of $\pm 60°$. Individual layers are further modulated periodically in the a crystal direction. The resulting crystal has superlattice controlled a and c parameters.

Finer fractions of a powdered macrocrystal, observed by electron microscopy, show that it tends to break down into smaller, simpler units: thin corrugated plates are formed, which themselves part along weak corrugation joints, forming elongated rods. The formation of rods deprives the basic serpentine layers of the satisfactory strain relief mechanism attributed to corrugation. The rods are seen to compensate for this deprivation by curling parallel to their elongation, eventually producing more stable chrysotile-like tubes. The complete metamorphosis from plates to tubes has been followed by selected area electron diffraction.

Aumento, F.

THE MID-ATLANTIC RIDGE NEAR 45° N. II. BASALTS FROM THE AREA OF CONFEDERATION PEAK; Can. J. Earth Sci., vol. 5, pp. 1-21, 1968.

Assisted by detailed bathymetric and bottom photographic coverage, a series of closely spaced samples of rock were taken by dredging along

a traverse from the centre of the Median Valley to the adjacent crest mountains on the Mid-Atlantic Ridge. The specimens show a gradation from tholeiitic to alkali basalts. Chemical variations, and the alkali content in particular, can be correlated with the depth of extrusion and with the topographic relationship of the volcanoes to the axis of the Median Valley.

Although the basalts show considerable evidence of gravity-controlled crystal fractionation, the trends so established are evidently not responsible for alkali enrichment, but appear to be superimposed onto the more fundamental, continuous trend from tholeiitic to alkali basalts.

Banerjee, I.

A STUDY OF GLACIAL VARVES AS TURBIDITES; (abst.), Geol. Soc. Am., Program North Eastern Section, Third Annual Meeting, Feb. 15-17, 1968, Washington, D.C., pp. 15-16, 1968.

In presenting a theory of the formation of glacial varves, Kuenen (1951, Geol. Foreningens, Stockholm Forh., v. 73, p. 69-84) showed that the sediment-laden meltwaters, entering glacial lakes, flowed along the bottom as turbidity currents which deposited the varves. Later, Mathews (1956, Geol. Soc. America Bull., v. 67, p. 537-552), studying a recent glacial lake, confirmed the existence of turbidity currents in the lake bottom.

The present study concerns the stratigraphic relations, thickness distribution, and sedimentary structures of the glacial varves of Lakes Barlow-Ojibway and Iroquois in Ontario, Canada, in relation to their mechanism of formation.

Stratigraphic relations studied in these areas show that thick, sandy varves (proximal turbidites) grade laterally into thin, silty varves (distal turbidites). Sequence of sedimentary structures studied in eskers also illustrates the gradual change in time from deposition by traction currents to deposition by turbidity currents, ultimately producing varves.

From a study of about 2,000 thickness measurements, it has been found that in a varve series both the silt (summer) and the clay (winter) layers have a log-normal distribution. Positive correlation between the log thicknesses of silt and clay layer is always present. Silt layers differ from the clay layers in their larger standard deviation within a series and their better correlation between one series and another, indicating a different mechanism of formation of silt.

The sedimentary structures in the varve include current-generated structures, such as current-ripple laminations, convolute laminations, parting lineations, and grooves. Subaqueous erosion is indicated by erosional channels varyingwidely in size and by large amounts of clasts of silt and

clay. Repeated grading in a single-summer layer is a feature which indicates action by turbidity currents. Load casts and clay flames are ubiquitous. Slump structures occur on a wide range of scale.

Summarizing the observations above, it seems that, although the varves were deposited by a low-density turbidity current carrying only silt or very fine sand, the structures produced are, in most cases, similar to those produced by denser currents in flysch basins.

Barnett, D.M.

GLACIAL LAKE McLEAN AND ITS RELATIONSHIPS WITH GLACIAL LAKE NASKAUPI; Geograph. Bull. (Can.), vol. 9, No. 2, pp. 96-101, 1967.

Five phases of glacial Lake McLean[1] are outlined from field observations. Shoreline development, vertical spacing and size are compared with those of the Naskaupi[1] glacial lakes in the adjacent George River basin. A series of ice barriers and overflow channels from the McLean lakes are mapped and discussed. The two lake systems remained discrete waterbodies but the higher phases of Lake McLean overflowed into the Naskaupi system.

En se fondant sur des observations effectuées sur place, l'auteur présente cinq phases de l'évolution du lac glaciaire McLean. Il en compare les rives, les différences d'élévation et les surfaces à celles des lacs glaciaires Naskaupi du bassin voisin de la rivière George. Une série de barrages de glace et de canaux d'écoulement sont cartographiés et étudiés. Les deux systèmes de lacs sont demeurés des nappes d'eau séparées, mais au cours des phases les plus anciennes les eaux du lac McLean ont débordé dans le réseau des lacs Naskaupi.

Barss, M.S., and Hacquebard, P.A.

AGE AND THE STRATIGRAPHY OF THE PICTOU GROUP IN THE MARITIME PROVINCES AS REVEALED BY FOSSIL SPORES; in Geology of the Atlantic region, Geol. Assoc. Can., Spec. Paper No. 4, pp. 267-282, 1967.

The Pictou Group is a transgressive lithostratigraphic unit which is present in many areas of the Maritime Provinces. No continuous sequence

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[1] The McLean and Naskaupi lakes discussed in this paper were features of the last glaciation and no longer exist. The names are put in italics to avoid confusion with the two present day lakes in Labrador which bear the same names.

of the entire group is present at any one locality, therefore precise correlations had not been established in many instances. Palynological studies of coal and clastic sediments have shown the presence of five zones, each characterized by a distinctive assemblage of miospores. These zones, the Vittatina zone, Potonieisporites zone, Thymospora zone, Torispora zone, and the Vestispora zone, represent Lower Permian, Stephanian, and Westphalian C-D ages. Stratigraphic correlations among twenty sections of Pictou or equivalent strata from different areas have been made by delineating the positions of the various miospore zones in each section.

Le Groupe de Pictou est une unité litho-stratigraphique que l'on retrouve dans plusieurs secteurs des provinces Maritimes. Aucune localité cependant ne fournit une coupe complète de tout le groupe, de sorte que des corrélations précises manquent encore pour plusieurs portions. Des études palynologiques des sédiments clastiques et houillers révèlent la présence de cinq zones, chacune caractérisée par un assemblage distinctif de miospores. Il s'agit de la zone Vittatina, la zone Potonieisporites, la zone Thymospora, la zone Torispora et la zone Vestipora, d'âges Permien inférieur, Stéphanien et Westphalien C-D. Nous avons établi, entre vingt coupes de différentes localités, des corrélations stratigraphiques de strates Pictou ou équivalents, en délimitant les positions des diverses zones de miospores à chacune des coupes.

Bhattacharyya, B.K.

SOME GENERAL PROPERTIES OF POTENTIAL FIELDS IN SPACE AND FREQUENCY DOMAIN: A REVIEW; Geoexploration, vol. 5, pp. 127-143, 1967.

This article presents some interesting relations satisfied by potential fields in space and frequency domains. Both gravity and magnetic fields are considered in detail. It has been observed that the amplitudes of different frequencies synthesizing a potential field signal are limited by an upper bound given by a fixed constant multiplied by exp (-Hs), where H is the depth to the top of the source and s, the frequency. This theorem is valid not only for gravity effect but also for any magnetic field component. A suitable combination of gravity and magnetic anomalies makes it possible to calculate the magnitude and direction of the magnetization vector. This calculation can also be carried out without the help of gravity anomaly, provided three-component magnetic data is available.

Bhattacharyya, B.K., and Raychaudhuri, B.

AEROMAGNETIC AND GEOLOGICAL INTERPRETATION OF A SECTION OF THE APPALACHIAN BELT IN CANADA; Can. J. Earth Sci., vol. 4, pp. 1015-1037, 1967.

Studies were made of total field aeromagnetic data over an area covering a section of the Appalachian belt in eastern Canada. This area is bounded by latitudes 45°N and 47°40'N and longitudes 62°30'W and 67°W. The residual magnetic values were filtered analytically in order to accentuate the effects of regional tectonic trends in the area. The second vertical derivative values were evaluated for outlining the contacts of magnetized geological formations with a reasonable degree of accuracy. Results of the analysis of the Bouguer anomaly map for the area seemed to correspond well with the tectonic trends indicated by the aeromagnetic data. Sixty-five anomalies were chosen from the residual and filtered maps to determine the following parameters of the causative bodies: (1) intensity of polarization; (2) direction-cosines of the polarization vector; and (3) depths to the top and bottom of the bodies.

The picture of the pre-Carboniferous basement, as inferred from aeromagnetic data, is that of a valley and ridge configuration characterized by a series of subparallel, elongated basement blocks with relative vertical displacements. The basement blocks are bounded by major fault systems, known or inferred, mostly of pre-Carboniferous age. These blocks are aligned mostly in the direction of major tectonic trend in the area. The details of subsurface basement topography are discussed on the basis of the results of interpretation of aeromagnetic data. Most interesting of all is a belt of high magnetic intensity running roughly in a NW-SE direction over the Gulf of St. Lawrence and Prince Edward Island. It has been suggested that this belt is caused by a pre-Taconic topographic high, or alternatively, by a pre-Carboniferous basement high bounded by fault zones subparallel with the fault system under the Cabot Strait.

Becker, A.

DESIGN FORMULAS FOR ELECTROMAGNETIC SENSING COILS; Geoexploration, vol. 5, No. 2, pp. 81-88, 1967.

It is demonstrated that for a certain class of electromagnetic sensing coils the geometry and weight of the device are essentially determined by the signal-to-noise ratio desired. The number of turns and the wire gauge are principally related to the required source impedance. For field use the device should be wound with aluminium wire on a mean diameter which is of the order of six times as large as the dimension of the winding section.

Bik, M.J.J.

ON THE PERIGLACIAL ORIGIN OF PRAIRIE MOUNDS; in Glacial geology of the Missouri Coteau, N. Dakota Geol. Surv., Misc. Ser. 30, pp. 83-94, 1967.

Various earlier hypotheses of supra-glacial, subglacial, and periglacial origin of prairie mounds are evaluated against new observations of the stratigraphy and characteristics of the constituting materials of prairie mounds of southern Alberta, and of their distribution patterns. It is concluded that a periglacial origin of the mounds is probable, and that most mounds formed along the shorelines of (a) proglacial lake(s) subsequent to the lowering of their (its) level.

(M. J. J. B.)

Burk, C.F., Jr.

CODING OF GEOLOGICAL NAMES AND TERMS; in A national system for storage and retrieval of geological data in Canada, National Advisory Committee on Research in the Geological Sciences, Chap. 12, pp. 43-47, 1967. (Abstract of report by chairman of subcommittee.)

In recording geological data for machine-processable files, codes for geological names and terms should be used only when it is in the best interests of the geologist recording the data to use them. Considerations involving subsequent computer operations should not influence the choice. In general, names and terms should be used in whatever form and content is most familiar and convenient to the geologist.

When names and terms are entered in a file as data, whether in coded or uncoded form, the prime consideration is that each be symbolically unique. Two approaches to coding are possible: (1) assigned codes, controlled by an authorized dictionary; and (2) derived codes, generated by a standard set of rules. For both approaches, a high mnemonic quality is desirable. For situations where a derived, mnemonic code is appropriate, the so-called 'Franklin' method of producing codes is recommended. In view of their fundamental importance to geological data files, a standard numeric code of geological time units is recommended.

(C. F. B.)

Burk, C.F., Jr.

FILES OF DATA ON FOSSIL FUELS DEPOSITS - A PROGRESS REPORT; in A national system for storage and retrieval of geological data in Canada, National Advisory Committee on Research in the Geological Sciences, Chap. 15, pp. 68-78, 1967. (Abstract of report by chairman of subcommittee.)

A file of geological data on fossil fuels and related economic sedimentary deposits, one example of many that could develop in the National System, was studied by a twelve-man subcommittee comprising members of industry and government agencies. Minimum standards for the geological

description of hydrocarbon (oil and gas) deposits are proposed, including some of wider application for other sedimentary deposits. The most important result of the development of such a file is expected to be a better, more objective understanding of the geological controls on the occurrence of such deposits, which will provide a basis for more efficient exploration and exploitation in the future.

Before a file on these data can become workable within the framework of a National System, the recommended entries and general specifications proposed must be tested and further studied, and applications demonstrated. This work would produce the basis for a tested file completely documented with input formats, definitions, detailed specifications, thesaurus control and output options. In view of the strong economic value of such a file, the public availability of most of the data, and the intriguing scientific relationships that might emerge, it is recommended that this file be one of the earliest developed within the framework of the proposed National System.
(C. F. B.)

Burk, C.F., Jr.

NATIONAL SYSTEM FOR STORAGE AND RETRIEVAL OF GEOLOGICAL DATA IN CANADA; (abst.) Geol. Soc. Am., Program, Ann. Meeting, Nov. 20-22, 1967, New Orleans, La., p. 29, 1967.

The present and expected growth of computer-processable geological data files in Canada lead the National Advisory Committee on Research in the Geological Sciences to form an ad hoc committee to develop the principles and standards necessary for implementing a national system for data storage and retrieval. The system is envisaged as a series of naturally developed, owner-controlled files, linked, however, by minimum standards that will permit the efficient exchange and dissemination of geological data. The system will depend on support from data collectors and data users, coordinated by a secretariat. Implicit in the system is the potential for creating interconnected "data banks" located throughout Canada, each containing various types and volumes of data.

Several steps have been taken toward developing the system: (1) A computer-assisted method for indexing geological data has been selected and operations have begun. (2) Procedures and standards with respect to reference numbers, geographic location, and coding have been recommended. (3) Pilot studies were conducted to evaluate principles and to propose minimum standards respecting geological field data, mineral deposits data, fossil-fuel deposits data, and geophysical data.

A census of existing computer-processable geological data files in Canada indicates that at least 135 files will be in operation by January 1968, ranging through a broad spectrum of content. Harnessing this important

resource of data, and ultimately all data, for the scientific advancement of geology and the development of Canada's natural resources is the prime objective of the national system.

Cameron, E.M.

A GEOCHEMICAL PROFILE OF THE SWAN HILLS REEF; Can. J. Earth Sci., vol. 5, pp. 287-309, 1968.

Over four hundred samples were taken from cores that form a vertical plane section through the Swan Hills Reef, an important oil-bearing reservoir in the Devonian rocks of west-central Alberta. Quantitative determinations for eight elements were made on the samples by direct-reading emission spectrometry. The resulting chemical data were treated by R-mode factor analysis techniques, including rotation to oblique solutions and the computation of factor scores. The distribution of the different factors within the reef was then determined by computing trend surfaces for the scores. Factors with low eigenvalues and even specific factors were found of considerable use for interpreting the data.

Dolomite in the reef appears to be derived mainly from high-magnesian calcite of possible algal origin that was formed on the windward side of the reef. Sr held in calcite as a solid solution impurity shows a primary trend to depletion in the organic framework facies that margins the reef. This is caused by greater diagenetic leaching of these rocks. Secondary variation of Sr may indicate periods when the reef was elevated above sea level and underwent subaerial weathering. Vertical variation of Mn and Fe held in solid solution in calcite appears to be related to tectonic changes in the region.

Cameron, E.M., and Horton, R.E.

ANALYSIS OF ROCKS USING A MULTICHANNEL EMISSION SPECTROMETER; Chem. Geol., vol. 2, pp. 135-145, 1967.

Direct-reading emission spectrometry is an excellent method for the rapid and precise analysis of many elements in rocks. By using an interrupted discharge for excitation, such as a high-voltage spark or condensed arc, it is possible to determine both major and trace elements, simultaneously if desired. To fully utilize the speed of the multichannel photoelectric spectrometer, it is desirable to automate sample preparation to as great a degree as possible and carry out the necessary computations by digital computer. Details are given for three methods that have been developed to determine:

(1) Major elements in a variety of rocks.

(2) Major and trace elements in a variety of rocks.

(3) Major and trace elements within a single rock type.

Copeland, M.J.

A NEW SPECIES OF DITHYROCARIS (PHYLLOCARIDA) FROM THE IMO FORMATION, UPPER MISSISSIPPIAN, OF ARKANSAS; J. Paleontol., vol. 41, No. 5, pp. 1195-1196, 1967.

Nodules containing phyllocarid remains occur in Upper Mississippian shale near Peyton Creek, Arkansas. They are associated with marine fossils of Late Mississippian age.

Copeland, M.J.

AN OCCURRENCE OF CARYOCARIS (CRUSTACEA, PHYLLOCARIDA) FROM THE CANADIAN ARCTIC; J. Paleontol., vol. 41, No. 5, pp. 1193-1194, 1967.

Specimens of Caryocaris from Cornwallis Island, District of Franklin are reported for the first time. They occur in a stratigraphic section containing Late Wenlockian graptolites.

Crain, I.K., and Bhattacharyya, B.K.

TREATMENT OF NON-EQUISPACED TWO-DIMENSIONAL DATA WITH A DIGITAL COMPUTER; Geoexploration, vol. 5, pp. 173-194, 1967.

Problems of acquisition and display of data with irregular control-point spacings are thoroughly discussed in this paper. Various methods are presented for computing values of the observed variable at equispaced points along two orthogonal directions with the help of irregularly distributed data. Only a few methods of interpolation are found accurate and reliable in maintaining broad as well as fine features of the original data without introducing undue distortion. One relatively simple method, the accuracy of which is considered adequate for studies of the broad features of the data, employs a quadratic, weighted average of the data points in the immediate vicinity of the grid point. However, the method best suited for accurate and detailed quantitative analysis uses least-squares fitting of the data with orthogonal polynomials generated by the Gram-Schmidt procedure.

Cumming, L.M.

DEVONIAN OF CANADIAN APPALACHIANS AND NEW ENGLAND STATES; (abst.), Proc. International Symposium on the Devonian System, Alta. Soc. Petrol. Geologists, vol. 1, pp. 42-43, 1967.

Belts of Devonian granitic rocks, having radiometric ages of 405-360 m.y., occupy the central core of the entire region. This Acadian orogeny was the major event in the structural development of the eastern part of the Appalachian fold system.

Lower Devonian volcanic rocks (chiefly rhyolite flows, welded tuffs and associated sediments) are widespread throughout the central granitic terrain. The Kineo volcanic sequence of Maine and west-central New Brunswick is Emsian in age (between Onondaga and Oriskany). This volcanic facies changes to a Lower Devonian carbonate facies which characterizes the Gaspé-Connecticut synclinorium. Sedimentary iron-formations with a Rhenish faunal facies (Torbrook Formation, Nova Scotia) and carbonates with interbeds of fine-grained pyroclastics (Cape Bon Ami Formation - host rock for copper sulphides at Murdochville, Quebec) reflect stability of the Lower Devonian sedimentary environment both north and south of the Lower Devonian volcanic activity.

The first pulse of the Acadian orogeny, dated as pre-Early Givetian, is bracketed locally in Maine between the Chapman and Mapleton sandstones. Continued Lower and Middle Devonian subsidence and sedimentation allowed flysch (e.g. Fortin Formation) and molasse (e.g. Gaspé Sandstone Group) to accumulate in successor basins along the northern flank of the central granitic terrain.

Post-orogenic Upper Devonian clastic sediments blanketed the Acadian folded zone. Remnants of these clastics are now preserved in several widely separated regions, e.g., south-central Newfoundland (Terrenceville Formation), southern New Brunswick (Perry Formation), and southern Gaspé Peninsula (Escuminac and Fleurant Formations).

Palaeontologically the region is classic ground for study of Devonian plants (Psilophyton from Gaspé) and Devonian fish (Bothriolepis from Chaleur Bay). Brachiopod, ostracod and plant-microspore zones have recently been established in New Brunswick and Gaspé. Fossiliferous limestone blocks, remnants of platform carbonates deposited near the northwestward limit of the Lower Devonian marine transgression, occur as subsidence breccia-blocks in the Cretaceous intrusive at Ile Ste. Hélène, in the St. Lawrence River at Montreal.

Cumming, L.M.

HUDSON BAY LOWLAND RIVER SYSTEMS; Earth science symposium on Hudson Bay, Program, Meeting 19-20 Feb., Ottawa, 1968.

Fourteen river systems comprising two major drainage systems are present in the Hudson Bay Lowlands. The divide between the two major drainage systems is the Precambrian ridge exposed southwest of Cape Henrietta Maria. These two major drainage systems reflect the position of two large tectono-sedimentary basins which underlie Hudson Bay Lowlands.

1. The James Bay Basin Drainage System is characterized by:
   A. Rivers which follow the northeast axial trend of the Basin (e.g., Moose and Albany Rivers).

   B. Rivers entrenched across the strike of sedimentary formations (e.g., Abitibi and Harricanaw Rivers).

   C. Rivers whose direction is controlled by the strike of resistant sedimentary formations (e.g., Attawapiskat River).

   D. Rivers with meanders controlled by a regional fracture pattern with Ordovician and Silurian sedimentary rocks (e.g., Little Current and Drowning Rivers).

2. The Hudson Bay Basin Drainage System, between Cape Henrietta Maria and Cape Churchill, is characterized by a radial drainage pattern. The Winisk and Shamattawa, Severn, Niskibi, Kaskattama, Hayes, and Nelson Rivers are part of this radial system. These rivers are remnants of consequence drainage converging toward the centre of Hudson Bay.

The Nelson, one of the great rivers of the continent, is presently beginning to be developed for hydroelectric power. Diversion of Churchill River waters into the Nelson will be an adjunct of this power development. By 1980, more than half of Manitoba's hydro power will be generated from the lower reaches of the Nelson River.

In the northern part of the Lowlands, east-flowing rivers, such as the North and South Knife Rivers and Herriot Creek, differ from larger rivers of the Lowlands by having poorly developed valleys and relatively ungraded courses. These smaller rivers probably represent post-glacial consequent streams.

Rivers of the Hudson Bay Lowlands are an important and unique natural resource, not only for hydroelectric power but also in terms of transportation, water regulation and water storage.

Cumming, L.M.

PLATFORM AND KLIPPE TECTONICS OF WESTERN NEWFOUNDLAND: A REVIEW; in Appalachian Tectonics, T.H. Clark, editor, Roy. Soc. Can., Spec. Publ. No. 10, pp. 10-17, 1967.

Parts of two contrasting tectono-stratigraphic regions dominate the geology of western Newfoundland. The Anticosti-Strait of Belle Isle Platform is characterized by relatively undeformed Lower Palaeozoic carbonate rocks, which rest upon Late Precambrian crystalline basement rocks. Superimposed on the margin of the platform rocks is a structurally more complex sequence of klippe rocks, which represent an Appalachian eugeosynclinal environment derived from central Newfoundland. Flat-lying Carboniferous sedimentary rocks overlap onto the margin of the platform on Port au Port Peninsula. To the south, Carboniferous sedimentary rocks are folded parallel to the margins of a northeast-trending trough.

Currie, K.L.

THE ORIGIN OF SHOCK METAMORPHISM IN SOME CANADIAN CRATERS; (abst.), Program, 30th Annual Meeting of the Meteoritical Society, 1967.

Deformation lamellae can be produced by compression under atmospheric confining pressure at temperatures above 800°C. The observed densification of glass is compatible with pressures of a few kilobars. Composition of rocks of igneous appearance in the craters suggests intervention of alkaline magmatic processes.

(K. L. C.)

Currie, K.L., and Shafigullah, M.

CARBONITE AND ALKALINE IGNEOUS ROCKS IN THE BRENT CRATER; Nature, vol. 215, No. 5102, pp. 725-726, 1967.

Rocks of igneous appearance in the Brent crater have the composition of potash rich trachytes, and are quite different in composition from the wall rocks. Veinlets of alnoitic and carbonatitic rocks occur in the breccia. The Brent crater is in a known locus of carbonatite intrusions. Although the petrographic evidence has been interpreted as demonstrating an impact origin for the crater, these data show that the petrographic evidence must be reassessed.

(K. L. C.)

Darnely, A.G.

ADAPTING GAMMA-RAY SPECTROMETER FOR PURPOSES OF AERIAL MAPPING; Northern Miner, Annual Review Number, 30 Nov., pp. 70-71, 1967.

During the summer of 1967 the Geological Survey of Canada has been undertaking field experiments with gamma-ray spectrometry in the Bancroft and Elliot Lake areas of Ontario. Ground and air measurements have been compared over two test strips, one in each area, 3 miles long by 1/2 a mile wide. Airborne spectrometry has been undertaken with the technical support of Atomic Energy of Canada Ltd. Detailed results will be available in the spring of 1968. Looking ahead into the not too distant future gamma-ray spectrometry will enable airborne geochemistry for potassium, uranium and thorium to be undertaken on a regional scale; on the gound field gamma-ray spectrometry will bring nearer the day of 'instant geochemistry' and greatly reduce the need for laboratory analyses.

The article is mainly devoted to an explanation in simple terms of the principles involved in gamma-ray spectrometry, the problems involved in its application and the relative merits and demerits of spectrometers compared with conventional scintillation counters.

(A. G. D.)

Donaldson, J.A.

TWO PROTEROZOIC CLASTIC SEQUENCES: A SEDIMENTOLOGICAL COMPARISON; Proc. Geol. Assoc. Can., vol. 18, pp. 33-54, 1967.

In the central barren lands, Northwest Territories, unmetamorphosed Proterozoic supracrustal rocks of the Dubawnt Group rest with profound unconformity on the deeply eroded Hudsonian orogen. The group consists of a pre-volcanic redbed sequence, a middle sequence of volcanic rocks and related hypabyssal intrusions, and a post-volcanic sedimentary sequence rich in quartzose sandstones.

A comparison of the two sedimentary sequences serves to emphasize both similarities and differences in composition, texture, and primary structures. The primary structures in particular suggest that fluvial processes were important in deposition of both sedimentary suites.

The older sequence, forming a thick prism of polymictic conglomerates, arkosic sandstones, siltstones, and mudstones, is interpreted to be a post-orogenic piedmont facies that accumulated in a structural basin under conditions of tectonic instability. The clastic part of the upper sequence,

forming a thin but laterally extensive blanket of quartz arenites, conglomerates, and siltstones, is interpreted to be an alluvial-plain deposit that accumulated slowly under conditions of extreme tectonic stability.

Dans la partie centrale des terres dénudées des Territoires du Nord-Ouest, des roches exogènes non métamorphisées du Protérozoïque appartenant au groupe Dubawnt reposent en discordance profonde sur l'orogène hudsonien profondément érodé. Le groupe comporte une séquence de roches en couches rouges pré-volcaniques, une séquence mitoyenne de roches volcaniques et d'intrusions hypabyssales apparentées et enfin une séquence de roches post-volcaniques sédimentaires riches en grès quartzeux.

La comparaison des deux séquences sédimentaires fait ressortir les ressemblances et les différences de composition, de texture et de structures primaires. Les structures primaires en particulier indiquent que des phénomènes fluviaux ont joué un rôle important dans la mise en place des deux séries sédimentaires.

La séquence la plus ancienne, qui prend la forme d'un prisme épais de conglomérats polymictiques, de grès arkosiques, de siltstones et de mudstones, serait un facies de piedmont post-orogénique qui s'est accumulé dans un bassin structural dans des conditions d'instabilité tectonique. La partie clastique de la séquence supérieure, formée d'un banc mince mais très étendu latéralement d'arénites à quartz, de conglomérats et de siltstones serait un dépôt de plaine d'alluvions qui s'est accumulé lentement dans des conditions de parfaite stabilité tectonique.

Dyck, W.

ADSORPTION OF SILVER ON BOROSILICATE GLASS; EFFECT OF pH AND TIME; Anal. Chem., vol. 40, pp. 454-455, 1968.

Loss of silver on walls of borosilicate glass containers due to adsorption was found to be proportional to the pH of the solution and length of storage time. In the equilibrium concentration range 10^{-9} to 10^{-3} moles Ag/litre the adsorption of silver on glass can be represented by Freundlich adsorption isotherms. Adsorption was found to be independent of temperature in the range 0-50°C. The presence of 1 per cent sodium nitrate suppressed the adsorption of silver by as much as a change in pH from 6 to 8.

The storage of pure 0.01 ppm silver nitrate solution in filled one-litre brown glass bottles for 50 days at a pH of 3.8 results in the loss of about 15 per cent of the silver and, at pH of 1.5, in about 5 per cent. Tests of silver adsorption on various surfaces at a pH of 4 and a silver concentration of 10^{-5} N gave adsorption values of about 10^{13} to 10^{15} silver ions per cm^2 of surface.

Dyck, W.

RECENT DEVELOPMENTS IN RADIOCARBON DATING: THEIR IMPLICATIONS FOR GEOCHRONOLOGY AND ARCHAEOLOGY; Current Anthropology, vol. 8, No. 4, pp. 349-351, 1967.

The radiocarbon dating method has withstood the test of time and found wide acceptance, as is shown by the ever-increasing demand for C-14 dates. Improved techniques have produced dating stations which permit the dating of samples up to 50,000 years old without isotope enrichment and up to 70,000 years old with isotope enrichment. Development of new procedures have made possible the dating of bones and shells with greater reliability. Three recent redeterminations of the half-life of C-14 have given a more accurate value of 5,730 years as compared to the older value of 5,570 years. Variations in the natural C-14 concentration discovered through the dating of tree rings of known age place a limit on the accuracy of the method. A gradual decrease of approximately 13 per cent in the C-14 concentration of the biosphere from 5,000 B.P. to the present shows that climatic and/or cosmic forces of significant proportions are acting upon our earth.

Ermanovics, I.F.,[1] Edgar, A.D.,[2] and Currie, K.L.

EVIDENCE BEARING ON THE ORIGIN OF THE BELLEORAM STOCK, SOUTHERN NEWFOUNDLAND; Can. J. Earth Sci., vol. 4, pp. 413-431, 1967.

The Belleoram stock of homogeneous adamellite is a shallow, late-orogenic intrusion emplaced in arkosic conglomerates, granite, intermediate to basic lavas, and clastic sedimentary rocks. The intruded rocks range in age from Cambrian to Late Devonian. Salic dykes and minor faults cutting the stock represent the closing phases of orogenic activity in this area.

Structural, petrographic, and chemical data indicate that the stock is of magmatic origin. Differential assimilation of the host conglomerate and shales may have locally modified the composition of the crystallizing magma. Field observations and modal analyses show that arkosic conglomerates near the stock have been altered to rocks of granitic composition. The margin of the stock has been basified near contacts with shale. Xenoliths of shale have been altered to compositions approaching that of their host. Hydrothermal experiments show that under appropriate conditions the magmatic vapour phase could transport soda, potash, alumina, and silica, in amounts sufficient to explain the observed compositional variation.

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[1] Queen's University, Kingston.

[2] University of Western Ontario, London.

These results suggest that under suitable conditions combined processes of autometasomatism and assimilation may be an important factor in granitization and basification at the margins of shallow intrusions.

Fahrig, W.F., Eade, K.E., and Adams, J.A.S.[1]

ABUNDANCE OF RADIOACTIVE ELEMENTS IN CRYSTALLINE SHIELD ROCKS; Nature, vol. 214, No. 5092, pp. 1002-1003, 1967.

The abundance of the radioactive elements Th, U, and K in the surface crystalline rocks of 200,000 square miles of New Quebec as determined from gamma spectrometric analyses of fifty composite samples are 9.2 ppm, 1.1 ppm and 2.3 per cent respectively. In this area rocks of amphibolite facies contain more of these elements than do rocks of granulite facies suggesting fractionation of these elements during regional metamorphism.

(K. E. E.)

Flawn, P.T., Caley, J.F., Howie, R.D., Cumming, L.M., Sanford, B.V., et al.

BASEMENT MAP OF NORTH AMERICA; Basement Rock Project Committee, Am. Assoc. Petroleum Geologists and U.S. Geol. Surv., Washington, D.C., scale, 1:5,000,000, 1967.

The map was compiled under an American Association of Petroleum Geologists committee led by Peter T. Flawn, director of the Texas Bureau of Economic Geology. The committee included more than 20 geologists from the U.S.G.S., the Geological Survey of Canada, Petróleos Mexicanos, state geological surveys, universities and the petroleum industry.

The map shows the extent and depth of sedimentary basins from northern Mexico (lat. 24°N) to central Canada (lat. 60°N). Contours of the basement are shown at intervals of 500, 1,000, 2,000 and 4,000 feet; the deepest basins extend downward more than 40,000 feet. Locations of basement-depth wells used in preparing the map are also shown. The map helps to identify those areas in which substantial amounts of oil and gas may have accumulated.

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[1] Rice University, Houston, Texas.

Folinsbee, R.E.,[1] Douglas, J.A.V., and Maxwell, J.A.

REVELSTOKE, A NEW TYPE I CARBONACEOUS CHONDRITE; Geochimica et Cosmochimica Acta, vol. 31, pp. 1625-1635, 1967.

The Revelstoke meteorite fell on March 31, 1965 in a desolate glaciated mountain-area in southeast British Columbia. Visual observations indicate that the bolide travelled along an azimuth of 093 at an inclination to the horizontal of 15 degrees. About 1 g of disaggregated material was recovered from the snow on a small frozen lake lying along the trace of the trajectory. This material was initially identified as a Type I carbonaceous chondrite by direct comparison by X-ray fluorescence spectroscopy with the Orgueil meteorite. Textural and mineralogical relationships in Revelstoke closely resemble those of Alais and Orgueil. The chemical composition of Revelstoke is similar to that of Orgueil.

Forman, S.A.,[2] Kodama, H.,[3] and Abbey, S.

A RE-EXAMINATION OF XANTHOPHYLLITE [CLINTONITE] FROM THE TYPE LOCALITY; Can. Mineralogist, vol. 9, Pt. 1, pp. 25-30, 1967.

Xanthophyllite, the yellow variety, from the type locality was examined mineralogically. It was found to be very little different from the green variety, valuevite. Thus the use of varietal names does not seem justified. An associated mineral, described by Rose (1842) as talc, was determined to be a chlorite, sheridanite. Chemical analyses of the type xanthophyllite and of the sheridanite are given.

Forman, S.A.,[2] Kodama, H.,[3] and Maxwell, J.A.

THE TRIOCTAHEDRAL BRITTLE MICAS; Am. Mineralogist, vol. 52, pp. 1122-1128, 1967.

All known trioctahedral brittle micas are shown to be similar, particularly in respect to chemical composition, crystallography, and geological occurrence. Thus there is no need for such species and varietal names as xanthophyllite, valuevite, brandisite, disterrite, holmite, holmsite, holmesite, and chrysophane. Arguments are given for choosing clintonite rather than seybertite as the species name.

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[1] University of Alberta, Edmonton.

[2] Mines Branch, Department of Energy, Mines and Resources, Ottawa.

[3] Canada Department of Argiculture, Soil Research Institute, Ottawa.

A new chemical analysis of clintonite is given: SiO_2 19.38, Al_2O_3 39.69, Fe_2O_3 0.35, FeO 1.48, CaO 12.72, MgO 20.99, Mn 0.001, SrO 0.14, H_2O 3.04, F 1.91, Cl 0.07.

Froese, E.

A NOTE ON STRONTIUM MAGNESIUM CARBONATE; Can. Mineralogist, vol. 9, Pt. 1, pp. 65-70, 1967.

The compound $SrMg(CO_3)_2$ and solid solutions (Sr, Ca)$Mg(CO_3)_2$ have been synthesized, and the system $CaCO_3$ - $SrCO_3$ - $MgCO_3$ has been investigated in the range 530°C-660°C and 1-4 kb. The powder diffraction pattern of $SrMg(CO_3)_2$ is very similar to that of dolomite and norsethite, $BaMg(CO_3)_2$. The hexagonal unit cell constants are a = 4.905 Å and c = 16.44 Å.

Goodwin, A.M., and Shklanka, R.[1]

ARCHEAN VOLCANO-TECTONIC BASINS: FORM AND PATTERN; Can. J. Earth Sci., vol. 4, pp. 777-795, 1967.

Two widely separated Archean volcano-sedimentary assemblages in the Superior Province of the Canadian Shield provide a composite view of Archean basin development. In both areas, a tectonically controlled distribution of felsic eruptive centres with associated differential subsidence leading to basin development is viewed as the prime cause of interrelated volcanic and sedimentary facies.

The two areas contain similar, sequentially arranged, volcanic and sedimentary assemblages in which mafic-to-felsic volcanic sequences are associated with clastic sediments and iron-formations. The main periods of basin subsidence were broadly synchronous with widespread felsic eruptions. The development of steep transportation gradients promoted clastic sedimentation. Felsic pyroclastic piles provided local detrital sources.

Banded iron-formations in both basins, attributed to volcanic exhalative origin are transitional from volcanic to clastic sedimentary associations, thereby demonstrating essential contemporaneity of volcanism and sedimentation. Michipicoten iron-formations display a shore-to-depth arrangement of oxide, carbonate, and sulphide facies, which conforms to the basin configuration existing during the main period of iron and silica deposition.

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[1] Ontario Department of Mines, Toronto.

This analysis of Archean basin development and configuration in describing paleophysiographic relationships provides insight into early crustal history.

Gross, G.A.

IRON DEPOSITS OF THE SOVIET UNION; Can. Mining Met. Bull., vol. 60, No. 668, pp. 1-6, 1967.

The Soviet Union has enormous reserves of iron ore in many different kinds of deposits that are widely distributed in this vast land area. The present iron ore industry is based mainly on deposits in Precambrian cherty iron-formation at Krivoy Rog, Kursk and Murmansk. Extensive reserves of both naturally enriched hematite ore and magnetite iron-formation in these areas alone could supply all the domestic ore required for several hundred years.

Many contact metasomatic magnetite deposits discovered in recent years in the eastern Ural Mountain belt and east of the Kusnetsov basin in Siberia are being developed, with ore reserves measured in billions of tons. Oolitic limonite-chamosite-siderite ores of Cretaceous and younger age at Kerch on the Black Sea and around the east and southern perimeter of the West Siberian basin constitute some of the largest concentrations of iron in the world. These sedimentary ores are low grade, of poor quality and difficult to beneficiate. Banded jasper magnetite and hematite iron-formation in volcanic rocks of Devonian age in Kazakhstan and along the Mongolian border are of special geological significance.

Iron deposits in the Krivoy Rog and Kursk areas were examined and a large number of geologists discussed their work on deposits in many other parts of the Soviet Union during the writer's seven-week study tour of mines and research institutes in Moscow, Leningrad, Novosibirsk in Siberia and Kiev in the Ukraine. The descriptive geology of iron deposits of useable ore and of marginal material has been well documented in the course of systematic work and a large number of scientists are studying fundamental problems on the origin and treatment of iron ore.

Hobson, G.D.

A RECONNAISSANCE SEISMIC REFRACTION SURVEY IN HUDSON BAY, CANADA; Proc. World Petrol. Congr., 7th Congress, Mexico City, vol. 2, pp. 813-826, 1967.

Seismic surveys were conducted in Hudson Bay during August and September 1965 as part of an extensive and comprehensive survey encompassing

the fields of geophysics, geology, and oceanography. The marine program was an extension of surveys conducted onshore in 1963 and 1964.

Three types of seismic surveys were conducted. A crustal refraction experiment was shot engaging nine university and governmental crews recording data at stations on the periphery of the Bay. Telemetering sonobuoys were monitored by instruments aboard one ship at a central location in the Bay. Forty-one charges were detonated electrically on bottom. A conventional marine refraction program was also conducted using two ships. The shot location was held constant at the centre of a profile while the recording vessel towed a cable and detectors across the shot-point. A repetitive spark-source profiling program was also conducted.

Considerable interest has been generated in this major sedimentary area of Canada by previous seismic and magnetic surveys. It is anticipated that a deep hole will be drilled in the Bay if geophysical data indicate favourable structural conditions.

These favourable structural conditions appear to be present. In general, seismic velocities in excess of 11,300 ft/sec were observed. An exceptionally high velocity of approximately 22,000 ft/sec was recorded consistently on the east side of the Bay indicating that there may be a considerable thickness of Proterozoic sediments underlying a considerable portion of the Bay. The presence of lower and intermediate values of seismic velocities indicates the probable presence of Mesozoic sediments overlying the Palaeozoic section. The thickness of sediments overlying the Proterozoic strata is calculated to be about 6,000 feet. There appears to be considerable structure within the sedimentary section.

Des levés séismiques effectués dans la baie d'Hudson au cours des mois d'août et de septembre 1965 faisaient partie d'un vaste programme d'études géologiques, géophysiques et océanographiques sur une superficie considérable. Ces études poursuivies en mer avait pour but de compléter les données relevées de la côte au cours des années 1963 et 1964.

Trois types de levés séismiques ont été effectués. Les ondes réfractées à la base de la croûte ont été observées par neuf équipes cantonnées sur la périférie de la baie. Ces équipes avaient été recrutées dans diverses universités et dans des agences gouvernementales. Des "sonobuoys" étaient télécommandées par des instruments à bord d'un vaisseau à peu près au centre de la baie. Quarante et une charges lourdes ont été explosées à l'électricité au fond de l'eau. Un programme suivant la méthode conventionnelle par réfraction séismique a aussi été poursuivi à l'aide de deux vaisseaux. Le centre de détonation étant fixé au point milieu d'un profil le vaisseau observateur touait le long du profil les détecteurs reliés à un câble. Une série de profils a aussi été menée au moyen d'une source "sparker" à répétition.

Les études séismiques et magnétiques faites dans cet important bassin sédimentaire du Canada ont soulevé un intérêt considérable. On croit prévoir qu'un trou de sonde sera foré à grande profondeur dans la baie si les données géophysiques indiquent des conditions structurales favorables.

De telles conditions semblent exister. En général, des vélocités séismiques dépassant 11,300 pieds/sec ont été observées. La vélocité exceptionnellement élevée de 22,000 pieds/sec a été enregistrée avec consistance du côté est de la baie. Ceci indique que de très grandes épaisseurs de sédiments d'âge protérozoïque doivent former une partie considérable du fond de la baie. L'observation de vélocités séismiques lentes et intermédiaires indique la présence probable de sédiments d'âge mésozoïque recouvrant les couches paléozoïques. L'épaisseur des sédiments recouvrant les lits protérozoiques peut être estimée à 6,000 pieds. Il semble que la section a été l'objet de déformations structurales considérables.

Hobson, G.D.

HUDSON BAY CRUSTAL SEISMIC EXPERIMENT: TIME AND DISTANCE DATA; Can. J. Earth Sci., vol. 4, pp. 879-899, 1967.

A crustal refraction experiment was shot in August 1965 in Hudson Bay as part of a comprehensive survey encompassing the fields of geophysics, geology, and oceanography. Nine university and government crews participated. Eight stations were located on the periphery of the bay, while telemetering sonobuoys were monitored at a central location in the bay. Good quality data were obtained from 41 shots. All preliminary data pertaining to participants, instrumentation, shot times and distances, travel times, etc. are tabulated in this report.

Hobson, G.D.

RECENT GEOPHYSICAL INVESTIGATIONS IN THE HUDSON BAY BASIN; Proc. Sixth Annual Conference, Ontario Petroleum Institute, London, Ontario, 1967.

During 1965, the Department of Mines and Technical Surveys undertook a rather comprehensive survey of Hudson Bay in a program that encompassed the fields of geology, hydrography, oceanography and geophysics. The Hudson Bay basin is set in a typical shield environment, surrounded on the north and south by Paleozoic formations and on the east and west by the Canadian Shield. Seismic investigations comprised a major part of the 1965 cruise and extended into the offshore regions the seismic programs previously conducted in the Lowlands of Manitoba and Ontario.

A thickness of 6,585 feet of sediments has been computed and located in the west central part of the bay. An arch on the Precambrian surface divides the James Bay and Hudson Bay Lowland areas; this arch has been designated as the Cape Henrietta-Maria Arch. Six distinct ranges of seismic velocities can be distinguished and these are correlated with lithology. The central shoal area is a broad arch structure that controls many of the physical and chemical phenomena in the bay. Upon the basis of seismic velocities, bedrock on the shoal is suggested to be Upper Devonian in age. Several figures can depict the aerial distribution of various geological formations in the Hudson Bay basin as defined by seismic velocities.

Hobson, G.D., and Overton, A.

A SEISMIC SECTION OF THE SVERDRUP BASIN, CANADIAN ARCTIC ISLANDS; in Seismic refraction prospecting, A.W. Musgrave, editor, Society Exploration Geophysics, Tulsa, Oklahoma, pp. 550-562, 1967.

Seven seismic refraction profiles were completed in 1961 in the Canadian Arctic Islands under the Polar Continental Shelf Project of the Department of Mines and Technical Surveys. These seven profiles were shot along a line extending from a location 30 miles north of Ellef Ringnes Island, along the west coast of this same island to a point 30 miles south of the island into Belcher Channel.

The program was carried out using an S-55 helicopter with the supply support and major moves by Otter fixed-wing aircraft. Dynamite charges were successfully detonated in depths of water to 1,285 feet without the use of "boosters". A Decca Survey Chain provided regional navigation but this system is not sufficiently accurate for long-range seismic refraction surveying. These seven profiles are presented in a cross-section across the Sverdrup Basin, correlated by seismic velocities, indicating a thickness of approximately 40,000 feet of sediment in the center of the Basin to a formation with a horizontal velocity of 20,000 ft/sec "Basement" or the base of the unmetamorphosed sediments may be 64,000 feet deep at this location.

Hobson, G.D., Overton, A., Clay, D.N., and Thatcher, W.

CRUSTAL STRUCTURE UNDER HUDSON BAY; Can. J. Earth Sci., vol. 4, pp. 929-947, 1967.

A crustal refraction experiment was conducted in August 1965 in Hudson Bay in which nine university and government crews participated. Good quality data were obtained from 41 shots providing sufficient data to permit time-term analyses of both P_n and P_1 arrivals. No consistent

intermediate arrivals were identified leading to the consideration of a two-layer crustal model. P_n time-terms indicate that the depth of the Mohorovicic discontinuity is between 26 and 41 kilometres.

Hofmann, H. J.

PRECAMBRIAN FOSSILS(?) NEAR ELLIOT LAKE, ONTARIO; Science, vol. 156, No. 3774, pp. 500-504, 1967.

Complex structures in Upper Huronian (Lower Proterozoic) quartzite north of Lake Huron are interpreted as probable metazoan fossils aged between 2 and 2.5×10^9 years. They are preserved as sand casts in the form of curved spindles having inclined lateral corrugations, axial marking, and apparent bilateral symmetry.

Hood, P. J.

GEOPHYSICAL SURVEYS OF THE CONTINENTAL SHELF SOUTH OF NOVA SCOTIA; Maritime Sediments, vol. 3, No. 1, pp. 6-11, 1967.

GEOLOGISTS PROBE SCOTIAN SHELF; Oilweek, vol. 18, No. 20, pp. 31-34, 1967.

Gravity, magnetic, and seismic surveys have been carried out on the Scotian Shelf in recent years by the Federal Government, the universities, and the oil industry. An interpreted geological map is presented which summarizes the conclusions deduced from these geophysical surveys together with bathymetry and depth estimates to the crystalline basement.

Georges Bank is underlain by Tertiary and Cretaceous sediments, and geophysical results indicate that the crystalline basement beneath Georges Bank is probably granite. In the northern part of the Scotian Shelf, the Cambro-Ordovician Meguma Group of slates and quartzitic greywackes produce a characteristic pattern of linear magnetic anomalies which parallels the coastline, and several large intrusions of granite have been inferred underlying the sediments south of Halifax, because they produce featureless, magnetically low, oval-shaped areas similar to those associated with Devonian granites on the mainland. A number of faults, mostly extensions from the mainland, are also interpreted in the same area.

The greatest thickness of sedimentary rocks (14, 750 feet) appears to occur in the vicinity of Sable Island. Chedabucto Bay is underlain by Mississippian and Triassic sedimentary rocks which fill a graben structure. The produced negative gravity anomaly, which extends eastwards from Chedabucto Bay, has been interpreted as mostly due to a thick sequence of

low-density Mississippian evaporites. Pleistocene-Cretaceous sediments overlie granite under Banquerean Bank.

(P. J. H.)

Hood, P. J.

MINERAL EXPLORATION: TRENDS AND DEVELOPMENTS IN 1967; Can. Mining J., vol. 89, No. 2, pp. 173-194, 1968.

This article reviewed the following topics for the year 1967:

(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 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.

In the 1967 review article the characteristics of the various airborne geophysical equipment available for purchase or as a contract service were summarized in tabular form. The tables were as follows:

(1) Airborne electromagnetic systems.

(2) Airborne magnetometers.

(3) Airborne scintillation counters.

(P. J. H.)

Hood, P. J., Bower, Margaret, and Godby, E. A.[1]

MAGNETIC SURVEYS IN HUDSON BAY; Earth science symposium on Hudson Bay, Program, Meeting 19-20 Feb., Ottawa, 1968.

During the 1965 Oceanographic Project in Hudson Bay, an aeromagnetic survey of a portion of central Hudson Bay was carried out as a

[1] National Aeronautical Establishment, Ottawa.

joint Geological Survey of Canada-National Aeronautical Establishment project. The area is bounded by the following coordinates 58°20'N, 89°W; 58° 47'N, 89°W; 58°58'N, 86°W; and 59°45'N, 86°W. The primary navigational aid used was the 6F Lambda Decca chain on loan from the Polar Continental Shelf Project which was installed in the southwest part of the Bay for the Hudson Bay Oceanographic Project. The survey lines flown were integral red Decca lines whose distance apart varied from about 2, 400 feet in the southwest to 3, 800 feet in the northeast end of the survey area. The flight elevation was closely maintained at 500 feet above sea-level. A rubidium-vapour magnetometer system modified by the National Aeronautical Establishment was used to digitally record on magnetic tape the total intensity of the earth's magnetic field at two heights. This was accomplished using a tail "stinger" installation together with a "bird", which was towed below the North Star aircraft and thus was an attempt to measure the first vertical derivative of the earth's magnetic field directly. Approximately 7, 000 line miles of aeromagnetic data with values every half second (approximately 150 feet) were obtained in the survey area and the Decca coordinates were also recorded at 10 second intervals (3, 000 feet) on the same magnetic tape. A rubidium vapour magnetometer was set up at Fort Churchill to record the diurnal variation of the earth's magnetic field during the flights. As both the navigational and aeromagnetic data had been digitally recorded it was possible to automate the compilation of the total intensity maps to a considerable extent.

Most of the small amplitude anomalies recorded were repeatable and some extend for many miles in directions which are quite different from the main anomalies observed. Depth-to-basement determinations carried out on the main anomalies consistently give values in excess of 8, 000 feet.

The 200-gamma generalized total intensity map of the southwestern part of Hudson Bay and its periphery shows that the northeast-striking Owl River magnetic high continues into Hudson Bay and bends in a southerly direction to become east-striking. There is some indication that a branch may continue northeastwards in the general direction of Cape Smith. The sea magnetometer data obtained to date does indicate however that the Cape Smith-Wakeham Bay belt of basic rocks extends into the Ottawa Islands.

It is interesting that the Ordovician and Silurian equators as determined by palaeomagnetic measurements on North American samples pass through Hudson Bay. Because the best chance of finding oil in useful quantities in Palaeozoic formations seems to be in paleolatitudes of less than 30 degrees (Irving and Haskell, 1962), Hudson Bay would appear to be a prime location for oil exploration. This hypothesis would include formations of Devonian age in Hudson Bay also.

Howie, R.D., and Cumming, L.M.

POSSIBLE BASEMENT GRABEN BENEATH MIRAMICHI BAY, NEW BRUNSWICK; in Geology of the Atlantic region, Geol. Assoc. Can., Spec. Paper No. 4, pp. 283-292, 1967.

The pre-Carboniferous basement beneath Miramichi Bay has a structure which appears to be a graben-like trough extending beneath the Gulf of St. Lawrence. This structure strikes in a northeast direction for about 70 miles, as judged by aeromagnetic trend lines in the offshore region and by the position of a -30 milligal Bouguer anomaly centred 30 miles offshore and 70 miles east of Bathurst, New Brunswick.

A refraction profile (from Tracadie to Cheticamp) crosses the northwest margin of the structure 10 miles east of Tracadie. There, the depression of the pre-Carboniferous basement is shown by the lateral change in seismic velocity from 5.9 to 4.6 km/sec. A depth determination from an aeromagnetic anomaly indicates that beneath Miramichi Bay the trough-floor is at a depth of -10,000 feet. Analogy with late stage structures on stabilized platforms suggests that the trough-floor is nearly flat and that the sedimentary fill, to the level of the present New Brunswick shelf, consists of Carboniferous (or younger) clastics and evaporites.

La structure du soubassement pré-carbonifère sous la baie Miramichi semble être un fossé de type graben, s'étendant sous le golfe Saint-Laurent. Ce fossé a une direction nord-est pour une distance d'environ 70 milles à en juger par les courbes aéromagnétiques relevées au loin de la côte et par la position d'une anomalie de Bouguer de -30 milligal située à 30 milles de la côte, 70 milles à l'est de Bathurst, Nouveau-Brunswick.

Un profil sismique de réfraction traverse la bordure nord-ouest du fossé à 10 milles à l'est de Tracadie. En ce point, la dépression du soubassement pré-carbonifère se manifeste par le changement latéral de vélocité sismique, laquelle passe de 5.9 à 4.6 km/sec. Une mesure de profondeur à partir d'une anomalie aéromagnétique révèle que sous la baie Miramichi le fond de la fosse est à -10,000 pieds. Par analogie avec les structures tardives que l'on observe sur les plate-formes stabilisées on pourrait penser que le fond du fossé est à peu près plat et que le comblement sédimentaire jusqu'au niveau de la plate-forme actuelle du Nouveau-Brunswick est constitué de débris clastiques et d'évaporites carbonifères (ou d'âge plus récent).

Hutchison, W.W.

GEOTHERMOMETRY FROM CHANGES IN STRESS BIREFRINGENCE AROUND INCLUSIONS IN GARNET DURING HEATING TO 900°C; Can. J. Earth Sci., vol. 4, pp. 1171-1183, 1967.

An examination of stress birefringence around inclusions in eight garnets during heating to 900° C, suggests that some changes in birefringence are due to fit-misfit relationships of inclusions in garnet.

Some garnets appear to have behaved as natural bombs, which have carefully preserved the misfit relationships since crystallization of the combination of detached or partly detached inclusion in garnet. This combination can be used to determine the temperatures of fit at room temperature for various inclusions in garnet. Using certain approximations the intersection of curves of fit (on a P-T plot) can be employed to determine possible temperatures and pressure of formation of the garnet. In addition the changes in birefringence around inclusions of quartz reveal whether the garnet (or quartz inclusion) crystallized above or below the α-β quartz inversion.

This technique is limited chiefly by the lack of P-V-T data on minerals, yet it can be applied to determine possible minimum and maximum temperatures and pressures of formation of garnets or their inclusions.

Hutchison, W.W., and Roddick, J.A.

RECORDING GEOLOGIC DATA FOR MACHINE RETRIEVAL AND PROCESSING; Western Miner, vol. 41, No. 2, pp. 39-43, 1968.

A coding system, useful for machine retrieval and processing, has been designed for field mapping of data from approximately 40,000 stations in the Coast Mountains of British Columbia. The data are recorded on punched cards and magnetic tapes, indexed for rapid access. Station locations are automatically digitized from base maps.

The chief advantages of such a system are: (1) greater consistency in mapping by various geologists; (2) more data in the time spent at an outcrop; (3) rapid, relatively cheaper retrieval; (4) data is directly readable for processing by a digital computer.

Jambor, J.L.

NEW LEAD SULFANTIMONIDES FROM MADOC, ONTARIO - PART 1; Can. Mineralogist, vol. 9, Pt. 1, pp. 7-24, 1967.

A small prospect pit in Precambrian marble at Madoc, Ontario, contains at least eight new lead sulfantimonides and ten previously known sulfosalts. The compositions of the minerals were determined by microprobe analyses and determinative curves constructed by plotting the mol ratio of Pb/Sb_2 and Pb/As_2 against the density of known lead sulfarsenides and sulfantimonides.

Microprobe analyses of the new mineral madocite correspond to $7PbS.3(Sb,As)_2S_3$, but the true formula may be $17PbS.8(Sb,As)_2S_3$. Madocite is orthorhombic, $a = 27.2$, $b = 34.1$, $c = 2c' = 8.12$Å, pseudocell space group Pba2 or Pbam, perfect {010} cleavage, $D_x = 5.98$ for $Z = 4$. The strongest lines of the powder pattern are 3.396 (10), 3.355 (9), 2.720 (8), 3.67 (7), 2.925 (6).

Veenite, $2PbS.(Sb,As)_2S_3$ with Sb:As = 5:3, has an orthorhombic pseudocell with $a' = 1/2a = 4.22$, $b = 26.2$, $c = 7.90$Å, space group $P2_1cn$ or Pmcn, $D_m = 5.92$, $D_x = 5.96$ for $Z = 8$. The x-ray powder pattern is like that of dufrenoysite, with strongest lines at 3.81 (10), 3.03 (9), 3.42 (8), 3.26 (8), 2.76 (7).

Jambor, J.L.

NEW LEAD SULFANTIMONIDES FROM MADOC, ONTARIO. PART 2 - MINERAL DESCRIPTIONS; Can. Mineralogist, vol. 9, Pt. 2, pp. 191-213, 1967.

Launayite, playfairite, sterryite, twinnite, guettardite, and sorbyite are new lead sulfantimonides from Madoc, Ontario. An additional sulfosalt, designated mineral QM, may be identical to Coleman's (1953) mineral Q from Yellowknife, N.W.T. The new minerals are associated with boulangerite, jamesonite, antimonian baumhauerite (Sb:As = ~1:1), zinckenite, semseyite, geocronite, robinsonite, and a few other sulfides and sulfosalts.

Jeletzky, J.A., and Zapfe, H.[1]

COLEOID AND ORTHOCERID CEPHALOPODS OF THE RHAETIAN ZLAMBACH MARL FROM THE FISCHERWIESE NEAR AUSSEE, STYRIA (AUSTRIA); Ann. Naturhist. Museums Wien, vol. 71, pp. 69-106, 1967, 4 plates, 1 figure.

[1] Palaeontological Institute, University of Vienna, Austria.

Kelley, D.G.

SOME ASPECTS OF CARBONIFEROUS STRATIGRAPHY AND DEPOSITIONAL HISTORY IN THE ATLANTIC PROVINCES; in Geology of the Atlantic region, Geol. Assoc. Can., Spec. Paper No. 4, pp. 213-228, 1967.

The development of present knowledge of regional Carboniferous stratigraphy and the problems associated with its nomenclature are reviewed.

The keystone of Carboniferous stratigraphy in eastern Canada for the past 50 years was provided by the work of W.A. Bell whose subdivisions, which he called "groups", were based primarily on age as indicated by fossils. This practice was challenged in the 1950's when it was found that some of the contacts between Bell's so-called "groups" were diachronous from place to place.

Removal of the time-restriction from the mainly Lower Carboniferous Horton and Windsor "Groups" and other minor modifications of definition permit use of these two terms as rock-stratigraphic units.

Some progress has been made at sorting out the mainly Upper Carboniferous stratigraphic units: Canso, Riverdale, Cumberland and Pictou "Groups". Recently proposed changes, although sound in principle, are poorly documented on a regional basis, so the familiar nomenclature of Bell is retained for the present, with minor modification.

An attempt is made to present an updated regional synthesis of the depositional history of the Carboniferous. The sediments are almost wholly non-marine and were deposited in a broad subsiding area known as the Fundy Basin. Uplands existed within this broad basin, some continuously and others intermittently, which partly to mainly separated the areas of deposition from one another, especially in the Early Carboniferous. The resulting troughs or sub-basins were in part fed by fault-bounded uplands.

Tectonic activity in the various upland areas during the Carboniferous did not occur everywhere at the same time, consequently, a contact between two time-stratigraphic units is unconformable adjacent to one upland and conformable adjacent to another. Uninterrupted sedimentation took place a few miles from areas of tectonic activity.

The most complete Carboniferous section is probably preserved in the area extending from southeastern New Brunswick and northern Nova Scotia to southwestern Newfoundland. It is within this central area of the Fundy Basin that folding and faulting during the Carboniferous was most active.

Kerr, J.W.

DEVONIAN OF THE FRANKLINIAN MIOGEOSYNCLINE AND ADJACENT CENTRAL STABLE REGION, ARCTIC CANADA; Proc. International Symposium on the Devonian System, Alta. Soc. Petrol. Geologists, vol. 1, pp. 677-692, 1967.

The Franklinian miogeosyncline trends east and northeast through the Queen Elizabeth Islands. A particular location for the flexure separating the geosyncline from the Central Stable Region was applicable in the Silurian and in the earliest Devonian. Later it had a different position, having migrated northwestward. At the same time two mildly positive basement features that trended across the flexure, became more pronounced, the Bache Peninsula arch, and the Boothia-Cornwallis belt. These two features, where they crossed the former geosyncline, acted as parts of the Central Stable Region, while the geosyncline subsided markedly beside them. The effect of the simultaneous flexure migration and basement uplift was that the miogeosyncline became restricted in late Early, Middle, and Late Devonian times. Later, it ceased to exist and the entire region was subjected to widespread erosion.

Throughout the area Devonian is widely conformable with Silurian. On the Central Stable Region and the shelfward margin of the geosyncline the systemic boundary is within Read Bay limestones. In central parts of the geosyncline it is within Cape Phillips shales, and in northwestern parts within fine clastics of the Cape Rawson Group. Graptolitic and shelly faunas are interbedded at this level.

Through most of Devonian time fine northwesterly-derived clastics of the outer miogeosynclinal margin grade with carbonates of the medial parts and red beds of shelfward parts. The clastics progressively encroached southeastward and covered the limestones. Unconformable syntectonic and post-tectonic clastic formations, including red beds, were deposited upon the southern miogeosynclinal margin and Central Stable Region in late Early and again in early Middle Devonian time, by widespread shallowing and basement uplift. Through Eifelian time widespread carbonate deposition in medial and shelfward parts of the miogeosyncline included reef buildups to 4,000 feet, followed by widespread sandy limestone in Givetian time. Middle Devonian carbonates grade northwestward to fine clastics. In latest Middle and through most of the Late Devonian, thick quartzose clastics were spread southerly, grading into and overlapping limestones. A Frasnian positive pulse of the Boothia uplift interrupted this deposition.

Kerr, J.W.

NARES SUBMARINE RIFT VALLEY AND THE RELATIVE ROTATION OF NORTH GREENLAND; Bull. Can. Petrol. Geol., vol. 15, No. 4, pp. 483-520, 1967.

Stratigraphy of Upper Proterozoic to Devonian sediments on opposite sides of the Nares Strait lineament conclusively disproves the suggestion that Greenland has drifted hundreds of kilometres to the northeast by strike-slip movement.

The stratigraphy allows either of two cases of lesser net displacement. One is 45 to 80 kilometres, in a direction 25 degrees east of the lineament trend and parallel to isopachs and facies belts. The other involves a complex rift valley with primarily down-dropping of intervening water-covered blocks, and up to several kilometres of oblique horizontal displacement resulting from crustal extension (stretching).

Structural evidence supports the second case and indicates that Nares Strait contains a submarine rift valley. This rift valley is an extensional structure, that formed between north Greenland and Ellesmere Island, and allowed those lands to rotate apart in counterclockwise and clockwise directions, respectively. Two segments of the rift valley, south and north of Latitude 80°N, are, respectively, the extensional and compressional segments. The overall path of the rift valley was predetermined by a regional stress system, but the detailed path was governed in part by local anisotropy of the continental blocks.

STAGE 1: Prior to rifting and continental breakup, north Greenland and Ellesmere Island formed a single land mass, and geological provinces, including the Precambrian crystalline basement, were continuous between the two.

STAGE 2: In about Late Cretaceous time, an extension fault progressing northward from Baffin Bay severed the region along prominent gneissic trends to about Latitude 80°N, and began to form the extensional segment of Nares rift valley. Extension was prevented from continuing north of Latitude 80°N by inferred transverse gneissic trends.

STAGE 3: Extension continued in the south, producing a triangular faulted depression, the Nares sphenochasm (Carey, 1958). The impeding gneissic trends resulted in the development of the Nares transform pivot (a term proposed herein) at about Latitude 80°N, by means of which extension of the sphenochasm was transformed northward into compression in the Nares sphenopiezm (Carey, 1963). The vertical Judge Daly fault zone developed in the compressional segment, oblique to the inferred gneissic trends and along the predetermined overall path of rifting. This zone was one of compressional and incipient strike-slip faulting, and separated two areas of folds and thrusts; in both areas overriding developed toward the fault zone.

STAGE 4: In post-Oligocene or post-Miocene time, extension of both segments produced the present structural form of Nares rift valley. The sphenochasm and sphenopiezm were breached, and the transform pivot was destroyed by a broad zone of en échelon extension faults. This latter zone apparently was able to follow the approximate path of the Judge Daly fault zone once an initial break had been made.

STAGE 5: A basic structural framework was modified by fluvial, glacial, and marine processes, to give Nares submarine rift valley its present morphology. The rift valley is probably not developing structurally at this time for the region is not active seismically.

Kerr, J.W.

NEW NOMENCLATURE FOR ORDOVICIAN ROCK UNITS OF THE EASTERN AND SOUTHERN QUEEN ELIZABETH ISLANDS, ARCTIC CANADA; Bull. Can. Petrol. Geol., vol. 15, No. 1, pp. 91-113, 1967.

Ordovician rock units in the eastern and southern Queen Elizabeth Islands have commonly been misidentified and the nomenclature has become confused, largely through a paucity of fossils and the failure of workers to recognize that there are not one, but two major evaporite units. This paper reviews the earlier work, documents the misunderstandings, and sets forth an expanded nomenclature that is widely applicable.

The Copes Bay Formation is now more accurately dated as of early Canadian age by the dating of overlying and equivalent units. The Baumann Fiord is a new formation of Canadian age whose type section, 2,560 feet (790 miles) of mainly gypsum-anhydrite, occurs east of Trold Fiord on central Ellesmere Island. The formation is represented on Cornwallis Island by gypsum-anhydrite in the core of the Centre Dome. The Eleanor River Formation remains as first proposed (Thorsteinsson, 1958), with a type section of 2,000 feet (615 metres) of limestone on Cornwallis Island; however, it is now better dated as of Canadian, probably Whiterock to Marmor age.

The Cornwallis Formation is raised to group status, the type section remaining on Cornwallis Island, and the boundaries coinciding with those of the earlier formation as erected by Thorsteinsson (1958). Three new formations that comprise the Cornwallis Group have their type sections in a single, long, conformable section northeast of Irene Bay on Ellesmere Island. The oldest, the Bay Fiord, is 1,650 feet (510 metres) of recessive, argillaceous, anhydritic limestone, shaly limestone and shale, of Middle Ordovician (about Ashby to Wilderness) age. The Thumb Mountain Formation comprises about 1,500 feet (462 metres) of bluff-forming limestone of about Barneveld and Eden age. The Irene Bay Formation is about 270 feet (83 metres) of recessive, greenish weathering, argillaceous limestone. A prolific shelly fauna, which has been called the "Arctic Ordovician fauna", occurs in the Irene Bay Formation and is regarded as late Caradocian in age. Graptolites of Ashgillian age occur at the base of the overlying Cape Phillips Formation. The Cornwallis-Cape Phillips contact is arbitrarily regarded as the boundary of Caradocian (Middle) and Ashgillian (Upper) of the European standard section, and therefore occurs within the Upper Ordovician (about Maysvillian) of the American standard section.

Kerr, J.W.

A SUBMERGED CONTINENTAL REMNANT BENEATH THE LABRADOR SEA; Earth and Planetary Science Letters, vol. 2, No. 4, pp. 283-289, 1967.

A new origin is proposed for Baffin Bay and the Labrador Sea. Greenland and Canada drifted apart by counterclockwise and clockwise rotation respectively. This was by activity on a now dormant northwesterly branch of the Mid-Atlantic Ridge. The drifting process includes three separate mechanisms: (1) continental extension (stretching); (2) simple continental rotation; and (3) the isolation of a submerged continental remnant.

Baffin Bay is at an early stage of development and a thinned continental crust extends fully beneath it. The Labrador Sea had developed further so that a central continental-like remnant is isolated by flanking belts of more nearly oceanic character.

The best pre-drift restoration is made when opposing 500 fathom lines are made parallel and about 220 kilometres apart. This may be the approximate distance that should separate the 500 fathom lines in other continental reconstructions.

Klassen, R.W., Delorme, L.D.,[1] and Mott, R.J.

GEOLOGY AND PALEONTOLOGY OF PLEISTOCENE DEPOSITS IN SOUTHWESTERN MANITOBA; Can. J. Earth Sci., vol. 4, pp. 433-447, 1967.

Sediments containing fossils and organic material occur within Pleistocene deposits underlying multiple tills in the Duck Mountain and Riding Mountain Uplands of southwestern Manitoba. Pollen, ostracods, and mollusks within the sediments on Duck Mountain indicate a cool-warm-cool climatic sequence, which began more than 37,760 years B.P. Bones of a ground squirrel (Citellus) and vole (Microtus) were recovered from an intertill silt on Riding Mountain. Grass associated with the bones was dated as more than 31,300 radiocarbon years B.P.

The sediments may be correlative with some of the beds of the recently redefined Port Talbot interstade in the Lake Erie region, though it is inferred they are older and correlative either with an early Wisconsin interstade or with the Sangamon interglacial in the mid-western United States.

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[1] Water Research Branch, Calgary.

King, C.A.M.,[1] and Buckley, Jane T.

THE ANALYSIS OF STONE SIZE AND SHAPE IN ARCTIC ENVIRONMENTS; J. Sediment. Petrol., vol. 38, No. 1, pp. 200-214, 1968.

Measurements were made of the size and shape of stones from a variety of depositional environments in the recently deglaciated and isostatically uplifted tundra area of west-central Baffin Island. The deposits sampled included beaches, raised and modern, both on limestone and on granite-gneiss, deltas, ice-contact deposits, eskers, kames, moraines, and solifluction deposits, as well as some doubtful features. Size measurements, using the mean and standard deviation of 50 stones, at each site, enabled several different groups of features to be differentiated. The roundness formula of Cailleux was found to be the most diagnostic for the shape measurements. Statistical analyses of the roundness values were interpreted in terms of depositional processes and stones from different known environments could be grouped accordingly. The doubtful features could then be fitted into the relevant category as a result of the roundness measurements.

King, C.A.M.,[1] and Buckley, Jane T.

THE CHRONOLOGY OF DEGLACIATION AROUND EQE BAY AND LAKE GILLIAN, BAFFIN ISLAND, N.W.T.; Geograph. Bull. (Can.), vol. 9, No. 1, pp. 20-32, 1967.

The stages of deglaciation in the area between Ikpik Bay on the Foxe Basin coast of Baffin Island, N.W.T., Canada and the inner part of Lake Gillian are traced and related to sea-level* by means of the numerous glacial-marine deltas which link the ice front positions, as indicated by ice contact faces, with sea-level as suggested by the level of the delta fronts. The marine limit, contemporaneous with an ice margin close to the sea, had a height of about 95 metres along the northern sector of the coast. It slopes down toward the northeast at 0.6 metre/km. The sea entered Lake Gillian until about 5,200 years ago when sea-level had fallen below 56 metres. The closer spacing of the isobases, indicated by deltas in Lake Gillian, suggests that uplift was retarded until after the ice had retreated from any given point. The deltas within the lake basin become progressively lower and younger upstream relative to the present sea-level. They provide evidence of the later stages of deglaciation.

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* Because of the lack of official bench marks in the area, the sea-level datum used was the maximum limit at which evidence of high tide was found in the form of seaweed, driftwood or "cliffing" in sand.

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[1] University of Nottingham, England.

Les auteurs discutent les étapes de la déglaciation dans la région située entre la baie Ikpik, sur la côte du bassin Foxe dans l'île Baffin, Territoires du Nord-Ouest (Canada), et la partie intérieure du lac Gillian. Elles les rapportent au niveau de la mer* grâce aux nombreux deltas glacio-marins reliant les emplacements des fronts glaciaires, indiqués par les faces de contact de la glace, avec le niveau de la mer comme le laisse deviner le niveau des fronts des deltas. La limite marine, contemporaine d'une marge de la glace voisine de la mer, avait une hauteur d'environ 95 mètres le long du secteur septentrional de la côte. Il descend vers le nord-est à 60 centimètres par kilomètre. La mer pénétra dans le lac Gillian jusqu'à il y a quelque 5,200 ans, alors que le niveau de la mer était tombé au-dessous de 56 mètres. Le rapprochement des isanabases, révélé par les deltas du lac Gillian, porte à croire que le soulèvement a été retardé jusqu'à ce que la glace se fût retirée d'un point donné. Les deltas situés dans le bassin du lac deviennent progressivement moins élevés et plus jeunes vers l'amont, par rapport au niveau actuel de la mer. Ils permettront de déterminer les étapes ultérieures de déglaciation.

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* A cause du manque de bornes-repères officielles dans la région, le point de repère du niveau de la mer utilisé était la limite maximum atteinte par la marée haute, et identifié par du varech, des débris de bois flotté ou le développement de falaises dans le sable.

Kornik, L.J., and MacLaren, A.S.

AEROMAGNETIC STUDY OF THE CHURCHILL-SUPERIOR BOUNDARY IN NORTHERN MANITOBA; Can. J. Earth Sci., vol. 3, pp. 547-557, 1967.

A regional aeromagnetic study of northern Manitoba suggests adjustments in the position of the Churchill-Superior boundary. This proposed boundary is correlated to a narrow, continuous magnetic low that changes direction at its northern end, from a northeast trend to an east-west trend that approximately parallels the 56°N latitude line.

The date pattern of age determinations chiefly supports the position of the proposed boundary. Comparison of aeromagnetic patterns to the geology establishes their close correlation. Aeromagnetic anomalies appear to be chiefly produced by near-surface material and can be correlated with the surface geology. A comparison of the gravity patterns to the aeromagnetic and geologic patterns establishes the apparent independence of the gravity patterns to the other two. The gravity anomalies appear to be produced by larger scale density contrasts which are not correlative with near-surface material. A deeper, crustal source of the gravity anomalies fits the evience better.

Lachance, G.R., and Plant, A.G.

A SIMPLE AND VERSATILE METHOD OF MOUNTING STANDARDS FOR USE IN ELECTRON MICROPROBE ANALYSIS; Can. Spectroscopy, vol. 12, No. 4, p. 134, 1967.

A method of mounting samples for electron microprobe analysis that is both simple and versatile is described. The mounting device is a threaded cylinder, quarter-inch in length, made from 10-32 brass threaded stock or 10-32 brass screws. Fragments or chips are mounted directly using epoxy resin in a drilled hole at one end of the cylinder. The mounts can be polished singly or in groups and any selected combinations of standards and samples can be screwed into a brass holder for probe analysis.

Lang, A.H.

ONE HUNDRED YEARS OF PROSPECTING IN CANADA; Can. Mining J., vol. 88, No. 5, pp. 55-63, 1967.

Production of metals and non-metallics was almost $2 1/2 billion in 1966 and for the century totals some $33 billion. This is a measure of successful prospecting, except that it does not include important finds not yet in production. Because of inherent uncertainties, there was also much unsuccessful searching. Important as this output was in our economic growth, prospecting was of greater influence because it was usually in the van of settlement and other activities and so had an inestimable role in shaping the Canada of today.

More detailed papers deal with parts of the theme, so this attempts to outline the whole story, including a few events before 1867 and areas that did not enter Confederation until later. It is confined virtually to metals and non-metallics. It sketches the personnel and methods of the four main kinds of prospecting: conventional, geological, geophysical, and geochemical, which merge into and supplement one another.

The first notable event was Frobisher's claim to have found gold in Baffinland in 1576, which resulted in a large expedition that mined 2,000 tons of worthless rock. In the 18th century coal was sought and mined at Cape Breton, iron in Quebec, and copper in Newfoundland; silver and lead were found at Lake Timiskaming, Hearne made his famous journey to the Coppermine, and Peter Pond noted the Athabasca oil-sands.

More important prospecting and mining began early in the 19th century with the discovery of gold in gravels south of Quebec City. It is noteworthy that these were placers, which can be found and worked fairly easily by inexpert persons, that important vein-gold mining began not long afterwards in Nova Scotia, and that the same sequence developed independently

in British Columbia a little later. It is not known that the activity in Quebec caused men to turn attention to the possibilities of the Nova Scotian veins, but the great Fraser-Cariboo gold rush, which followed the California activity and the first important placer discovery in British Columbia in 1857, directly caused attention to be given first to gold in veins and then to silver and base-metal lodes, and the same sequence followed the greatest placer rush of all in the Klondike in 1898. These events caused British Columbia and the Yukon to be the main Canadian prospecting fields and sources of metals at the turn of the century, and were the main cause of the building of the Canadian Pacific Railway and later lines to join East and West. Construction of the Canadian Pacific Railway and a branch caused the first discoveries of copper at Sudbury and silver at Cobalt by construction blacksmiths. These events gave great impetus to prospecting there and elsewhere, and caused in 1907 the ascendency of mining in the Canadian Shield. The depression and the increased price of gold caused gold to be sought throughout the Shield and Cordillera, even to the Arctic. World War II gave emphasis to strategic metals and minerals and was followed by the uranium boom. Emphasis is now on iron, silver, and non-ferrous metals; renewed interest is being taken in uranium but on a more technical level than that of the novices who were so numerous and unsuccessful during the boom. Interest in metals like uranium and molybdenum not formerly in great demand, technological improvements in mining and treating low-grade ores, and advanced methods of prospecting that permit detection of buried deposits have, particularly in the last decade, caused partial reversion of emphasis to old mining districts and accessible areas.

Conventional prospecting is regarded as the searching, by persons without advanced training, of gravels, outcrops, and rocks slightly covered by overburden, and the use of simple instruments like dip needles, Geigers, and mineral lamps. The early prospectors were frontiersmen who could turn their hands to anything but would work for wages only as a last resort. Full-time prospectors emerged, generally self-financing or grubstaked by individuals, syndicates or companies. Some spent much time studying and attending courses provided by various organizations after 1895. The best men were or are as good as could be imagined for the work involved, and won high regard. Excepting the possibility of overlooked finds in accessible areas, they have become faced with the necessity of working in remote places or of acquiring further skills in order to work within the advanced categories. There have also been many amateurs, mostly novices; some who became adept by study and experience were successful, but areas to which they can devote spare time have diminished. This matter should not be confused with mineral collecting which, although admirable, is not prospecting.

Geologists had important but not sharply definable roles: (1) in preliminary work outlining favourable places for prospecting, (2) in actually finding deposits, (3) in guiding the appraisal and testing of discoveries and anomalies, and (4) auxiliary to the operation of mines. Only deposits found by role (2) are regarded as geological discoveries. These are of two main

kinds, those found incidentally to geological mapping, and those found as deliberate objectives. Important examples of both kinds are cited. The future of this kind of work is believed to depend mainly on the success of research on various applications, including the origin of ores, and on the number of geologists spared from the other three roles to formulate hypotheses of possible ore occurrences.

Geophysical methods based on electrical, magnetic or other properties of rocks and ores began long ago with the use of dip needles. Extensive Canadian use in searching for deposits hidden by overburden and barren rock began in the 20's, one of the first productive discoveries being an orebody found in Newfoundland in 1926. Use of these methods has become widespread and resulted or assisted in many important finds, some of which are mentioned. The most successful techniques appear to have been magnetic or electromagnetic surveys on the ground or from the air, and induced polarization surveys on the ground, or their combinations.

Geochemical methods based on dispersion of minute amounts of metals in the rocks around deposits or in soil, water, stream sediments or plants derived from them have been used in other countries since the 30's but not in Canada until more recently because of the success of other methods and a belief that glaciation had made most of our terrains unsuitable. The latter has proved less serious and several projects have, during the last few years, provided support in the discovery of mines and main roles in finding some important prospects. Work of this kind is increasing. It generally involves large, systematic sampling programs and plotting, extensive analytical facilities, and experienced interpretation. Some methods involving fairly portable equipment could be used by one or a few men with adequate training and methodical aptitude.

Advanced geological, geophysical, and geochemical methods offer opportunities for an increasing number of discoveries, particularly because they may be successful in areas fairly close to settlement and transportation, by suggesting conditions beneath the overburden that is generally much more prevalent than outcropping rock. Anomalies and hypotheses suggested by advanced methods are often vague and need corroboration or narrowing before drilling. This has led to various combinations of methods and some large and costly programs. Some have included detailed geological studies and conventional prospectors. Programs comprising all approaches thought to offer possibilities have been called 'saturation prospecting'.

Study of 77 mines that began production in the decade 1945-55 indicated that 31 were old mines or prospects and that, of the remainder, 22 were conventional, 17 geological, and 7 geophysical finds. Study of 175 that began production in the last decade indicated that 120 were old mines or prospects and that, of the remainder, 18 were conventional, 15 geological, and 20 geophysical finds; 16 were attributed to combinations, including 6

geochemical supports. The average time from discovery to production was 30 years for all mines and 6 1/2 for those found since 1945.

(A. H. L.)

Larochelle, A.

THE PALAEOMAGNETISM OF THE SUDBURY DIABASE DYKE SWARM; Can. J. Earth Sci., vol. 4, pp. 323-332, 1967.

Previously published results on the palaeomagnetism of the Sudbury diabase dyke swarm had indicated that these dykes were formed at low palaeomagnetic latitude. A new and independent set of data described in the present study confirms this view and suggests further that the dykes were not disturbed significantly since the time of their intrusion, over 1,000 m.y. ago. It is also suggested that the dykes sampled were intruded intermittently over a period extending for less than 10,000 years.

Les données paléomagnétiques sur les dykes de Sudbury publiées antérieurement à cette étude s'accordaient pour indiquer que ceux-ci ont vraisemblablement été injectés près de l'équateur paléomagnétique. La nouvelle série de résultats présentée dans ce rapport confirme cette hypothèse et suggère en plus que les dykes n'ont pas été dérangés de façon appréciable depuis l'époque de leur injection, soit depuis au-delà d'un milliard d'années. On croit pouvoir déduire aussi de ces résultats que les dykes échantillonnés ont été formés par intermittence au cours d'une période de beaucoup inférieure à 10,000 ans.

Larochelle, A., and Currie, K. L.

PALEOMAGNETIC STUDY OF IGNEOUS ROCKS FROM THE MANICOUAGAN STRUCTURE, QUEBEC; J. Geophys. Res., vol. 72, No. 16, pp. 4163-4169, 1967.

The Lower Triassic Manicouagan group is comprised of breccia, basalt diorite, and andesite, forming flat sheets partly filling a structural depression in Precambrian rocks. Cored, oriented samples show remarkably stable thermoremanent magnetization. Statistical analysis of the data shows that formation of the Manicouagan group has taken 10,000 years or less. Comparison with other Triassic pole positions from North America suggests that the area north of the St. Lawrence River has not rotated with respect to the rest of the continent since Triassic time.

Lewis, C.F.M., and McNeely, R.N.[1]

SURVEY OF LAKE ONTARIO BOTTOM DEPOSITS; Proceedings, Tenth Conference on Great Lakes Research, University of Michigan, pp. 133-142, 1967.

Short gravity cores and grab samples, recovered during a continuing reconnaissance survey initiated in 1966, were used to study the distribution, stratigraphy, and chronology of Lake Ontario bottom deposits. Three major groups of surficial deposits were recognized: (1) complex nearshore sediments, (2) glaciolacustrine clays, (3) postglacial muds. Organic contents of 2 to 6 per cent and median particle diameters of 1 to 4 microns are typical of the offshore surficial muds. Pollen in these sediments facilitates correlation and subdivision and indicates that the present sedimentation rate in the main basin is approximately 10 cm per century. Several sediment sequences confirm the postglacial low-level Admiralty Lake stage and suggest it may have reached lower levels than previously believed.

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[1] Queen's University, Kingston, Ontario.

Little, H.W.

GEOLOGICAL SURVEY EMBARKS ON INTENSIVE 'U' PROGRAM; Northern Miner, Annual Review Number, 30 Nov., 1967.

The revival of G.S.C. research on uranium deposits was initiated by Paper 65-33 and was crystallized by the recommendations of a Working Group under S.M. Roscoe. In 1966 five field research projects were undertaken, and eight in 1967; in 1968 seven additional projects are expected to be initiated. The role of the coordinator of the Uranium Program is also outlined.

(H.W.L.)

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

GEOLOGICAL SURVEY OF CANADA, RADIOCARBON DATES VI; Radiocarbon, vol. 9, pp. 156-197, 1967. (Also reprinted as Geol. Surv. Can., Paper 67-2, Part B.)

One hundred and fifty-eight radiocarbon age determinations made by the Geological Survey of Canada Radiocarbon Dating Laboratory are reported. They are on specimens from the following parts of Canada: Prince Edward Island (1); Quebec (8); Ontario (16); Manitoba (6); Saskatchewan (8); Alberta (15); British Columbia (14); Yukon (4); N.W.T. - mainland (17); N.W.T. - Arctic Islands (69). Comparative sets of dates on a bison jaw and

teeth from the jaw show good agreement between the collagen of the jaw and the dentin of the teeth, but the inorganic (carbonate) fractions of both are much younger and do not agree with one another. Further tests for contamination of marine and freshwater shells, and of peats from permafrost areas, are tabulated. In all cases (and all samples gave finite ages) there was good agreement between the different fractions of shell material and between the more soluble (humic) and less soluble fractions of peat.

MacLaren, A.S., and Charbonneau, B.W.

CHARACTERISTICS OF MAGNETIC DATA OVER MAJOR SUBDIVISIONS OF THE CANADIAN SHIELD; Proc. Geol. Assoc. Can., vol. 19, pp. 57-65, 1968.

An aeromagnetic anomaly map containing most of the presently available data over the Canadian Shield and adjacent areas is presented. Several interesting features are also shown at enlarged scales.

The magnetic expressions of portions of the Grenville-Superior, Superior-Churchill, and Churchill-Slave metamorphic 'fronts' within the area of compilation are compared with each other and with the Moose River magnetic belt which lies wholly within the Superior structural province.

Une carte des anomalies magnétiques du Bouclier canadien et des régions voisines est présentée, contenant le maximum de résultats acquis jusqu'à maintenant. Plusieurs détails intéressants apparaissent à plus grande échelle.

Les caractères généraux des portions du front métamorphique Grenville-Superior, Superior-Churchill, Churchill-Slave, qui font partie de la région étudiée sont comparés entre eux et à la "ceinture magnétique" de Moose River située entièrement dans la province structurale Superior.

McGregor, D.C.

COMPOSITION AND RANGE OF SOME DEVONIAN SPORE ASSEMBLAGES OF CANADA; Rev. Palaeobotany Palynology, vol. 1, pp. 173-183, 1967.

Two distinct spore assemblages occur in Lower and (?)early Middle Devonian rocks of Gaspé Bay, Quebec. The older one, which has been dated faunally as Gedinnian, Siegenian and Early Emsian, is associated in its upper part with the so-called Psilophyton flora and contains predominantly small, acamerate and azonate spores with a reticulate, radially ribbed or minutely sculptured exine. Most of the spores are different from any previously described. The younger assemblage, not dated faunally, succeeds the

other abruptly. It contains Ancyrospora spp., Dibolisporites spp., Rhabdosporites langi Richardson, and others of relatively large size which also occur in Eifelian and Early Givetian rocks of Scotland and the U.S.S.R.

In the Canadian Arctic, five successive assemblages of spores have been recognized in the Bird Fiord, Hecla Bay and Griper Bay Formations of the southern Queen Elizabeth Islands. They contain a number of species that also are present in Givetian to Famennian rocks of western Canada, Spitsbergen, Scotland, the U.S.S.R. and Australia. Where faunal control is available, the stratigraphic ranges of many of these species, for example Archaeoperisaccus spp. and Lophozonotriletes cristifer (Luber) Kedo, are in general agreement with the ranges given by Chibrikova (1963), Kedo (1955, 1957), Naumova (1953), and others.

McGregor, D.C.

KRYSHTOFOVICHIA, NIKITINSPORITES, AND ARCHAEOPERISACCUS; (abst.), Can. Botan. Assoc., Palaebot. Sect., 1967, Ann. Meeting, Ottawa, 1967.

1. In 1934, Nikitin described Kryshtofovichia africani, consisting of monolete, two-walled microspores closely associated with sporangia and anchor-spined megaspores, from the Frasnian (Lake Devonian) Petino beds in Voronezh district, U.S.S.R.

2. In 1953, Naumova described dispersed monolete, two-walled miospores, for which she instituted the form-genus Archaeoperisaccus, also from the Petino beds. Subsequently, several workers recorded dispersed Archaeoperisaccus from Frasnian rocks of the U.S.S.R. and Canada.

3. In 1959, Chaloner found isolated anchor-spined megaspores in Frasnian rocks of the Canadian Arctic, noted their similarity to those of Kryshtofovichia, and instituted the name Nikitinsporites canadensis for them.

4. Winslow (unpublished) discovered a specimen of Nikitinsporites bearing four adhering Kryshtofovichia-like miospores, in Frasnian rocks of the Northwest Territories.

5. The present writer recovered dispersed specimens of Archaeoperisaccus from a fragment of the sample from which Chaloner obtained Nikitinsporites canadensis, and also from a sample of rock from the Petino beds.

Comparisons of drawings and photographs, published descriptions, and where possible type specimens of Archaeoperisaccus, Kryshtofovichia, Nikitinsporites, and small spores associated with Nikitinsporites, leads to the conclusion that species of Archaeoperisaccus similar to A. concinnus

Naumova are the microspores of Kryshtofovichia africani. At least one heterosporous Devonian plant, K. africani, possibly a lycopsid, produced monolete microspores of the Archaeoperisaccus type and trilete megaspores of the Nikitinsporites type. Other species of Archaeoperisaccus (e.g. A. timanicus Pashkevich) and other genera of anchor-spined spores (e.g. Ancyrospora and Hystricosporites), all of Devonian age, have not yet been related to any natural plant group or to one another.

Archaeoperisaccus has been recovered only from rocks assigned to the Frasnian stage of the Late Devonian of North America and the U.S.S.R., and has considerable promise as an index fossil. Nikitinsporites may be similarly restricted, but this suggestion has yet to be confirmed.

Mott, R.J.

A RADIOCARBON-DATED MARINE ALGAL BED OF THE CHAMPLAIN SEA EPISODE NEAR OTTAWA, ONTARIO; Can. J. Earth Sci., vol. 5, pp. 319-324, 1968.

A bed of marine algae (seaweed) in a sand pit in Champlain Sea sediments southwest of Ottawa, Ontario, was dated by the radiocarbon method and gave an age of 10,800 ± 150 years (GSC-570). Marine shells from above and below the algal bed gave radiocarbon ages of 10,620 ± 200 years (GSC-587) and 10,880 ± 160 years (GSC-588) respectively.

The algae and underlying shells have been excellently preserved as a result of rapid burial following deposition and remaining beneath a high water table. The similarity of the radiocarbon dates on the algae and on the shells above and below, and with previous dates on shells from other Champlain Sea deposits indicates the reliability of these shell dates.

Mott, R.J., and Prest, V.K.

STRATIGRAPHY AND PALYNOLOGY OF BURIED ORGANIC DEPOSITS FROM CAPE BRETON ISLAND, NOVA SCOTIA; Can. J. Earth Sci., vol. 4, pp. 709-724, 1967.

Pollen analysis of four non-glacial, sub-till deposits on Cape Breton Island, Nova Scotia, yielded pollen assemblages indicative of climates cooler than the present in that area. New radiocarbon dates from Hillsborough (>51,000 years), Bay St. Lawrence (>38,300), and Whycocomagh (>44,000 years) place the deposition of these deposits in pre-classical Wisconsin time. The Hillsborough and Whycocomagh deposits are considered to be time-equivalent based on pollen analysis. A lack of distinct assemblages at Bay St. Lawrence and Benacadie prohibits correlation with one another and with the Hillsborough and Whycocomagh beds. Inferences drawn

from the pollen flora and the stratigraphy indicate an early Wisconsin interstadial age for these deposits rather than a Sangamon interglacial age. They are tentatively correlated with the St. Pierre interstade in Quebec.

Norris, A.W.

DEVONIAN OF NORTHERN YUKON TERRITORY AND ADJACENT DISTRICT OF MACKENZIE; Proc. International Symposium on the Devonian System, Alta. Soc. Petrol. Geologists, vol. 1, pp. 753-780, 1967.

Conclusions are based on some 36 sections studied by members of the GSC Operation Porcupine in 1962 in an area of about 80,000 square miles north of latitude 65 degrees and west of longitude 132 degrees.

Formation names used comprise the Michelle, Gossage, Prongs Creek, Cranswick, Ogilvie, Hume, Hare Indian, Canol, an unnamed shale, and Imperial - of which the first five are new.

The Michelle Formation of Emsian to Eifelian age consists of limestone, dolomite and shale developed in the Hart-Ogilvie Rivers area. The Gossage Formation applies to banded dolomites and limestones roughly coeval with the Bear Rock evaporites and breccia. The Prongs Creek Formation applies to shale, argillaceous limestone and chert developed in the Richardson Mountain uplift, and ranges in age from Lower to Middle Devonian and possibly younger. The Cranswick Formation of Eifelian age consists of limestone and calcareous shale developed in the Snake River area. The Ogilvie Formation of Eifelian to Givetian age consists of resistant grey-weathering carbonates. The Hume Formation of Eifelian to Givetian age pinches out westward near Snake River. An unusually thick sequence of green calcareous shale in the Snake River area is referred to the Hare Indian Formation, but is largely older than this formation of the type area. The Canol Shale of Frasnian age occurs mainly in the eastern part of the area. The unnamed shale refers to an interval of poorly exposed shales ranging in age from Middle to Upper Devonian present mainly in the Ogilvie Mountains. The Imperial Formation of Frasnian to Famennian age consists of clastic rocks up to 6,000 feet thick.

Norris, D.K.

STRUCTURAL ANALYSIS OF THE QUEENSWAY FOLDS, OTTAWA, CANADA; Can. J. Earth Sci., vol. 4, pp. 299-321, 1967.

The Queensway folds are an anticline-syncline pair in layered limestone and shale of the Ottawa Formation in the Ottawa-St. Lawrence

Lowlands. They are parallel, flexural-slip folds with horizontal axes trending northwest, parallel to the surface trace of the Gloucester fault.

Five principal fracture subpatterns were recognized in the fold-pair, caused by at least four geometrically distinct stress fields. The principal stress directions at failure for all five subpatterns coincided, moreover, with the three orthogonal fabric axes, and the maximum principal stress was either parallel or perpendicular to the fold axes and to the Gloucester fault.

Slickenside striae on bedding and on fractures at an angle to bedding indicate two principal kinematic patterns in the fold-pair; the one arises from motion in the deformation plane as a consequence of the folding and the other from strike-slip motion perpendicular to that plane as a consequence of displacement on the Gloucester fault.

Slickensides indicate that each bed was free to move relative to adjacent ones during folding and that the fundamental structural unit in flexural-slip folding is the bed. Model studies support the field data and indicate that the sense and magnitude of interbed slip in any structural position is dependent upon an integral of conditions throughout the fold-pair and that the fundamental fold unit is the anticline-syncline pair.

Pedder, A.E.H.

LYRIELASMA AND A NEW RELATED GENUS OF DEVONIAN TETRACORALS; Proc. Roy. Soc. Victoria, vol. 80, pp. 1-30, 1967.

The type species of Lyrielasma and six related species from the Lower Devonian of SE Australia are described and figured. Subspecies are recognized in three of these and a variety in another. The generic concept of Lyrielasma is conserved by referring to it only species having a peripheral stereozone containing an appreciable amount of lamellar sclerenchyme. Similar fasciculate species lacking such a stereozone are placed in a new genus Embolophyllum. As originally named the type species of Lyrielasma was a junior primary homonym; a new name therefore is proposed for it. Systematically treated taxa are: Lyrielasma chapmani chapmani nom. nov., L. chapmani praecursor Philip, L. sp. nov., cf. L. chapmani nom. nov., Embolophyllum asper (Hill), E. aggregatum aggregatum (Hill), E. aggregatum cracente subsp. nov., E. aequiseptatum aequiseptatum (Hill), E. aequiseptatum buchanense subsp. nov., E. mundum sp. nov., E. (?) mansfieldense (Dun), E. (?) mansfieldense var. fecundum nov.

Pedder, A.E.H.

LOWER DEVONIAN STREPTELASMATID, LINDSTROEMIID AND POSSIBLE AMPLEXOCARINIID CORALS FROM VICTORIA; Proc. Roy. Soc. Victoria, vol. 80, pp. 107-130, 1967.

Four new genera and eight new, or newly combined species are described and figured, their systematics and distribution being as follows:

Family STREPTELASMATIDAE

Streptelasma (?) vagans sp. nov., late Gedinnian or Siegenian, Loyola, Vict.

Family LINDSTROEMIIDAE

Haptophyllum erisma (Hill) gen. nov., Emsian, Buchan, Vict.
Taralasma radiatum (Hill) gen. nov., Emsian, Buchan, Vict.
Tanjilasma meridionale (Philip) gen. nov., late Gedinnian or Siegenian, Tyers R., Vict.
Metriophyllum devexicarinatum sp. nov., late Gedinnian or Siegenian, Tyers R., Vict.
M. solidum solidum sp. et subsp. nov., Emsian, Buchan, Vict.
M. solidum murrindalense sp. et subsp. nov., Emsian, Buchan, Vict.
Boolelasma pycnotheca gen. et sp. nov., late Gedinnian or Siegenian, Tyers R., Vict.

Family AMPLEXOCARINIIDAE

Amplexocarinia (?) fistella sp. nov., late Gedinnian or Siegenian, Loyola, Vict.

Philip, G.M.,[1] and Pedder, A.E.H.

THE AGE OF THE LILYDALE LIMESTONE (DEVONIAN), VICTORIA; J. Paleontol., vol. 41, pp. 795-798, 1967.

The Lilydale Limestone, in the highest part of the Yering Group, Victoria, contains conodonts, in particular Eognathodus sulcatus Philip, which indicate correlation with the early Siegenian Coopers Creek Formation of eastern Victoria (previously thought to be significantly older than the Lilydale Limestone). A re-assessment of the Lilydale tetracoral fauna supports this correlation, particularly in the common occurrence of Lyrielasma subcaespitosum (Chapman, non Meek) and Paradisphyllum ops (Philip). This assignment of the Lilydale Limestone to the early Siegenian places an upper limit to the age of the Yering Group.

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[1] University of New England, N.S.W., Australia.

Philip, G.M., [1] and Pedder, A.E.H.

A CORRELATION OF SOME DEVONIAN LIMESTONES OF NEW SOUTH WALES AND VICTORIA; Geol. Mag., vol. 104, pp. 232-239, 1967.

A sequence of 11 tetracoral and conodont faunas, ranging from early Gedinnian to late Givetian, is recognized in the Lower and Middle Devonian limestones of New South Wales and Victoria. These faunas are not only important stratigraphically in eastern Australia, but also provide a basis for the correlation of the Australian Devonian with overseas stages. A table of correlation is given for the principal Devonian limestone sequences of New South Wales and Victoria.

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[1] University of New England, N.S.W., Australia.

Poole, W.H.

TECTONIC EVOLUTION OF APPALACHIAN REGION OF CANADA; in Geology of the Atlantic region, Geol. Assoc. Can., Spec. Paper No. 4, pp. 9-51, 1967.

The Appalachian Geosyncline (in broad sense) developed from late Hadrynian (latest Proterozoic) to Permian. Throughout its evolution, the geosyncline was bounded on the northwest by the St. Lawrence Platform comprising a pre-Hadrynian, Grenville crystalline basement upon which was deposited platform-type sediments during the Palaeozoic. Within the southeast part of the geosyncline, the Avalon Geosyncline with Hadrynian volcanic-bearing strata was developed, and was locally deformed and intruded by Hadrynian granite. By latest Hadrynian, the geosyncline had been converted to the Avalon Platform, upon which were deposited relatively thin, marine, dominantly pelitic sediments of Cambrian to Early Ordovician age. From Cambrian to Devonian, the Avalon Platform in southern New Brunswick and Cape Breton Island separated the Acadian Geosyncline to the northwest from the Meguma Geosyncline to the southeast. Three phases of the Ordovician Taconian Orogeny in the Acadian Geosyncline resulted mainly in ultramafic intrusion in pre-Middle Ordovician volcanic belts; local folding, metamorphism and granite intrusion; rise of geanticlinal belts; and the westward movement onto the St. Lawrence Platform of West Newfoundland of two klippen of mainly geosynclinal rocks and their contained ultramafic-mafic intrusions. The Meguma Geosyncline was essentially unaffected by Taconian Orogeny.

Silurian and Lower Devonian sediments and volcanics are mainly shallow-water and subaerial types, in contrast to the deep-water strata of the Ordovician. During the Middle and Late Devonian Acadian Orogeny, almost

the entire Appalachian Geosyncline was deformed, intruded extensively by granites, converted to a semi-stable orogen, uplifted and eroded. Upper Devonian to Permian, mainly continental red-bed sediments and minor local volcanic rocks were deposited unconformably upon the orogen. A sea occupied part of the area only once, during middle Mississippian, and deposited Windsor limestone, evaporites and associated clastics. Thickest deposits occur in the Fundy Geosyncline, a zone of faulted orogen extending from Bay of Fundy to White Bay, Newfoundland, which was bordered by late Palaeozoic platforms. The geosyncline consisted of many troughs, basins, and uplifts. Faulting, basinal subsidence, and block uplift of the Maritime Disturbance controlled deposition and gave rise to local folding and unconformities. Coal swamps were common in late Pennsylvanian. By Permian time, tectonic activity of the Maritime Disturbance had all but ceased. Upper Triassic continental red beds and basalt were deposited in a fault-trough formed along part of the southern edge of the Fundy Geosyncline. Post-Triassic was a time mainly of erosion, intrusion of Cretaceous Monteregian stocks in southwestern Quebec, and of Jurassic or Cretaceous lamprophyres in northeastern Newfoundland, and of deposition on continental shelves.

Le Géosynclinal Appalachien (sensu lato) s'est développé depuis l'Hadrynien supérieur (Protérozoïque le plus tardif) jusqu'au Permien. Pendant toute son évolution il était bordé au Nord-Ouest par la Plate-forme du Saint-Laurent comprenant un soubassement cristallin grenvillien pré-Hadrynien sur lequel se sont accumulés au cours du Paléozoïque des sédiments typiques du milieu de plate-forme. Dans le secteur sud-est du grand géosynclinal, s'est développé le Géosynclinal d'Avalon constitué de strates et d'éléments volcaniques hadryniens qui, par la suite ont été localement déformés et recoupés par un granite hadrynien. A la toute fin de l'Hadrynien ce géosynclinal devenait la Plate-forme d'Avalon laquelle du Cambrien à l'Ordovicien inférieur, reçut un dépôt de sédiments marins surtout pélitiques et relativement minces. Du Cambrien au Dévonien, dans le secteur du Nouveau-Brunswick méridional et de l'île du Cap-Breton, la Plate-forme d'Avalon s'intercalait entre le Géosynclinal Acadien au Nord-Ouest et le Géosynclinal de Meguma au Sud-Est.

Trois phases de l'Orogénèse Taconienne ordovicienne modifièrent le Géosynclinal Acadien. Il y eut successivement la mise en place d'amas ultrabasiques dans les zones volcaniques pré-Ordovicien moyen, un plissement local, un métamorphisme, une intrusion granitique, le soulèvement de sillons géanticlinaux et finalement le transport vers l'Ouest jusque sur la Plate-forme laurentienne du Terre-Neuve occidental de deux klippen constitués surtout de formations géosynclinales et des intrusions ultrabasiques et basiques qu'elles contenaient. Par contre le Géosynclinal de Meguma n'a presque pas été affecté par l'Orogénèse Taconienne.

Les sédiments et laves du Silurien et du Dévonien inférieur qui révèlent principalement un milieu marin peu profond ou un milieu subaérien accusent un contraste marqué avec les formations d'eau profonde de

l'Ordovicien. Lors de l'Orogénèse Acadienne se situant au Dévonien moyen et supérieur presque tout le Géosynclinal Appalachien a été déformé, recoupé par de nombreux massifs granitiques, transformé en un orogène semi-stable, exhaussé puis finalement érodé. A partir du Dévonien supérieur jusqu'au Permien des sédiments principalement en lits rouges et de type continental et, ici et là quelques minces coulées volcaniques, formèrent à la surface de l'orogène une couverture discordante. La mer n'envahit qu'une fois et qu'une partie de cette région au cours du Mississipien moyen. A cette invasion se rattachent le calcaire de Windsor et des évaporites associées à des dépôts détritiques. Les dépôts les plus épais se situent dans le Géosynclinal de Fundy qui s'étend de la baie de Fundy à la baie Blanche à Terre-Neuve. C'est une zone d'orogénèse traversée de failles et flanquée de plate-formes ayant pris naissance au Paléozoïque supérieur. Ce géosynclinal comptait plusieurs fosses, bassins et sillons. L'épisode de la Déformation Maritime qui se caractérisa par le développement de failles, l'affaissement de bassins et la soulèvement de blocs contrôla à ce moment la sédimentation et donna lieu localement à un plissement et à des discordances. Des marécages houillers abondèrent au Pennsylvanien. Au Permien toute activité tectonique se rattachant à la Déformation Maritime avait cessé. Des basaltes accompagnés de lits rouges continentaux s'accumulèrent au Trias supérieur dans un fossé bordé de failles qui longeait en partie la bordure sud du Géosynclinal de Fundy. Après le Trias commença une période d'érosion entrecoupée au Sud-Ouest du Québec lors du Crétacé par la mise en place des stocks montérégiens et au Nord-Est de Terre-Neuve, au Jurassique ou Crétacé, par l'intrusion de lamprophyres. Concurremment s'effectuait une sédimentation des plate-formes continentales.

Rimsaite, J.

BIOTITES INTERMEDIATE BETWEEN DIOCTAHEDRAL AND TRIOCTAHEDRAL MICAS; Clays and Clay Minerals, Proc. 15th Conf., New York, Pergamon, pp. 375-393, 1967.

Orange-yellow detrital flakes of biotite are common carriers of potassium and trace elements in soils and clays. Because the flakes differ in degree of alteration and may be derived from different sources, it is difficult to obtain homogeneous material for studies of their physical and chemical properties that may be compared with the original mica. A similar orange-yellow altered biotite occurs with fresh biotites in alkalic rocks of a nepheline deposit. The fresh and altered biotites were separated for chemical and mineralogical studies of the effects of weathering on biotite in its parent rock.

The common iron-rich biotites with octahedral occupancy between 5.5 and 5.8 alter to bright orange-yellow biotites with octahedral occupancy approaching five. These biotites, intermediate between the trioctahedral and

dioctahedral micas, form as a result of oxidation during the process of their alteration to chlorite-vermiculite.

Biotites with octahedral occupancy approaching five were prepared experimentally by heating a natural biotite that contained high ferrous iron. The main differences between the natural and laboratory oxidized biotites are: the naturally oxidized micas lose 30 per cent of the original potassium, adsorb about 2 wt. per cent water, and apparently gain about 25 per cent hydroxyl, whereas laboratory oxidized micas retain potassium and lose hydroxyl and argon. The oxidized micas retain the crystal structure of the original mica.

Rimsaite, J.

OPTICAL HETEROGENEITY OF FELDSPARS OBSERVED IN DIVERSE CANADIAN ROCKS; Schweiz. Mineral. Petrog. Mitt., vol. 47, pp. 61-75, 1967.

Nearly one thousand Canadian rocks examined in thin sections are found to contain heterogeneous feldspars. Nine types of heterogeneity and five morphological types of alteration are distinguished and described. Distinctions are made on the basis of optical heterogeneity, and corresponding variations in chemical composition have been confirmed by chemical tests on a few samples. Occurrence and distribution of these feldspars in 200 rocks of diverse age, origin and type are summarized. Heterogeneity may result from environmental changes during crystal growth or from subsequent migration of ions. Migration of ions may be recognized from a study of heterogeneous feldspars and is particularly important for evaluation of chemical analyses and trace-element studies.

Rimsaite, J.

STUDIES OF MICAS FROM UNCOMMON ROCKS: I. MICAS FROM NEPHELINE SYENITE, BLUE MOUNTAIN, ONTARIO AND FROM CARBONATITE, OKA, QUEBEC; Can. Mineralogist, vol. 9, Pt. 2, p. 304, 1967.

Chemical compositions and paragenetic studies of micas from the Blue Mountain nepheline deposit indicate at least five periods of crystallization of micaceous minerals:

1. Brown biotite: $(K_{1.9}Na_{.07})(Al_{.66}Ti_{.24}Fe_{.42}^{'''}Fe_{2.14}^{''}Mg_{2.02}Mn_{.08}Li_{.08})(Si_{5.2}Al_{2.8})O_{20}(OH_{2.99}F_{.27}Cl_{.18}O_{.28})$ resembles in chemical composition biotites of the surrounding paragneisses. It contains more manganese and titanium, and appears to be older than other micas from the nepheline synenite. It is succeeded by

2. Coarse-grained muscovite: with brown bands along the (001) fractures; and

3. Bright-green biotite: $(K_{1.91}Na_{.08})(Al_{.54}Ti_{.15}Fe_{1.02}^{'''}Fe_{2.54}^{''}Mg_{1.07}Mn_{.09}Li_{.09})(Si_{5.27}Al_{2.73})O_{20}(OH_{2.42}F_{.32}Cl_{.06}O_{.60})$. The green biotite replaces the brown mica along the fractures. It contains a relatively high ratio of ferric iron to ferrous iron and apparently crystallizes in an alkalic environment.

4. Medium-fine grained muscovite with fine-grained cancrinite replace nepheline along the fractures, and are post-nepheline.

5. Very-fine grained "hydronephelite": a mixture of muscovite and analcite, is a hydrothermal or diagenetic alteration product of nepheline; it also replaces feldspars and coarse micaceous minerals. The "hydronephelite" contains relatively high strontium (777 ppm) and very little iron (0.4%).

The iron-rich biotite oxidizes on weathering to orange-yellow mica that contains a high ratio of ferric iron to ferrous iron: $(K_{1.34}Na_{.08}Ca_{.08})(Al_{.37}Ti_{.13}Fe_{2.94}^{'''}Fe_{.38}^{''}Mg_{1.2}Mn_{.07})(Si_{5.05}Al_{2.95})O_{19.34}(OH_{4.99}F_{.30})$, and finally alters to vermiculite.

The biotite from the Oka carbonatite is zoned, thus resembling zoned biotites from alkali lamprophyres. However, the succession of the mica zones is different; in micas from alkali lamprophyres the outermost band adjacent to feldspathic groundmass is enriched in iron, whereas in micas from the carbonatite, the outermost band adjacent to carbonate groundmass is pale beige (poor in iron). Electron probe microanalysis of the zoned micas indicated two- to five-fold variations in concentrations of Al, Fe, Mg and Ti while Si and K remained fairly constant. The zoned mica reflects changing physico-chemical conditions during crystallization of carbonatite.

This study presents two examples of the stability of micas: (1) the zoned mica with earlier-formed zones retaining their chemical composition during crystallization of successive zones in a calcic environment, and (2) the unstable brown mica which is being replaced by green mica under apparently alkalic conditions.

Roddick, J.A., Wheeler, J.O., Gabrielse, H., and Souther, J.G.

AGE AND NATURE OF THE CANADIAN PART OF THE CIRCUM-PACIFIC OROGENIC BELT; Tectonophysics, vol. 4, No. 6, pp. 319-337, 1967.

The Canadian Cordilleran orogen evolved from a miogeosyncline which existed from Proterozoic to mid-Jurassic time in the Rocky Mountains

and part of the Yukon, and a more or less contemporaneous, complex eugeosyncline on the west.

The history of the eugeosynclinal belt since the mid-Palaeozoic, was influenced by the more or less persistent Coast and Omineca crystalline geanticlines and at times, by the non-metamorphic Pinchi geanticline between them.

Since mid-Triassic time the crystalline geanticlines have been the principal sites of frequent uplift, recurrent granitic intrusion, metamorphism and deformation.

Orogeny was rarely widespread at any time. The crystalline geanticlines were repeatedly deformed but not always synchronously, whereas adjoining troughs were rarely deformed more than once.

Orogenic pulses took place at the following times: Proterozoic, Early and mid-Palaeozoic, Middle and locally Early Triassic, Middle Jurassic, latest Jurassic and earliest Cretaceous, mid-Cretaceous, Early and Late Tertiary.

Roed, M.A.,[1] Mountjoy, E.W.,[2] and Rutter, N.W.

THE ATHABASCA VALLEY ERRATICS TRAIN, ALBERTA AND PLEISTOCENE ICE MOVEMENTS ACROSS THE CONTINENTAL DIVIDE; Can. J. Earth Sci., vol. 4, pp. 625-632, 1967.

The Athabasca Valley Erratics Train contains a variety of low- to medium-grade metamorphic rocks, the most abundant of which is talcose schist, with lesser amounts of garnet schist and biotite-quartz schist. This erratics train occurs in and west of the Athabasca Valley west of Edson, Alberta. It is probably a late stage deposit of the same glacier that carried and deposited the Erratics Train, Foothills of Alberta. The metamorphic erratics were incorporated into a glacier that originated in the northern part of the Monashee Mountains and Premier Range of British Columbia. This ice movement is also recorded by numerous U-shaped valleys, which extend across the Continental Divide. Thus, during a brief period in late(?) Wisconsin time, the Cordilleran ice in the Rocky Mountains of the Jasper National Park area was partly derived from west of the Continental Divide and the Rocky Mountain Trench. These data agree with the inferred ice movements shown on the 1958 Glacial Map of Canada.

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[1] University of Alberta, Edmonton.

[2] McGill University, Montreal.

Russell, D.A.[1], and Chamney, T.P.

NOTES ON THE BIOSTRATIGRAPHY OF DINOSAURIAN AND MICROFOSSIL FAUNAS IN THE EDMONTON FORMATION (CRETACEOUS), ALBERTA; Nat. Mus. Can., Natural History Papers, No. 35, pp. 1-22, 1967.

In the course of examining fossil vertebrate collections and sediment samples from the lower portion of the Edmonton Formation of the Red Deer valley in Alberta, the authors have noted the occurrence of distinct dinosaurian and microfossil assemblages within the unit. Both authors have studied this outcrop area of the Edmonton, and the discussion of the local stratigraphy given below is the result of their mutual deliberations. Otherwise microfossil materials have been collated by Chamney, and Russell is responsible for comments relating to the dinosaurs.

The lower member (sensu Bell 1949, or members A to D of Ower) of the Edmonton Formation in the Red Deer valley is recognized as an essentially symmetrical sequence of sedimentary facies bounded above and below by marine shales. The sequence begins with beach sands at the base of the formation, and these are overlain by brackish water coal-bearing deposits and then freshwater siltstones and shales. The sequence is then reversed, although the sedimentary facies are thinner in the upper portion of the lower Edmonton. Foraminiferida occur within every sedimentary facies except the freshwater deposits in the centre of the sequence. Edmontosaurus is the only hadrosaur known to occur in the lower coal-bearing strata, whereas Cheneosaurus, Hypacrosaurus, and Saurolophus occur in the central freshwater facies. Anchiceratops occurs in association with both hadrosaurian faunas.

[1] National Museum of Canada, Ottawa.

Schwarz, E.J.

DEPENDENCE OF MAGNETIC PROPERTIES ON THE THERMAL HISTORY OF NATURAL POLYCRYSTALLINE PYRRHOTITE, $Fe_{0.89}S$; J. Geomagnetism Geoelectricity, vol. 19, No. 2, pp. 91-101, 1967.

Thirty-two specimens of virtually pure pyrrhotite were annealed at temperatures up to 600°C for periods ranging from 10 minutes to several days in argon atmosphere. Magnetic properties of these specimens were determined with a magnetic balance or a ballistic magnetometer both before, during and/or after annealing. The results show that both the magnetization at 20°C in fields up to 2,550 oe and the occurrence of the γ transition depends on the thermal history of the specimen. The data obtained during and after

annealing strongly support the concept of variations in the degree of sublattice component order affecting the magnetic susceptibility. The degree of order seems to be high after annealing at 400°C, and it seems to be drastically reduced during annealing at 600°C. An application of the dependence of magnetic properties on the thermal history of pyrrhotite to problems in ore genesis is not yet apparent.

Schwarz, E.J.

THERMOMAGNETIC ANALYSIS AND ORE GENESIS; Can. J. Earth Sci., vol. 4, pp. 1119-1125, 1967.

The potential of rock magnetism in studies on the genesis of ore deposits is examined. It is suggested that techniques based on magnetic properties other than the direction of the stable part of the natural remanent magnetization might prove usefully applicable. More specifically the analysis of the type of remanent magnetization in ores and their wall rocks is suggested as a worthwhile approach in the study of ore genesis. Other methods suggested are based on the occurrence of chemical or physical changes affecting ferromagnetic minerals in ores during heating. It may be possible to relate the results of such experiments to the thermal conditions prevailing at the time of either formation of minerals in ore deposits or acquisition of stable remanent magnetization.

Schwarz, E.J., and Christie, K.W.

ORIGINAL REMANENT MAGNETIZATION OF ONTARIO POTSHERDS; J. Geophys. Res., vol. 72, No. 12, pp. 3263-3269, 1967.

The nature of the original remanent magnetization of eighteen potsherds dated between 500 B.C. and 1700 A.D. was investigated by comparing its thermal decay with the acquisition of pTRM in the present geomagnetic field. The original remanence of these specimens is complex rather than pure and stable TRM acquired during cooling through the Curie point in the contemporary geomagnetic field after the pots were originally fired. A comparison of CRM and pTRM acquired by synthetic Fe_3O_4 with the results obtained for the potsherds indicates that most of the sherds acquired CRM during firing well below the Curie point and pTRM during cooling after the original firing. A comparison of the original pTRM component of the sherds with pTRM acquired in the present geomagnetic field suggests a decrease in geomagnetic total force in South-West Ontario during the last two millenniums. This conclusion is in qualitative agreement with results obtained elsewhere.

Schwarz, E.J., and Symons, D.T.A.

ON THE INTENSITY OF THE PALEOMAGNETIC FIELD BETWEEN 100 MILLION AND 2,500 MILLION YEARS AGO; Phys. Earth Planet. Interiors, vol. 1, pp. 122-128, 1968.

The thermal decay of the natural remanent magnetization was compared with the acquisition of thermoremanent magnetization in a field of 0.49 Oe for 41 samples of igneous rocks. The radiometric ages of these rocks are between 100 m.y. and 2,500 m.y. Both the low and high stability components of the natural remanence of most of the samples are complex. However for 25 samples, at least the component of intermediate stability against heating is interpreted to be of the thermoremanent type. The data obtained after heating to at least four successive temperatures in the intermediate temperature range were used to calculate the field strength at the contemporary magnetic equator. The results of these calculations tentatively suggest that the equatorial paleomagnetic intensity 1) decreased between 200 m.y. and 100 m.y. ago, 2) increased between 600 m.y. and 200 m.y. ago, and 3) ranged between limits of 0.2 and 0.9 Oe with an average of approximately 0.45 Oe for the rest of the Precambrian era investigated in this preliminary study. The Precambrian results tend to suggest a high and low equatorial field strength respectively 1,100 m.y. and 1,400 m.y. ago.

Simpson, P.R.,[1] and Chamberlain, J.A.

NICKEL DISTRIBUTION IN SERPENTINITES FROM PUDDY LAKE, ONTARIO; Proc. Geol. Assoc. Can., vol. 18, pp. 67-91, 1967.

Nickel in a serpentinite body of Archaen Age at Puddy Lake is partitioned variably between several spinel phases, sulphides and silicates. Serpentinites in which nickel is concentrated in magnetite are notable for a near-absence of sulphides. Conversely, serpentinites in which magnetite is nickel-poor contains the following relatively abundant sulphides: chalcopyrite, millerite, siegenite, pyrite, sphalerite and pentlandite. Sulphur content of serpentinite is thus an important factor in nickel distribution at Puddy Lake.

Sulphide textures and sulphur distribution suggest that sulphur was present in the magma during emplacement and that nickel equilibrated between sulphides, silicates and oxides. The nickel-rich magnetite, which on an average contains 1.25 per cent nickel, was formed during serpentinization of the original dunite in zones which were relatively sulphur-deficient. This nickel-rich secondary magnetite appears to have been partly remobilized by hydrothermal solutions into coarse veins near contacts with a younger granite intrusion.

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[1] Geology Department, Cambridge University, England.

Le nickel dans un massif de serpentine d'âge archéen au lac Puddy est réparti de façon variable entre plusieurs phases de spinelle, des sulfures et des silicates. Les serpentines dans lesquelles la magnétite est fortement nickélifère se distinguent par l'absence presque totale de sulfures. Par contre, les serpentines dans lesquelles la magnétite a une faible teneur en nickel présentent une abondance relative des sulfures suivants: chalcopyrite, millérite, siegénite, pyrite, sphalérite et pentlandite. La teneur en soufre de la serpentine est donc un facteur important dans la répartition du nickel au lac Puddy.

Les textures des sulfures et la répartition du soufre portent à croire que le soufre était présent dans le magma durant la mise en place et que le nickel était équilibré entre les sulfures, les silicates et les oxydes. La magnétite fortement nickélifère, qui renferme 1.25 p. 100 de nickel en moyenne, a été formée lors de la transformation de la dunite initiale en serpentine dans des zones qui étaient relativement pauvres en soufre. Cette magnétite secondaire riche en nickel semble avoir été reformée par l'effet de solutions hydrothermiques en veines grossières au voisinage des contacts avec une intrusion granitique plus récente.

Souther, J.G.

ACID VOLCANISM AND ITS RELATIONSHIP TO THE TECTONIC HISTORY OF THE CORDILLERA OF BRITISH COLUMBIA, CANADA; Bull. Volcanologique, tome XXX, pp. 161-176, 1967.

Volcanic activity has occurred intermittently in the Canadian Cordillera from Proterozoic to Recent time. The pre-Carboniferous volcanic rocks are confined to small areas in the eastern belt of the Cordillera but those of Carboniferous and younger age are widely distributed in the western and central belts, and their sequence and place of eruption can be related to other events in the tectonic history of the region.

Five main episodes of volcanic activity are recognized: (1) Permo-Carboniferous, (2) Upper Triassic to Middle Jurassic, (3) Upper Cretaceous to Eocene, (4) Miocene-Pliocene, (5) Pleistocene and Recent. The rock assemblages related to each episode are separated, one from another, by regional unconformities or disconformities and each assemblage is characterized by a different type of volcanism. During the Permo-Carboniferous, widespread submarine eruption of basalt and basic andesite was accompanied by extensive faulting and intrusion of ultrabasic bodies. The Upper Triassic to Middle Jurassic was a time of extreme tectonic activity during which great thicknesses of clastic sediments as well as andesitic and spilitic lavas accumulated in the eugeosyncline. Volcanism during the Upper Cretaceous-Paleocene was of the explosive type, yielding mainly pyroclastic deposits of rhyolitic to andesitic composition. During the Miocene and early Paleocene vast areas of the central Cordillera were flooded with

basalt flows that spread in thin sheets over much of the interior plateau of British Columbia. Composite cones and inter canyon flows of dacite and olivine basalt were erupted during Pleistocene and Recent time.

The Upper Cretaceous-Paleocene volcanism produced a unique assemblage of predominantly acid and intermediate rocks consisting of welded-tuffs, explosion-breccias and minor flows associated with ring-dikes and collapse features. This volcanism corresponds in time with a period of extensive plutonism, during which large bodies of quartz monzonite were intruded along the eastern margin of the Coast Range Crystalline Belt. Field evidence and radiometric ages, as well as chemical and petrographic data support the conclusion that the acid volcanism and quartz monzonite intrusion are related to the same episode of plutonic activity and that both were derived from the same magma.

(J.G.S.)

Stalker, A. MacS.

IDENTIFICATION OF SASKATCHEWAN GRAVELS AND SANDS; Can. J. Earth Sci., vol. 5, pp. 155-163, 1968.

'Saskatchewan gravels and sands' is the name used for numerous, widely scattered deposits of gravel and sand found on the Canadian Prairies. These deposits represent the final phase of deposition by preglacial rivers before the first Pleistocene ice-sheet disrupted regional drainage. In the past, Saskatchewan gravels and sands have been identified chiefly by their absence of stones from the Canadian Shield and position below the drift in buried valleys or on low ground. These remain the basic criteria. Sole dependence on them, however, has resulted in extraneous deposits being called Saskatchewan. Such misidentifications cannot be eliminated entirely, but their number can be greatly decreased by use of additional checks. These include intensive study of each deposit and its topographic position, and establishing that there was both an adequate source for the gravel and sand contained in it and competent means of transporting that material from source to present site. In addition, the valley containing the deposit must have formed an integral part of the preglacial drainage system, its cross-section and longitudinal profile must have resembled those of a typical preglacial valley, and there must not have been any competing valley that could have carried the local, preglacial drainage more efficiently.

Taylor, G.C.

SURFACE DEVONIAN STRATIGRAPHY OF NORTHEAST BRITISH COLUMBIA; Proc. International Symposium on the Devonian System, Alta. Soc. Petrol. Geologists, vol. 2, p. 148, 1967.

Five lithologically distinct rock units of Devonian age are recognized in this area. New formation names have been proposed for all except an uppermost, previously named sequence of dark-grey shales, the Besa River Formation.

Strata of Early Devonian age in this region rest unconformably on Silurian rocks. They are divided into two formations, a lowermost sequence of finely crystalline argillaceous dolomite with very rare fossil fish, the Muncho-McConnell; and an overlying Wokkpash Formation of yellow-brown-weathering sandstone, dolomitic sandstone and argillaceous dolomite.

The Middle Devonian beds, separated from underlying strata by a disconformity, are subdivided into three formations; a lower Stone Formation, a middle Dunedin Formation, and overlying shales of the Besa River Formation. The Stone Formation, dated as Eifelian, consists of dolomite, argillaceous dolomite, dolomite breccia and scattered interbeds of limestone. It varies appreciably in thickness within the report area. The Dunedin Formation rests with local disconformity on the underlying dolomites, and has a diachronous upper contact. It consists predominantly of dark-grey argillaceous limestone ranging in age from late Eifelian to Givetian. Changes in thickness of the Dunedin in this region can probably be attributed largely to the diachronous nature of its upper surface. The overlying Besa River Formation is from 1,000 to 3,000 feet thick, and contains fossils of Middle and Upper Devonian and Mississippian ages. Both lower and upper contacts are diachronous.

Trettin, H. P.

DEVONIAN OF THE FRANKLINIAN EUGEOSYNCLINE; Proc. International Symposium on the Devonian System, Alta Soc. Petrol. Geologists, vol. 1, pp. 693-701, 1967.

The magmatic belt of the Franklinian geosyncline, represented by the lower Palaeozoic and Proterozoic rocks of northern Axel Heiberg and Ellesmere Islands, differs in depositional and tectonic history from the "miogeosyncline" in the south.

Devonian sedimentary and volcanic strata are confined to northern Axel Heiberg Island; granitic intrusions occur on both Axel Heiberg and Ellesmere Islands.

The red weathering Lower Devonian Stallworthy Formation comprising about 12,000 feet of quartz-chert arenite; siltstone, conglomerate, shale, and minor tuff indicates non-marine and deltaic environments. Resting unconformably upon late Wenlockian strata, it is a post-tectonic deposit related to movements that began in the Wenlockian, and probably culminated in the early Ludlovian.

The Stallworthy is conformably overlain by the Svartevaeg Formation, about 10,400 feet of graded volcanic arenite and siltstone with keratophyre, spilite, basalt, conglomerate, breccia, and shale. The conglomerates and breccias are submarine slides, and include Silurian

carbonates; the arenites and siltstones are turbidites. The formation, tentatively considered as Middle Devonian, suggests a sudden down-warping which probably preceded a major orogeny culminating in granitic intrusions.

The intrusions comprise numerous small, high-level plutons of quartz diorite, quartz monzonite, granodiorite, diorite, etc., and at least one stock indicative of greater depth. The youngest known strata intruded are Lower Silurian, but a K-Ar age determination suggests emplacement 360 ± 25 m.y. ago, i.e. probably in the late Middle or Late Devonian, just prior to, or contemporaneously with a major uplift of the northernmost regions that produced a thick Upper Devonian clastic wedge in the south.

Trettin, H.P., and Hills, L.V.[1]

TRIASSIC "TAR SANDS" OF MELVILLE ISLAND, CANADIAN ARCTIC ARCHIPELAGO; Proc. World Petro. Congr., 7th Congress, Mexico City, vol. 3, pp. 773-787, 1967.

Bitumen deposits, discovered in the Bjorne Formation of Melville Island in 1962, are the first reported major showing of petroleum in the Arctic Archipelago. Although of no present economic value, they are encouraging for exploration around the margin of the Sverdrup Basin.

The Bjorne Formation, the Lower Triassic marginal facies of the Sverdrup Basin, here forms a homocline dipping gently into the basin, and represents a fan-shaped prograding delta that received sediments from Palaeozoic formations to the south.

Outcrops suggest that between 50 and 100 MM brl of asphaltic oil are present, with only 30 MM brl or less in concentrations above 6 per cent by weight. The bitumen, oxidized and polymerized at the surface to less than 7° API, shows variations in sulphur and nickel content suggestive of variations in original gravity between 16° and 31° API.

The showings are near the depositional limit of the formation, mostly in basement-controlled sedimentary troughs. The oil occurs in sandstones and conglomerates in the upper part of the formation beneath a disconformable Jurassic seal.

Geological evidence and sulphur isotope determinations suggest that it originated in Pennsylvanian to Jurassic beds, and migrated up dip in Middle Jurassic or later time.

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[1] University of Calgary, Alberta

La découverte, en 1962, de dépôts bitumineux dans la formation Bjorne de l'île Melville a été le premier indice important de l'existence de pétrole dans l'archipel de l'Arctique. Bien que ces gisements n'aient aucune valeur commerciale à l'heure actuelle, ils encourageront l'exploration au pourtour du bassin Sverdrup.

La formation Bjorne, qui constitue le facies triasique inférieur du pourtour du bassin Sverdrup, forme ici un pli isoclinal à inclinaison peu prononcée vers l'intérieur du bassin et représente un delta avançant en forme d'éventail qui a reçu des sédiments des formations paléozoïques plus au sud.

Les affleurements portent à croire qu'il y existe entre 50 et 100 millions de barils d'huile bitumineuse, dont seulement 30 millions de barils ou moins s'y retrouvent en concentrations dépassant 6 p. 100 du poids total. Le bitume, oxydé et polymérisé à la surface jusqu'à moins de 7° A. P. I., révèle des teneurs variables de soufre et de nickel qui laissent supposer des variations de 16° à 31° A. P. I. dans la gravité originale.

Le bitume se retrouve près de la limite de dépôt de la formation, surtout dans des fosses sédimentaires formées par la roche de fond. L'huile est renfermée dans les grès et les conglomérats de la partie supérieure de la formation, sous un bouchon jurassique discordant.

Les indices géologiques et les déterminations isotopiques du soufre laissent croire qu'il a pris naissance dans les couches pennsylvaniennes à jurassiques et a remonté la pente lors du Jurassique moyen ou plus tard.

Whitmore, D. R. E.

FILES OF DATA ON MINERAL DEPOSITS - A PROGRESS REPORT; in A national system for storage and retrieval of geological data in Canada, National Advisory Committee on Research in the Geological Sciences, Chap. 14, pp. 54-67, 1967, (Abstract of report by chairman of subcommittee).

A subcommittee representing government, universities and industry makes recommendations on the systematic collection and recording of data on mineral deposits, based on discussions and on a test which involved the creation of a machine-processable file by a group of geologists and its manipulation to provide answers to simple questions.

The committee confined its attention to files of measurements of the characteristics of entire deposits, one of several kinds of file which may relate to mineral deposits. It feels that with further development such files will allow statistical comparisons among various features of mineral deposits

which will suggest fresh insights into their formation and distribution. To achieve this will require not only the development of and adherence to standards but also the creation of new data.

(D.R.E.W.)

Williams, H.

SILURIAN ROCKS OF NEWFOUNDLAND; in Geology of the Atlantic region, Geol. Assoc. Can., Spec. Paper No. 4, pp. 93-137, 1967.

Recent reconnaissance mapping and a review of earlier work indicate that Silurian rocks, mainly of Llandovery and early Wenlock age, are widely distributed throughout Newfoundland. The rocks are everywhere of remarkably similar facies and four lithic units can be recognized as follows: (a) greywackes with conglomerate, siltstone, and slate interbeds, (b) conglomerates with greywacke and argillite interbeds, (c) volcanic rocks, and (d) red to grey micaceous sandstones. The greywacke and conglomerate units are confined to central Newfoundland where in most places they conformably overlie Middle Ordovician (Caradocian) graptolitic slates. The volcanic and sandstone units are more widespread and either overlie earlier Silurian rocks, or else lie directly upon Ordovician or Cambrian rocks. The greywackes and conglomerates, characterized by shelly faunas, are mainly of shallow water marine deposition. The volcanic rocks and overlying sandstones are interpreted to be chiefly of terrestrial accumulation.

Where sedimentation was complete, the Silurian units collectively record a transition from a deep water marine environment to a shallow water marine and then a terrestrial environment. The contrasted facies everywhere evident between Ordovician rocks and terrestrial rocks of the Silurian volcanic and sandstone units, together with the indiscriminate occurrence of Silurian rocks upon Ordovician platforms and volcanic mobile zones alike across the Newfoundland Appalachians, indicate that the development of the system during the Silurian had very little in common with earlier Palaeozoic development. Silurian deposition appears to have been confined to troughs (now largely fault-bounded belts) bordered by contemporaneous tectonic lands and marked by important volcanic episodes at one or more stages during their evolution.

Certains travaux récents de reconnaissance et une réévaluation des anciens travaux, font croire qu'il y a beaucoup de Silurien à Terre-Neuve. Il se rattacherait principalement au Llandovery et au Wenlock inférieur. Un peu partout, on retrouve à peu près le même facies constitué de quatre unités lithologiques qui sont comme suit: (a) grauwacke avec conglomérat, siltstone et entrelits d'ardoises; (b) conglomérat avec grauwacke et entrelits d'argilite; (c) roches volcaniques; (d) grès micacé, allant de rouge à gris. Les unités de conglomérat et grauwacke ne se retrouvent qu'au centre de Terre-Neuve et généralement, ils recouvrent, en concordance des

ardoises graptolitiques de l'Ordovicien moyen (Caradoc). L'assemblage gréso-volcanique est plus commun. On le retrouve, soit recouvrant un Silurien plus ancien, soit reposant directement sur des formations ordoviciennes ou cambriennes. L'unité de grauwackes et conglomérats qui possède souvent une faune coquillière appartient, en grande partie, à un milieu marin peu profond. Les coulées volcaniques et les grès qui les recouvrent se rattachent, à notre avis, à un milieu terrestre.

Là, où la sédimentation s'est poursuivie d'une façon continue, l'ensemble des unités siluriennes révèle un passage graduel d'un milieu marin profond à un milieu marin peu profond pour finalement aboutir à des conditions terrestres.

Le contraste de facies, que l'on observe partout entre l'Ordovicien et les formations terrestres volcano-détritiques du Silurien, joint à la présence, sans discrimination, du Silurien sur les plate-formes ordoviciennes et les zones mobiles volcaniques à travers toutes les Appalaches terreneuviennes, montre que le développement du système au Silurien avait peu d'affinités avec les phases antérieures du début du Paléozoïque. La sédimentation silurienne semble s'être confinée à des fosses (maintenant des zones bordées de failles) flanquées de hautes-terres naissant de mouvements tectoniques contemporains. Ajouté à ceci, un volcanisme épisodique très poussé qui s'est manifesté en une ou plusieurs phases lors de cette évolution.