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RÉSUMÉS DE PUBLICATIONS PAR LES CHERCHEURS DE LA COMMISSION GÉOLOGIQUE DU CANADA, 1982

Agterberg, F.P.

RECENT DEVELOPMENTS IN GEOMATHEMATICS; Geo-Processing, v. 2, p. 1-32, 1982.

Recent applications of mathematical statistics for problem-solving in the earth sciences are reviewed. Special attention is given to new developments in quantitative stratigraphy, spatial analysis, applications of image analysis, use of multivariate statistical techniques in mineral–resources evaluation, and geostatistical crustal abundance models. Case history studies are presented for illustration of each of these five topics.

Agterberg, F.P.

REGIONAL MINERAL APPRAISAL: AN ANALYTICAL APPROACH; in Future Resources, their Geostatistical Appraisal, ed. R.T. Newcomb, West Virginia University Press, Morgantown, p. 37-51, 1982.

This paper contains a brief description of two types of statistical methods which may be useful in regional mineral resource estimation. These are: (1) methods based on simple models for the distribution of metals in rocks and mineral deposits in large regions; and (2) multivariate statistical analysis of geological and other reconnaissance data to estimate (a) probabilities for the occurrence of individual mineral deposits and (b) expected values of the total numbers of undiscovered deposits and amounts of ore in target areas.

Hudson, C.B. and **Agterberg, F.P.**

PAIRED COMPARISON MODELS IN BIO-STRATIGRAPHY; Mathematical Geology, v. 14, no. 2, p. 141-159, 1982.

Paired comparison models can be used to study the order of stratigraphic events along a relative time scale when differences in order are observed to occur in stratigraphic sections or wells. They give parameters of (1) a binomial distribution for the probability of earlier, later, or simultaneous occurrences of events. In the Bradley-Terry and Davidson models differences in positions of events along a logarithmic scale are assumed to satisfy a logistic frequency distribution. In the recently developed RASC model, a normal frequency distribution along a linear scale is used. The properties of these three models are reviewed and computer algorithms used to obtain practical solutions are discussed. The three models have each been applied to three published data sets (10 highest and lowest occurrences of Eocene nannofossils in 9 wells in California; 16 lowest occurrences of Cambrian trilobites and other fossils in 7 stratigraphic sections in Texas; and 41 highest occurrences of Cenozoic foraminifera and other microfossils in 16 wells, Canadian Atlantic Margin). Results of the three models are not significantly different. However, only the RASC model can be applied to large data sets because its computer algorithm avoids the use of time-consuming iterative processes required when other models are used.

Agterberg, F.P. and **Nel, L.D.**

ALGORITHMS FOR THE RANKING OF STRATIGRAPHIC EVENTS; Computers and Geosciences, v. 8, no. 1, p. 69-90, 1982.

The two algorithms documented in this paper form the first part of the RASC program for ranking and scaling of stratigraphic events. This FORTRAN IV computer program was developed originally to establish a zonation of the Cenozoic benthonic and planktonic foraminiferal record (highest occurrences of 206 taxa) in 22 wells on the Canadian Atlantic continental margin. The first ranking technique (presorting option) consists of the calculation of ranks based on a comparison of each event to all other events. The second technique (modified Hay method) calculates permutations in which each event is located before events with which it shows inconsistencies by using relative order frequencies. The occurrence of cyclical inconsistencies involving more than two events is described and methods to solve this situation are presented. The position of each event in the final stratigraphic ranking or optimum sequence is an "average" of all positions encountered for it.

Agterberg, F.P. and **Nel, L.D.**

ALGORITHMS FOR THE SCALING OF STRATIGRAPHIC EVENTS; Computers and Geosciences, v. 8, no. 2, p. 163-189, 1982.

The scaling algorithms presented in this paper form the second part of the RASC program for ranking and scaling of biostratigraphic events and other events which can be identified uniquely. An optimum sequence constructed by a ranking algorithm provides the starting point for estimating average "distances" between successive events. Frequency of crossover (mismatch) of events in sections is used for this purpose. Distances are clustered by constructing a dendrogram which can be used as a standard and permits definition of assemblage zones. Options of the second part of the RASC program include the following: (i) Normality test option: Each section is compared to the standard. This allows the detection of events which in a given section occur significantly above or below their average position in the standard. (ii) Marker horizon option: Each stratigraphic event is assumed to satisfy a normal probability curve with equal variance along the relative time axis. Chronostratigraphic (marker) horizons such as bentonite beds resulting from volcanic ash falls are assigned zero variance if the marker horizon option is used. (iii) Unique event option: After ranking and scaling the events for all more abundant fossil species, a rare (unique) event can be entered into the optimum sequence by comparing its position in a single or few sections to those of the more abundant taxa.

Aitken, J.D.

PRECAMBRIAN OF THE MACKENZIE FOLD BELT – A STRATIGRAPHIC AND TECTONIC OVERVIEW; in Precambrian Sulphide Deposits, H.S. Robinson Memorial Volume, ed. R.W. Hutchinson, C.D. Spence, and J.M. Franklin, Geological Association of Canada Special Paper 25, 1982.

The Proterozoic rocks of the Mackenzie Mountains are host to stratabound deposits of zinc, copper and iron. A major unconformity separates the exposed Proterozoic succession into two dissimilar successions which probably correspond to the Purcell and Windermere Supergroups of the southern Canadian Cordillera. The older succession ('Mackenzie Mountains Supergroup') consists of chemical and mature clastic sedimentary formations of platformal origin that thicken gradually southwestward. The younger succession ('Ekwi Supergroup') is dominated by immature clastic rocks laid down in southwestward-thickening wedges in a continental-margin environment. Volcanic rocks are rare in both sections.

Les roches protérozoïques des Montagnes de Mackenzie sont les hôtes de dépôts de zinc, cuivre et fer liés aux strates. Une discordance majeure divise la succession protérozoïque telle qu'exposée, en deux successions dissemblables qui correspondent probablement aux supergroupes de Purcell et de Windermere de la Cordillère Canadienne méridionale. La succession la plus ancienne ('supergroupe de Montagnes de Mackenzie') consiste en formations sédimentaires chimiques et clastiques évoluées déposées sur une plateforme, et qui s'épaississent graduellement vers le sud-ouest. La succession plus récente ('supergroupe d'Ekwi') est dominée au contraire par des roches clastiques immatures déposées en biseaux s'épaississant eux-aussi vers le sud-ouest, et témoignant d'un environnement de bordure continentale. Les roches volcaniques sont rares dans les deux successions.

Morris, W.A. and **Aitken, J.D.**

PALEOMAGNETISM OF THE LITTLE DAL LAVAS, MACKENZIE MOUNTAINS, NORTHWEST TERRITORIES, CANADA; Canadian Journal of Earth Sciences, v. 19, p. 2020-2027, 1982.

The Proterozoic stratigraphic column of the Mackenzie Mountains is dominated by two main successions, the platformal "Mackenzie Mountains Supergroup" beneath, and the Windermere-equivalent Rapitan Group and younger strata, of rift-depression and slope origin, above. The former succession is at least partly older than 770 Ma, the latter younger than 770 Ma. These two main successions are locally separated by an unconformity-bounded succession, the "copper cycle". An important question is whether the copper cycle is more closely related in time and in origin to the older or the younger main succession. Determination of the paleomagnetism of the basaltic lavas locally preserved at the top of the Little Dal Group (top of the Mackenzie Mountains Supergroup) and comparison of their remanence directions with those published for other rocks bearing on the question were thought to be one way of shedding light on this question. Accordingly, paleomagnetic investigation of 10 sites in the Keele River area and six sites in the Thundercloud Range area was undertaken to obtain the remanence direction related to the initial extrusion of the lavas. Coherent directional groupings were only obtained from Little Dal lavas in the Keele River area. Of the three magnetizations found, LD-L ($D = 304°$, $I = 20°$, $\alpha_{95} = 7°$) is assumed to represent the magnetization acquired on crystallization of the lavas. If this assumption is correct, the significant difference from the direction LD-A ($D = 265°$, $I = 26°$, $\alpha_{95} = 4°$) reported elsewhere for strata low in the Little Dal Group suggests either that the lavas significantly postdate the group or that significant movement of the North American plate occurred during accumulation of the 2 km or so of platformal strata between the lower Little Dal beds and the lavas. The new results presented here also admit the conclusion that the Little Dal lavas do not represent the same igneous events as diabase intrusions dated at about 770 Ma that cut the lower Little Dal.

La colonne stratigraphique protérozoïque des monts Mackenzie et composée en prédominance de deux successions principales, en dessous se trouve le "supergroupe des monts Mackenzie" originant sur la plate-forme, et au-dessus on observe le groupe de Rapitan, équivalent au Windermere, et des strates plus jeunes, originaires d'un fossé d'effondrement et de la pente continentale. La première succession est au moins en partie plus âgée que 770 Ma, la dernière est plus récente que 770 Ma. Ces deux successions principales sont séparées localement par une discordance liée à une succession, "le cycle de cuivre". Une question importante est à savoir si le cycle de cuivre est plus étroitement relié, dans le temps et par l'origine, avec la succession principale la plus ancienne ou avec la plus récente. La détermination du paléomagnétisme des laves basaltiques préservées localement au sommet du groupe Little Dal (sommet du supergroupe des monts Mackenzie), et une comparaison de leur direction de rémanence avec celles publiées antérieurement pour d'autres roches apparentées à ce problème, ont été considérées comme un moyen d'apporter des éléments de réponse à la question. En conséquence, une étude paléomagnétique sur 10 sites dans la région de la rivière Keele et sur six sites dans la région de Thundercloud Range a été entreprise pour déterminer la direction de rémanence liée à l'extrusion de la lave. Une direction cohérente d'un groupe d'échantillons a été obtenue pour les laves de Little Dal dans la région de la rivière Keele. Parmi les trois directions d'aimantation mesurées, LD-L ($D = 304°$, $I = 20°$, $\alpha_{95} = 7°$) est considérée comme étant l'aimantation acquise lors de la cristallisation des laves. Si ce résultat est supposément correct, la différence significative d'avec la direction LD-A ($D = 265°$, $I = 26°$, $\alpha_{95} = 4°$) rapportée ailleurs pour les couches en position inférieure dans le groupe Little Dal indique soit que les laves sont définitivement postérieures au groupe, ou qu'un déplacement significatif de la plaque de l'Amérique du Nord se produisit durant la période d'accumulation d'environ 2 km de couches sur la plate-forme entre les lits de la zone inférieure du groupe Little Dal et les laves. Les nouveaux résultats sont compatibles avec la conclusion que les laves de Little Dal ne correspondent pas au même phénomène d'intrusion des diabases datées à environ 770 Ma, lesquelles recoupent la partie inférieure du groupe Little Dal.

Boyle, D.R.

THE FORMATION OF BASAL-TYPE URANIUM DEPOSITS IN SOUTH CENTRAL BRITISH COLUMBIA; Economic Geology, v. 77, p. 1176-1209, 1982.

The basal-type uranium deposits in south central British Columbia occur within unconsolidated, late Miocene fluvial paleochannel sediments that overlie major fault zones within the Okanagan Highlands Intrusive Complex. Prior to the formation of mineralization, paleovalleys containing host sediments were flooded by Pliocene valley basalts of the Plateau Basalt Formation. Five uranium deposits have been outlined to date, of which the Blizzard (4,020 metric tons U) and Tyee (650 metric tons U) are the largest. The basement intrusive complex underlying the deposits varies in age from early Cretaceous to Eocene and is comprised of quartz

monzonite, granodiorite, Coryell monzonite, porphyritic granite, and pegmatite. All these phases are fractured and altered due to repeated tectonic activity. Structural analysis of the complex leads to the conclusion that it is a fabric-loosened body of interconnecting fault and fracture systems capable of sustaining well-developed intermediate and regional ground-water flow systems.

The mineralized host sediments comprise a complex sequence of interfingering conglomerates, arkosic sandstones, and mudstones. Organic material is abundant in many, but not all, mineralized beds. Uranium mineralization is present in the form of uranous (ningyoite) or uranyl (saleeite, autunite) phosphates coating clastic grains and filling voids. Because of very strong reducing conditions related to large concentrations of marcasite and organic material, ningyoite is the only uranium mineral in the Tyee deposit, whereas the Blizzard deposit contains a more complex assemblage of minerals (saleeite, autunite, ningyoite). The observed paragenetic sequence of mineral precipitation in the Blizzard deposit (autunite-saleeite-ningyoite) indicates that the uranyl minerals, saleeite and autunite, are primary. Small amounts of Zn, Ni, Co, and Mo have been introduced into the Blizzard deposit whereas Mo is the only nonore-forming element enriched in the Tyee deposit. Mn is the only depleted element in both deposits.

The paleoclimate at the time of ore formation was characterized by a temperate climate accompanied by a moderate amount of uniformly distributed precipitation.

Investigations of the source of the ore-forming elements (U, Ca, Mg, PO_4), including ground-water leaching of the intrusive basement rocks, volcanic rocks (Eocene), host sediments, as well as emplacement of ore by hydrothermal activity, have led to the conclusion that these elements were derived by ground-water leaching of the Okanagan Highlands Intrusive Complex. The deposits are believed to have formed by the infiltration into fluvial sediments of deep-seated, structurally controlled, ground waters that migrated in a well-developed regional hydrologic system within the Okanagan Highlands Intrusive Complex. Research indicates that the ore-forming ground waters were cold, slightly bicarbonated (150-400 ppm), highly uraniferous (10-50 ppb), and slightly oxidizing (dissolved oxygen = 2-4 ppm). In addition, the ore-forming ground waters contained sufficient amounts of Ca, Mg, and PO_4 to account for the observed mineralogy. Upon entering the host sediments the ground waters were rapidly acidified as the result of the formation of humic acids and oxidation of iron sulfides.

Mineralization formed after a period of extensional tectonism (late Miocene-early Pliocene) leading to optimum ground-water leaching of the intrusive basement complex and prior to a period of epeirogenesis (late Pliocene-Pleistocene uplift) which resulted in cessation of the ore-forming hydrologic regime. The maximum period of formation is estimated to be between 4 and 1 m.y.

Boyle, R.W.

GOLD DEPOSITS: A REVIEW OF THEIR GEOLOGICAL AND GEOCHEMICAL SETTING; in Geology of Canadian Gold Deposits, Proceedings of the CIM Gold Symposium, September 1980, ed. R.W. Hodder and W. Petruk, The Canadian Institute of Mining and Metallurgy, Special Volume 24, p. 1-5, 1982.

The general types of lode (vein) gold and auriferous placer deposits have been described, together with some brief notes on their origins.

The quartz-pebble conglomerate deposits currently provide the bulk of the world's production of gold, some 58 per cent. The other deposits, mainly the vein and disseminated types, eluvial and alluvial placers and the various polymetallic veins, lodes, massive bodies and stockworks (by-product gold), now provide the remaining 42 per cent of the production.

The epigenetic vein, lode, stockwork and disseminated types of gold deposits probably originated mainly by metamorphic secretion processes, the source rocks of the gold and its associated elements being mainly in the enclosing volcanic and/or sedimentary rock sequences. Modern gold placers are of sedimentary origin, the gold being winnowed into pay streaks as the result of both chemical (accretion) and physical (gravity) processes operating during weathering and subsequent sedimentation. The auriferous quartz-pebble conglomerate deposits probably originated as placers, the gold and many of its associated elements having undergone radical chemical reworking during subsequent diagenetic and metamorphic events.

Boyle, R.W.

GOLD, SILVER, AND PLATINUM METAL DEPOSITS IN THE CANADIAN CORDILLERA – THEIR GEOLOGICAL AND GEOCHEMICAL SETTING; in Precious Metals in the Northern Cordillera, The Association of Exploration Geochemists, p. 1-19, 1982.

The geology and geochemistry of the principal types of gold, silver and platinum-metal deposits that occur or can be expected to occur in the Canadian Cordillera are described.

The gold and silver deposits include various skarn, vein, lode, disseminated, and tabular types in which quartz, carbonates, pyrite, pyrrhotite, arsenopyrite, and the base metal sulphides and sulphosalts are the principal constituents. Auriferous quartz-pebble conglomerate deposits are unknown in the Canadian Cordillera but should be sought in the Precambrian (Proterozoic) terranes of this geological province. Gold placers are widespread in the Cordillera and have been exploited for more than a century.

Only one platinum-metal placer (Tulameen) has been worked in the Canadian Cordillera, but platinoid minerals have a widespread occurrence in many auriferous placer districts. Bedrock platinum-metal deposits are not presently known in the Cordillera. However, numerous occurrences of platinum metals in Ni-Cu sulphide ores, in Cu ores, and in segregations and impregnations in basic and ultrabasic rocks suggest that terranes containing such rocks should be explored carefully for these primary deposits.

Most geochemical methods of prospecting are applicable in the search for argentiferous, auriferous, and platinum-metal deposits, including those based on rocks (lithogeochemical), soils and glacial materials (pedogeochemical), waters and drainage sediments (hydrogeochemical), vegetation (biogeochemical), and gases (atmogeochemical). Particularly effective, especially for locating gold and platinum-metal deposits, are those methods based on the sampling of drainage sediments, glacial materials, and soils, analyzing these materials directly or analyzing heavy mineral separates obtained from them.

Boyle, R.W.

GEOCHEMICAL METHODS FOR THE DISCOVERY OF BLIND MINERAL DEPOSITS; CIM Bulletin, Part 1: August 1982, p. 123-142. Part 2: September 1982, p. 113-132.

Areal (two-dimensional) geochemical surveys, based mainly on secondary dispersion halos and trains in media such as surface waters, soils and drainage sediments, have proven particularly successful in recent years and have greatly

assisted in the discovery of a large number of varied mineral deposits. Three-dimensional surveys based on primary halos and leakage halos have received relatively little attention by research organizations and the mineral industry. Such surveys offer many novel approaches for discovering blind mineral deposits deeply buried below overburden or within their host bedrocks.

This paper reviews detailed methods for the discovery of blind mineral deposits based on sampling rocks (lithochemical methods), soils and other types of overburden (pedochemical methods), waters (hydrochemical methods), gases (atmochemical methods) and biological materials (biogeochemical methods). All are applicable to the discovery of blind deposits; the efficacy of each or in combination depends essentially on the type of mineralization, the extent of the development of the primary and secondary dispersion halos, and the finances available for sampling techniques employing overburden drilling, bedrock drilling, and sophisticated water, gas and vegetation collection.

Boyle, R.W.

GEOCHEMICAL PROSPECTING FOR THORIUM AND URANIUM DEPOSITS; Developments in Economic Geology, 16, 498 p., 1982.

The general chemistry and geochemistry of thorium and uranium are briefly described in the opening chapter, and this is followed by a chapter on the deposits of the two elements with emphasis on their indicator (pathfinder) elements and on the primary and secondary dispersion characteristics of thorium and uranium in the vicinity of their deposits. The next seven chapters form the main part of the book and describe geochemical prospecting for thorium and uranium, stressing selection of areas in which to prospect, radiometric surveys, analytical geochemical surveys based on rocks (lithochemical surveys), unconsolidated materials (pedochemical surveys), natural waters and sediments (hydrochemical surveys), biological materials (biogeochemical surveys), gases (atmochemical surveys), and miscellaneous methods. A final brief chapter reviews radiometric and analytical methods for the detection and estimation of thorium and uranium.

All of the analytical geochemical methods are applicable in prospecting for thorium and uranium, especially where radiometric methods fail as the result of attenuation by overburden, water, deep leaching, and so on. Efficiency in the discovery of thorium and/or uranium orebodies is promoted by an integrated methods approach employing geological pattern recognition, analytical geochemical surveys, and radiometric surveys.

Bristow, Q.

INSTRUMENTATION FOR NATURAL GAMMA RAY SPECTROMETRY; in Seminar on Nuclear Analytical Technology and Applications in Mineral Exploration, Mining and Processing, Ottawa, 28 June-2 July, 1982, International Atomic Energy Agency, Extended Synopsis IAEA-SR-73, 10 p.

Gamma ray spectrometry is used in uranium exploration to determine as precisely as possible the crustal distribution of potassium, uranium and thorium by quantitative measurements of the gamma radiation from the natural radioisotopes associated with these elements. This applies to airborne and ground surveys and to borehole logging.

The table below identifies the radioisotopes, and the principle gamma ray energies which can be used to distinguish one radiation signal from another.

Bristow, Q. and **Killeen, P.G.**

NATURAL GAMMA-RAY SPECTRAL LOGGING USING SCINTILLATION DETECTORS; in Symposium on Uranium Exploration Methods; Review of the NEA/IAEA R&D Programme, Paris, June 1-4, 1982, 13 p., 1982.

The limitations of gross-count logging systems in mixed uranium-thorium environments have prompted the development and production of gamma ray spectrometric logging equipment (particularly portable units for use in rugged terrain) by a number of manufacturers.

Sodium iodide and cesium iodide scintillation detectors are still used almost exclusively as the radiation sensors but some advances have been made in detector technology with bismuth germanate being one of the most promising new detector materials.

Work on improving methods of stabilizing down-hole scintillation detectors against the effects of temperature change on the gamma-ray energy spectrum has indicated that artificially induced scintillations from light emitting diodes or alpha particle sources (e.g. Am^{241}) implanted in the crystal are subject to error when the probe assembly is undergoing a temperature transition. Low energy gamma-ray sources, such as Ba^{133} (356 keV) are used in most spectral loggers today, although it has limitations. A more promising approach to correct for spectral drift is the application of spectral fitting techniques to the recorded data.

Considerable progress has been made in the development of model borehole calibration facilities to derive the calibration factors necessary for spectral logging. The energy dependence of borehole correction factors has also been investigated.

Microcomputer technology has now reached the stage where on-line data processing is practical. Portable logging equipment is commercially available with on-line display of quantitative uranium determinations implemented by inverse filtering as well as recording raw data on a digital cartridge tape.

Bristow, Q., Killeen, P.G., and **Mwenifumbo, J.C.**

COMPARISON OF STANDARDIZED GAMMA-RAY LOG CALIBRATION MEASUREMENTS: OTTAWA, ADELAIDE AND GRAND JUNCTION; in Symposium on Uranium Exploration Methods Review of the NEA/IAEA R&D Programme, Paris, June 1-4, 10 p., 1982.

Gamma-ray logging probes are calibrated in model boreholes which consist of a concrete sandwich containing a central "ore zone" and upper and lower "barren zones". Unexplained discrepancies have been reported for probes calibrated in model boreholes at Ottawa, Canada; Grand Junction, U.S.A.; and Adelaide, Australia.

Intercalibration measurements were made at the three locations using the R&D logging system of the Geological Survey of Canada (G.S.C.) which provides full spectral recording on magnetic tape. All calibration measurements were repeated at least three times with each of three standardized probes, in all of the appropriate model holes. During the logging measurements, the contents of ten energy windows plus 256-channel gamma-ray spectra were recorded every sample time (e.g. two seconds). The method of full spectral recording made it possible to select, 'after-the-fact', any desired energy windows in the spectrum and to produce new gamma-ray spectral logs from the re-windowed data. Thus the presence of thorium could be detected and measured and the Z-effect could be taken into account for each model.

Fully corrected count-rates within the ore zones and areas under the log curve were determined for every run of every probe in every model for every window. From this

information accurate ratios of uranium concentrations in the model holes in different countries were calculated (i.e. relative values). However, absolute uranium grades cannot be assigned until the 'true' uranium content of any one of the models is determined.

Cameron, A.R. and **Kalkreuth, W.D.**

PETROLOGICAL CHARACTERISTICS OF JURASSIC-CRETACEOUS COALS IN THE FOOTHILLS AND ROCKY MOUNTAINS OF WESTERN CANADA; Proceedings – 5th ROMOCO Symposium, 1982, Utah Geological and Mineral Survey, Bulletin 118, 1982.

Christie, R.L.

GEOLOGY AT THE TOP OF THE WORLD – CONCEPTS CHANGE AS EXPLORATION ADVANCES; Geos, v. 11, no. 1, p. 10-13, 1982.

Exploration of the Canadian Arctic Islands began centuries before the science of geology as we know it had been developed, and geological investigations during expeditions of the 1800s coincided with a blossoming of the new science. The concept of 'geosynclines' and other novel theories on sedimentation and mountain-building were based on syntheses of the geology of vast, newly explored areas such as Arctic North America. Today, refined geological 'models' and terms are proposed to account for new information obtained by geologists using aircraft and ship.

Dawes, P.R. and **Christie, R.L.**

HISTORY OF EXPLORATION AND GEOLOGY IN THE NARES STRAIT REGION; in Nares Strait and the Drift of Greenland: a Conflict in Plate Tectonics; Meddelelser om Grønland, Geoscience 8, p. 19-36, 1982.

Exploration in the Nares Strait region in the late 19th and early 20th centuries was connected with the seaway's position as a principal route of geographic discovery. Few of the early expeditions were directed towards obtaining data for the young science of geology. At the turn of the century, with the passing of the main era of geographical discovery, including the race for the North Pole and the establishment of Greenland's insularity, geological understanding of the region advanced rapidly and geologists more or less became 'standard' members of expeditions to this part of the Arctic.

Systematic geological studies in the Nares Strait region began when Lauge Koch mapped the Greenland side of the Strait in the period 1916-23; such investigations on the Canadian side by the Geological Survey of Canada took place in the 1950s and later. Early private expeditions and later work by university and petroleum and mineral enterprises have also contributed many geological data, as have several 'military operations' centred on Thule Air Base in Greenland. Regional geological mapping in Greenland was renewed by the Geological Survey of Greenland in the 1970s and continues today.

Cooperative Danish-Canadian projects, initiated by "Operation Grant Land" in 1965-66 in northern Nares Strait, have aimed at coordinating field studies in order to better assess correlation of stratigraphy and structure across the Strait.

Greenland and Nares Strait held important positions in the early ideas about the horizontal mass movements of the continents, and both Frank B. Taylor and Alfred Wegener featured the narrow linear channel between Ellesmere Island and Greenland in their respective theories of continental drift. These two creative theorists built on the immense global knowledge assembled by Eduard Suess, who published one of the earliest appraisals of the region. Early geological maps of the Nares Strait region by Bailey Willis and Lauge Koch were used by Wegener in support of his theory of continental drift.

Peel, J.S. and **Christie, R.L.**

CAMBRIAN-ORDOVICIAN PLATFORM STRATIGRAPHY: CORRELATIONS AROUND KANE BASIN; in Nares Strait and the Drift of Greenland: a Conflict in Plate Tectonics; Meddelelser om Grønland, Geoscience 8, p. 117-135, 1982.

Cambrian and Ordovician platform strata in western North Greenland and adjacent Ellesmere Island were deposited on an elongate platform lying to the south of the Franklinian Trough. The sequence is dominated by carbonates with prominent evaporite horizons and subsidiary shales and sandstones. A transect across the platform shows changes in facies and increase in thickness from inner platform sequences in Inglefield Land and Bache Peninsula, to the south, to outer platform sequences in the Judge Daly Promontory area; clastic trough deposition characterises sections in northern Ellesmere Island. This paper briefly describes and correlates these sequences occurring around Kane Basin. The regional framework and close similarity of Cambrian and Ordovician sequences in Greenland and Canada indicate that substantial transcurrent net displacement has not taken place along Nares Strait. Of special note are narrow belts of Ordovician evaporites which cross Nares Strait from Ellesmere Island into Greenland without displacement at the present day. The continuity of these environmentally specialised belts of deposition demonstrates that net transcurrent displacement along Nares Strait since the Early Ordovician has not exceeded 50 km.

Peel, J.S., Dawes, P.R., Collinson, J.D., and **Christie, R.L.**

PROTEROZOIC-BASAL CAMBRIAN STRATIGRAPHY ACROSS NARES STRAIT: CORRELATION BETWEEN INGLEFIELD LAND AND BACHE PENINSULA; in Nares Strait and the Drift of Greenland: a Conflict in Plate Tectonics; Meddelelser om Grønland, Geoscience 8, p. 105-115, 1982.

In the Kane Basin region of Nares Strait (78° to 79°N) unmetamorphosed Proterozoic and basal Cambrian platform strata overlie the Precambrian Shield both in Inglefield Land in Greenland, and on Bache Peninsula in Ellesmere Island. The platform succession is composed of two shallow-water clastic sequences separated by an erosional disconformity. The lower formation, of multicoloured sandstone and siltstone with minor shale and stromatolitic dolomite, is assigned to the redefined Rensselaer Bay Formation; the upper, composed of red and overlying white sandstone with dolomitic sandstone and siltstone at the top, is assigned to the Dallas Bugt Formation. Basic sills from the Rensselaer Bay Formation have yielded isotopic ages as old as 1200 m.y., while the trace fossils **Rusophycus** and **Skolithos** suggest a basal Cambrian age for the Dallas Bugt Formation.

The platform sequences of Inglefield Land and Bache Peninsula show striking similarity in lithology and thickness and the detail correlation is supported by the evidence from isotopic ages of basic sills and from trace fossils. In both areas the bipartite succession is overlain with apparent conformity by dolomites that pass upwards into limestones containing Early Cambrian macrofauna.

The Rensselaer Bay Formation thickens southwards and passes into the much thicker sedimentary sequence of the Thule Basin, while the Dallas Bugt Formation and the

overlying dolomites thicken northwards, indicating that the two formations were laid down in separate sedimentary basins. The close correlation of the platform successions and the corresponding configuration of the depositional slopes on both sides of the Kane Basin clearly indicate that the Proterozoic – Early Cambrian sedimentary pattern has not been radically disturbed by tectonism or by any appreciable transcurrent movement along Nares Strait.

Mathewes, R.W. and **Clague, J.J.**

STRATIGRAPHIC RELATIONSHIPS AND PALEOECOLOGY OF A LATE-GLACIAL PEAT BED FROM THE QUEEN CHARLOTTE ISLANDS, BRITISH COLUMBIA; Canadian Journal of Earth Sciences, v. 19, p. 1185-1195, 1982.

The stratigraphic relationships of late-glacial and Holocene sediments exposed in sea cliffs at Cape Ball on the Queen Charlotte Islands are summarized, based on section descriptions and 13 radiocarbon dates on wood, peat, and marine pelecypod shells. One peat bed dated at 12 400 ± 100 years BP (GSC-3112) to 10 200 ± 90 BP (GSC-3159) was investigated for pollen and plant macrofossils. This study extends the late Pleistocene vegetation history of the Queen Charlotte Islands by about 1550 years, and suggests that the record will date back to before 13 700 ± 100 BP (GSC-3222).

Four local pollen zones are described from the 70 cm thick peat, beginning with a 7 cm thick herb-dominated zone (CB-1), characterized by up to 60% grass pollen, and including a unique assemblage with abundant Apiaceae, Cyperaceae, **Empetrum**/Ericaceae, **Polemonium, Plantago macrocarpa, Fritillaria,** and **Ranunculus.** A high diversity of other herbs, including subalpine/alpine species and two taxa presently absent from the Charlottes (**Armeria maritima** and **Polemonium caeruleum** type), suggests that this zone represents an open floodplain vegetation with no modern analogue. Zone CB-2 (63-45 cm) is dominated by **Pinus contorta** type pollen (65-70%) and moderate values for fern spores. Zone CB-3 (45-30 cm) shows a rapid rise of **Picea** pollen from 3 to 39%, followed by a drop to about 12%. Fern spores (20-50%) and **Alnus** (6%) also reach maximum levels in this zone. Abundant wood fragments and sand inclusions are compatible with an interpretation of a swampy floodplain forest during this interval. The uppermost zone (30-0 cm) exhibits high **Pinus contorta** (40-60%) and Cyperaceae (12-38%) values, along with a moderate abundance of grasses, ferns, and Apiaceae. Estuarine and marine sediments with pelecypod shells, deposited during a marine transgression, overlie the peat bed.

Implications for the controversy over the existence of late Pleistocene refugia in the Charlottes are briefly discussed.

Les relations stratigraphiques des sédiments tardi-glaciaires et holocènes exposés dans les falaises littorales à Cape Ball et sur les Îles Reine-Charlotte sont résumés sommairement au moyen de descriptions de sections et de 13 datations au radiocarbone sur des morceaux de bois, de la tourbe et des coquilles marines de pélécypodes. Un lit de tourbe d'âge compris entre 12 400 ± 100 (GSC-3112) à 10 200 ± 90 (GSC-3159) années avant présent a été étudié pour ses pollens et macrofossiles végétaux. Cette étude prolonge d'environ 1550 années l'histoire de la végétation des îles Reine-Charlotte au Pléistocène supérieur, et suggère des dates antérieures à 13 700 ± 100 (GSC-3222).

On y décrit quatre zones locales à pollens réparties sur une épaisseur de 70 cm de tourbe, en commençant par une zone très riche en herbes (CB-1), caractérisée par plus de 60% de pollens d'herbes et incluant un assemblage exclusif avec abondamment d'Apiacées, de Cypéracées, d'**Empetrum**/Ericacées, de **Polemonium,** de **Plantago macrocarpa,** de **Fritillaria** et de **Ranunculus.** Une grande variété d'autres herbes, comprenant des espèces subalpines/alpines et deux taxons présentement absents dans les Charlottes (type **Ameria maritima** et **Polemonium caeruleum**) témoignent que cette zone représente une végétation d'une plaine d'inondation ouverte sans d'analogue actuel. La zone CB-2 (63-45 cm) contient principalement le type de pollen **Pinus contorta** (65-70%) avec un contenu modéré en spores de fougères. La zone CB-3 (45-30 cm) expose une augmentation rapide en pollens de **Picea,** passant de 3 à 39%, suivie d'une chute à plus ou moins 12%. Les spores de fougères (20-50%) et d'**Alnus** (6%) atteignent également leurs valeurs maximales dans cette zone. La présence d'une grande quantité de morceaux de bois et d'inclusions sableuses est conciliable avec l'interprétation qu'une forêt marécageuse existait dans une plaine d'inondation pendant cet intervalle. La zone supérieure (30-0 cm) possède des valeurs élevées de **Pinus contorta** (40-60%) et de Cypéracées (12-38%), lesquels sont accompagnés d'une quantité modérée d'herbes, de fougères et d'Apiacées. Les sédiments d'estuaire et marins contenant des coquilles de pélécypodes, déposés lors d'une transgression marine, reposent par-dessus le lit de tourbe.

Une brève discussion est présentée au sujet de l'incidence de notre étude sur la controverse relative à l'existence des refuges au Pléistocène supérieur dans les Charlottes.

Clague, J.J., Jozsa, L.A., and Parker, M.L.

DENDROCHRONOLOGICAL DATING OF GLACIER-DAMMED LAKES: AN EXAMPLE FROM YUKON TERRITORY, CANADA; Arctic and Alpine Research, v. 14, no. 4, p. 301-310, 1982.

The chronology of prehistoric, glacier-dammed lakes can be established, in many cases, through the use of dendrochronological techniques. Driftwood deposited at the margins of a glacier-dammed lake can be precisely dated, and the history of the lake thereby deduced, by matching the annual ring patterns in the driftwood with those of nearby old living trees. Dating is facilitated by X-ray densitometric analysis, whereby digital data on ring width and intraring density variations are obtained from X-ray images of wood.

Dendrochronology is not subject to the severe limitations on precision inherent in radiocarbon and other absolute dating techniques. It is the preferred method for dating recent geologic and other events where exact ages are required and where appropriate fossil material (i.e., reasonably well preserved wood with sensitive annual ring patterns) is available.

Dendrochronological techniques were applied to Neoglacial Lake Alsek, a former glacier-dammed lake in southwestern Yukon Territory with a complex history of filling and emptying. Lake Alsek forms whenever Lowell Glacier, a large surging glacier in the St. Elias Mountains, advances across Alsek Valley and blocks Alsek River. Dendro-dating of driftwood, combined with sparse historical and other data, indicate that Lake Alsek last extended beyond the front of the St. Elias Mountains to the vicinity of Haines Junction between A.D. 1848 and 1891, probably in the early 1850s.

Clague, J.J. and Rampton, V.N.

NEOGLACIAL LAKE ALSEK; Canadian Journal of Earth Sciences, v. 19, p. 94-117, 1982.

Lowell Glacier, a large valley glacier in the St. Elias Mountains of southwestern Yukon Territory, advanced across Alsek Valley and blocked south-flowing Alsek River many

times during the Neoglacial interval. The resulting lake, termed Neoglacial Lake Alsek, extended east of the front of the St. Elias Mountains and inundated parts of Dezadeash Valley that presently are populated. Lake Alsek, at its maximum, was about 200 m deep at the glacier dam and over 100 km long. Staircase flights of beaches, wave-cut benches, layers of driftwood, and thin lacustrine sediments provide evidence of the former lake. Giant dunes and flood terraces on the floor of Alsek Valley indicate that the lake emptied catastrophically when the Lowell Glacier dam failed.

Several phases of Lake Alsek have been identified. Each was preceded and followed by intervals during which the lake was empty and the present southward drainage pattern in Alsek Valley prevailed. Historical records, radiocarbon and tree-ring dates on driftwood, and radiocarbon dates on buried soils separating lacustrine units indicate that Lake Alsek extended into Dezadeash Valley sometime between A.D. 1848 and 1891, between A.D. 1736 and 1832, twice between 250 and 500 years ago, and at least once between 800 and 2900 years ago. In addition, a small lake may have existed in Alsek Valley after 1891, but before 1917, although the evidence for this is equivocal. During each ponding phase, Lake Alsek may have emptied and filled repeatedly, perhaps on a regular cycle, as is common for some existing glacier-dammed lakes.

Lowell Glacier, during a future surge, might again block Alsek River and form a new lake. However, populated areas in Dezadeash Valley probably would not be inundated because Lowell Glacier has thinned and receded somewhat since Lake Alsek last extended beyond the St. Elias Mountains in the nineteenth century.

Le glacier Lowell, un grand glacier des montagnes St-Elias dans le sud-ouest du Territoire du Yukon, a avancé en travers de la vallée Alsek et a bloqué l'écoulement en direction sud de la rivière Alsek plusieurs fois pendant l'intervalle néoglaciaire. Le lac résultant, appelé le lac Alsek néoglaciaire, s'est étendu à l'est du front des montagnes St-Elias et a inondé des secteurs de la vallée Dezadeash qui sont actuellement habités. Le lac Alsek, à son maximum, accusait environ 200 m de profondeur à la hauteur au barrage par le glacier et avait plus de 200 km de long. Des plages formant des paliers disposés en escalier, des banquettes d'érosion littorale, des couches de bois flottant et un mince lit de sédiments lacustres apportent les preuves de l'existence d'un ancient lac. Des dunes géantes et des terrasses d'inondation au bas de la vallée Alsek indiquent que le lac s'est vidé de manière catastrophique lorsque le barrage formé par le glacier Lowell a cédé.

Plusieurs phases du lac Alsek ont été identifiées. Chaque phase a été précédée et suivie par des intervalles pendant lesquels le lac se vidait et dont le drainage actuel du lac vers le sud dans la vallée Alsek prédominait. Des renseignements historiques, des datations au radiocarbone et à l'aide des anneaux de croissance mesurés dans le bois flottant, et des datations au radiocarbone de sols enfouis séparant les couches lacustres indiquent que le lac Alsek s'étendait dans la vallée du Dezadeash pendant quelque temps entre 1848 et 1891 A.D., entre 1836 et 1832 A.D., deux fois entre il y a 250 et 500 ans passés et au moins une fois entre 800 et 2900 ans passés. En plus, un petit lac a pu exister dans la vallée Alsek après 1891, mais avant 1917, bien que la preuve demeure équivoque. Durant chaque phase de formation du lac Alsek résultant d'un barrage par le glacier, le lac a pu se vider et se remplir de manière répétitive, probablement avec un cycle régulier, comme on le rencontre fréquemment pour les lacs ainsi formés à l'aide d'un barrage par un glacier.

Le glacier Lowell pourrait lors d'une future avancée glaciaire bloquer à nouveau la rivière Alsek et former un nouveau lac. Cependant, les régions habitées dans la vallée Dezadeash ne seraient probablement pas inondées car le glacier Lowell s'est aminci et a considérablement reculé depuis sa dernière avancée loin des montagnes St-Elias au cours du dix-neuvième siècle.

Clague, J.J., Mathewes, R.W., and Warner, B.G.
LATE QUATERNARY GEOLOGY OF EASTERN GRAHAM ISLAND, QUEEN CHARLOTTE ISLANDS, BRITISH COLUMBIA; Canadian Journal of Earth Sciences, v. 19, p. 1786-1795, 1982.

A reconnaissance study of Quaternary sediments exposed in coastal bluffs on eastern Graham Island has revealed the presence of two major till units, each of which is underlain by glaciomarine stony mud, outwash sand and gravel, and laminated to massive silt and sand of undetermined origin. Sediment units below the surface drift are older than the radiocarbon dating limit. Sediments above this drift provide a nearly continuous record of geologic events from before 16 000 years BP until the present.

Stratigraphic evidence and radiocarbon dates indicate that: (1) late Wisconsin glaciation of the coastal lowlands of Graham Island was weak and of short duration; and (2) a period of low sea levels during late Pleistocene time was followed by a transgression that culminated about 7500-8000 years ago when the sea was about 15 m higher relative to the land than at present. Marine regression during middle and late Holocene time produced wave-cut scarps, wave-cut benches overlain by littoral sediments, bars, spits, and beach and dune ridges.

Une étude de reconnaissance des sédiments du Quaternaire exposés dans les escarpements côtiers de la zone est de l'île Graham a révélé la présence de deux unités importantes de till, chacune d'elles recouvrant des lits de boue caillouteuse glaciomarine, de sable et gravier d'épandage fluvio-glaciaire et de limon et sable laminés à massifs d'origine indéterminée. Les unités sédimentaires sous-jacentes au drift de surface sont plus anciennes que la limite d'âge obtenue au radiocarbone. Les sédiments sus-jacents à ce drift fournissent des renseignements presque continus sur les phénomènes géologiques d'il y a plus de 16 000 ans avant le présent jusqu'à l'époque actuelle.

La stratigraphie et les datations au radiocarbone indiquent que: (1) la glaciation du Wisconsin supérieur sur les basses-terres de la côte de l'île Graham fut faible et de courte durée; et (2) la période caractérisée par des niveaux de la mer peu élevés durant le Pléistocène supérieur a été suivie par une transgression qui a atteint une étendue maximum il y a environ 7500 ans lorsque le niveau de la mer se situait à 15 m au-dessus des terres actuelles. Une régression marine durant l'Holocène supérieur a produit des escarpements dans le littoral, des banquettes littorales recouvertes de sédiments littoraux, des barres, des langues de sable, des levées de plage et des chaînes de dunes.

Clague, J.J., Harper, J.R., Hebda, R.J., and Howes, D.E.
LATE QUATERNARY SEA LEVELS AND CRUSTAL MOVEMENTS, COASTAL BRITISH COLUMBIA; Canadian Journal of Earth Sciences, v. 19, p. 597-618, 1982.

Late Quaternary sea-level fluctuations on the British Columbia coast have been established from studies of terrestrial and marine sediments and landforms. These studies indicate that the sea-level history of mainland British

Columbia and eastern Vancouver Island is very different from that of the Queen Charlotte Islands and western Vancouver Island. Specifically, in the former areas, there was a rapid rise of submerged coastal lowlands between about 13 000 and 10 000 years ago. Emergence culminated about 6000-9000 years ago, depending on the locality, when the sea, relative to the land, was 12 m or more lower than at present in some areas. During middle and late Holocene time, relative sea level rose on the mainland coast and at least locally on eastern Vancouver Island, resulting in inundation of coastal archaeological sites and low-lying terrestrial vegetation. Tidal records and precise levelling suggest ongoing submergence of at least part of this region.

In contrast, shorelines on the Queen Charlotte Islands were below present from before 13 700 years ago until approximately 9500-10 000 years ago. A transgression at the close of the Pleistocene climaxed about 7500-8500 years ago when relative sea level probably was about 15 m above present in most areas. Most the emergence that followed apparently occurred in the last 5000-6000 years. There has been a similar pattern of emergence on the west coast of Vancouver Island during late Holocene time.

The above patterns of late Quaternary sea-level change are attributed to complex isostatic response to downwasting and retreat of the late Wisconsin Cordilleran Ice Sheet, to transfers of water from melting ice sheets to oceans, and to plate interactions on the British Columbia continental margin. Late Pleistocene and early Holocene crustal movements were dominantly isostatic. Although the recent regression on the outer coast likely is due, at least in part, to tectonic uplift, some late Holocene sea-level change in this area and elsewhere on the British Columbia coast may be either eustatic in nature or a residual isostatic response to deglaciation, which occurred thousands of years earlier.

Des études de sédiments terrestres et marins et des formes de paysage sur la côte de la Colombie-Britannique ont permis de déterminer les fluctuations du niveau de la mer pour l'étage supérieur du Quaternaire. Ces études démontrent que l'historique du niveau de la mer de la Colombie-Britannique continentale et du secteur est de l'Île de Vancouver est très différent de celui des Îles de la Reine-Charlotte et du secteur ouest de l'Île de Vancouver. Plus spécifiquement, dans les premières régions il y eut un soulèvement rapide des plaines littorales de la côte submergée entre 13 000 et 10 000 années approximativement. L'émersion a atteint un point culminant il y a environ 6000-9000 années, dépendant du site considéré, lorsque la mer par rapport à la terre ferme était de 12 m ou plus en-dessous du niveau actuel de certaines régions. Durant la période de l'Holocène moyen et supérieur, le niveau relatif de la mer s'éléva sur la côte du continent et au moins localement sur le secteur est de l'Île de Vancouver, conduisant à une inondation des sites archéologiques sur la côte et de la végétation qui poussait sur les terres situées justes au-dessus du niveau de la mer. Les données enregistrées sur les marées et des mesures précises de nivellement suggèrent une submergence active dans au moins une partie de cette région.

Contrairement, les rivages des Îles de la Reine-Charlotte étaient en-dessous de leur niveau actuel à la période précédant 13 700 années et jusqu'à il y a approximativement 9500-10 000 années. Une transgression marine à la fin du Pléistocène a atteint son apogée il y a environ 7500-8500 années, lorsque le niveau relatif de la mer était environ 15 m au-dessus du niveau actuel de la plupart des régions. La plus grande superficie d'émersion qui s'en suivit semble s'être réalisée au cours des dernières 5000-6000 années. Durant l'Holocène supérieur, un type d'émersion analogue existait sur le secteur ouest de l'Île de Vancouver.

Les types de variations du niveau de la mer décrits ci-dessus pour l'étage supérieur du Quaternaire sont attribués à une réaction par soulèvement isostatique complexe faisant suite au retrait de la calotte glacière de la Cordillère au Wisconsin supérieur, au passage des eaux de fonte des glaces de la calotte vers l'océan, et aux interactions des plaques sur la marge continentale de la Colombie-Britannique. Au Pléistocène supérieur et à l'Holocène inférieur les mouvements de la croûte étaient principalement de nature isostatique. Bien que la récente régression sur la côte externe semble résulter, au moins en partie, d'un soulèvement tectonique, une certaine variation du niveau de la mer à l'Holocène supérieur dans cette région a pu relever soit d'une cause eustatique ou d'une réaction isostatique résiduelle à la déglaciation qui s'est produite des milliers d'années auparavant.

Warner, B.G., Mathewes, R.W., and **Clague, J.J.**

ICE-FREE CONDITIONS ON THE QUEEN CHARLOTTE ISLANDS, BRITISH COLUMBIA, AT THE HEIGHT OF LATE WISCONSIN GLACIATION; Science, v. 218, 12 November, 1982, p. 675-677.

New radiocarbon dates and plant macrofossil data establish that parts of the Queen Charlotte Islands, British Columbia, were ice-free during and subsequent to the late Wisconsin glacial maximum on the Pacific coast of Canada. A paleoecological investigation of dated sediments at Cape Ball has indicated that a varied flora consisting of terrestrial and aquatic plants was present there about 16,000 years ago. This finding provides support for the existence of a heretofore questioned biotic refugium on the Queen Charlotte Islands during the last glaciation. These results shed new light on problems of glacial chronology, climatic change, biogeography, and archeology along the western margin of North America.

Clague, J.J. and **Souther, J.G.**

THE DUSTY CREEK LANDSLIDE ON MOUNT CAYLEY, BRITISH COLUMBIA; Canadian Journal of Earth Sciences, v. 19, p. 524-539, 1982.

A large (ca. 5×10^6 m^3) landslide occurred on the west flank of Mount Cayley in the southern Coast Mountains of British Columbia in 1963. Failure commenced when a large block of poorly consolidated tuff breccia and columnar-jointed dacite was detached from the subvolcanic basement and slid into the valley of Dusty Creek, a small tributary of Turbid Creek. As the detached block accelerated, it quickly fragmented into an aggregate consisting of angular clasts up to several metres across, partially supported by a matrix of fine comminuted rock material. The landslide debris moved about 1 km down Dusty Creek as a wedge-shaped mass up to 70 m thick, banking up on turns and attaining a maximum velocity of 15-20 m/s. The debris mass thinned as it spread across the broader, flatter valley of Turbid Creek, and was deposited as an irregular blanket with a maximum thickness of 65 m along a 1 km length of this valley. As a result of the landslide, Turbid and Dusty Creeks were blocked, and lakes formed behind the debris. These debris dams were soon overtopped and rapidly breached, causing floods and probably debris flows to sweep down Turbid Creek valley far beyond the terminus of the landslide.

From an analysis of the annual rings of slide-damaged trees, it is concluded that the landslide probably occurred in July 1963. Although the largest earthquake of 1963 and a moderately intense rainstorm also occurred during this month, there were much larger earthquakes and storms in this area on many previous occasions, and these did not cause

large slope failures. Thus, it appears that the stability of the slope at the head of Dusty Creek gradually deteriorated over a long period of time until a relatively minor event, such as a small earthquake or storm, triggered the failure.

The main contributing factors to this landslide are geologic and include the presence of: (1) hydrothermally altered faults and fractures in poorly lithified pyroclastic rocks and in jointed volcanic flows; (2) an outward-sloping unconformity separating the Quaternary volcanic sequence from older basement rocks; and (3) fractured glassy selvages surrounding small intrusions in the base of the volcanic pile.

Deposits of one or more landslides that predate the 1963 event also occur in Turbid Creek valley. These older deposits are present over a much larger area than the 1963 slide deposits and probably were emplaced by highly mobile debris flows with high water content.

Un important glissement de terrain (totalisant ca. 5×10^6 m^3) a eu lieu en 1963 sur le flanc ouest du Mont Cayley dans la chaîne Côtière de la Colombie-Britannique. La rupture a débuté lorsque un gros bloc de brèche volcanique pyroclastique peu consolidée et de dacite à colonnades s'est détaché du socle subvolcanique et glissa dans la vallée de Dusty Creek, un petit tributaire du Turbid Creek. Au cours de sa chute accélérée le bloc détaché s'est rapidement brisé en un agrégat composé de fragments anguleux pouvant avoir plusieurs mètres de section et supportés en partie par une matrice de matériaux rocheux finement broyés. Les débris de ce glissement de terrain se sont déplacés sur une distance d'environ 1 km vers l'aval dans le Dusty Creek sous forme d'une masse en coin d'une épaisseur atteignant 70 km, construisant des bancs dans les virages et se déplaçant à une vitesse maximum de 15-20 m/s. La masse de débris s'amincissait au fur et à mesure qu'elle s'étalait dans la platière élargie de la vallée du Turbid Creek, et a formé un dépôt sédimentaire étendu irrégulièrement et ayant une épaisseur maximum de 65 m, les débris sont répartis sur une distance de 1 km le long de cette vallée. Ce glissement de terrain a obstrué les cours d'eau Turbid et Dusty, et des lacs se sont formés à l'arrière des débris. Ces digues composées de débris furent rapidement couvertes d'eau et des brèches s'ouvrirent, causant des inondations et la formation de coulées boueuses transportant le long de la vallée du Turbid Creek des matériaux bien au-delà de la limite du glissement de terrain.

Une analyse entreprise sur les anneaux de croissance annuelle des arbres endommagés a permis de conclure que le glissement de terrain a eu lieu en juillet 1963. Malgré le tremblement de terre le plus intense de 1963 et une tempête de pluie modérée durant ce mois de juillet, cette région a connu auparavant d'autres tremblements de terre plus intenses et des tempêtes plus violentes, et ce à maintes reprises, pourtant la rupture le long de la pente n'avait pas eu lieu. Donc, il apparaît que la stabilité de la pente à la tête du Dusty Creek s'est plutôt détériorée graduellement sur une longue période de temps jusqu'au point qu'un événement, tel un faible tremblement de terre ou une tempête, puisse déclencher la rupture.

Les principaux facteurs à l'origine de ce glissement de terrain sont de nature géologique et incluent la contribution: (1) des failles et des fissures dans des roches pyroclastiques mal consolidées et altérées par activités hydrothermales, ainsi que des joints dans des coulées volcaniques; (2) d'une discordance avec pente vers l'extérieur séparant la séquence volcanique quaternaire d'avec les roches plus anciennes du socle; et (3) des salbandes vitrifiées et fissurées entourant de petites intrusions à la base de l'accumulation volcanique.

Des dépôts de matériaux provenant d'un ou de plusieurs glissements de terrain antérieurs à celui de 1963 se sont accumulés dans la vallée du Turbid Creek. Ces dépôts plus anciens occupent une plus grande superficie que ceux du glissement de 1963 et leur mise en place est due probablement à des coulées boueuses plus mobiles ayant une plus grande teneur en eau.

Copeland, M.J.

PALAEOCOPID OSTRACODA AND THE ORDOVICIAN-SILURIAN BOUNDARY IN CANADA; Eighth International Symposium on Ostracoda, Houston, Texas, July 25-30, 1982.

Mass extinction of benthos at the end of the Ordovician presents an enigma. Only within the last few years has the concept of a glacial regime and a 'Hirnantian' stage been proposed to account for the faunally depauperate interval between known Ashgill and Llandovery faunal assemblages. The glacial explanation may be valid or not but it is obvious that some catastrophic event transpired causing environmental change and macro-evolution of most of the benthic faunas.

This faunal extinction and reestablishment is well exemplified by the palaeocope Ostracoda. In Canada, two faunal sequences from strata 4000 km apart serve to verify the concept of inter systemic catastrophism with resulting macroevolution. In Anticosti Basin of eastern Canada an epicontinental drepanellacean-tetradellid hollinacean fauna is abruptly terminated at the end of the Gamachian and replaced by an Early Silurian Niagaran beyrichiacean fauna of Appalachian Province aspect. In Selwyn Basin of northwestern Canada a platformal Ashgill drepanellacean-eurychilinid hollinacean fauna is replaced in the Early Llandovery by a beyrichiacean fauna of Eurarctic aspect.

It is considered that during the short 'Hirnantian' interval a period existed during which benthic palaeocope hollinacean faunas of Appalachian and north European aspect combined to produce the beyrichiacean prototype. This as yet unknown shallow platform Ordovician-Silurian boundary fauna should occur in present day deep continental margin and slope deposits of the North Atlantic. Radiation of this beyrichiacean fauna during the Early Silurian followed resumption of 'normal' sea level but resulted in the development of two entirely different provincial beyrichiacean lineages.

Sinclair, A.J., Drummond, A.D., Carter, N.C., and **Dawson, K.M.**

A PRELIMINARY ANALYSIS OF GOLD AND SILVER GRADES OF PORPHYRY-TYPE DEPOSITS IN WESTERN CANADA; in Precious Metals in the Northern Cordillera, The Association of Exploration Geochemists, p. 157-172, 1982.

Au and Ag average grades of porphyry-type deposits in Western Canada group in a manner surprisingly consistent with existing classifications, viz., depth zone and petrologic affinity of related plutonism. Probability graphs, scatter diagrams and triangular plots are used as data display techniques that lead to some insight to porphyry systems regarding their precious metal average abundances and the use of these abundances in the development of an empirical classification scheme for porphyry-type deposits of the Canadian Cordillera.

Mossman, D.J., **Delabio, R.N.**, and MacIntosh, P.

MINERALOGY OF CLAY MARKER SEAMS IN SOME SASKATCHEWAN POTASH MINES; GAC/MAC Annual Meeting, 1982.

The mineralogy of clay seams present in the ore zone(s) at the following mines has been investigated: Cominco (Vanscoy); Central Potash (Colonsay); Potash Corporation of

Saskatchewan (Allan) and (Lanigan). A total of 48 samples has been examined. In each case, following concentration of clay minerals by centrifuging, X-ray diffractograms were obtained for: untreated, glycolated and heat treated material (300°C, 450°C, 580°C, 650°C, 725°C). Additional runs were made on several samples under conditions of controlled humidity.

In addition to halite, sylvite and traces of carnallite, numerous water-insoluble constituents are present. Dolomite and anhydrite are the main ones. Quartz, fibrous hematite, hydrocarbon, and sporadic non-diagnostic palynomorphs occur in minor amounts.

The main clay minerals are chlorite (14Å), illite and Mg-septechlorite (7Å). Of the two chlorites the septechlorite is the more thermally stable. The presence of sepiolite, vermiculite, smectite and traces of mixed layer (chlorite-montmorillonite) clay is strongly suspected in some samples. The septechlorite, sepiolite and (possibly) vermiculite very likely originated as direct products of evaporation, under hypersaline conditions, or are the result of diagenesis. Absence of these minerals in a sample selected from (Second) red beds on the rim of the evaporite basin distant from potash deposits is evidence supportive of this concept. Illite and 14A chlorite are of regional (detrital) origin.

Mossman, D.J., **Delabio, R.N.**, and Mackintosh, A.D.

MINERALOGY OF CLAY MARKER SEAMS IN SOME SASKATCHEWAN POTASH MINES; Canadian Journal of Earth Sciences, v. 19, p. 2126-2140, 1982.

Water-insoluble material is present mainly as thin stratigraphic layers throughout the potash ore zone(s) of the Prairie Evaporite. These clay seams constitute about 6% of the ore as mined. After clay minerals, which make up about one third of the total, the main water-insoluble constituents, in approximate order of decreasing abundance, are anhydrite, dolomite, hematite, quartz, potassium feldspar, hydrocarbon, and sporadic non-diagnostic palynomorphs.

Clay mineralogy in the following mines has been studied: Cominco (Vanscoy); Central Canada Potash Co. Ltd. (Cononsay); and Potash Corporation of Saskatchewan (Allan and Lanigan). A total of 49 samples has been examined. In each sample, following concentration of clay minerals by centrifuging, X-ray diffractograms were obtained for untreated, glycolated, and heat-treated material (300, 450, 580, 650, and 725°C). Additional runs were made on several samples under conditions of controlled humidity.

The main clay minerals are Fe-Mg chlorite (14 Å (1.4 nm)), illite, and Mg-septechlorite (7 Å (0.7 nm)). Of the two chlorites, septechlorite is the more thermally stable. One or more of sepiolite, smectite, mixed layer (chlorite-smectite), and possibly traces of vermiculite are also present in some samples. The spetechlorite, sepiolite, and vermiculite very likely originated as direct products of evaporation under hypersaline conditions, or are the result of diagenesis. Absence of otherwise ubiquitous septechlorite in a sample from Second Red Beds west of the 0-edge of the evaporite basin supports this concept. The proportions and kinds of clay minerals present in the ore zone(s) seem to reflect the extent to which hypersaline conditions were developed. The illite and 14 Å (1.4 nm) chlorite are of regional (detrital) origin.

Des matériaux insolubles dans l'eau se présentent principalement sous forme de minces couches stratigraphiques au travers la zone(s) de potasse de l'évaporite de la formation Prairie. Ces couches d'argile constituent environ 6% de la zone minéralisée exploitée. À part les minéraux argileux qui forment près d'un tiers de la masse totale, les constituants insolubles dans l'eau sont dans un ordre d'abondance décroissante approximative: l'anhydrite, la dolomite, l'hématite, le quartz, le feldspath potassique, des hydrocarbures et des palynomorphes sporadiques mal définis.

La minéralogie des argiles a été étudiée dans les exploitations minières suivantes: Cominco (Vanscoy); Central Canada Potash Co. Ltd. (Colonsay); Potash Corporation of Saskatchewan (Allan et Lanigan). Un total de 49 échantillons furent analysés. Après une concentration préalable des minéraux argileux, des diffractogrammes de rayons-X furent enregistrés pour chaque échantillon à l'état naturel, après solvation au glycol, et traitements thermiques (300, 450, 580, 650 et 725°C). Des balayages supplémentaires ont été effectués pour plusieurs échantillons sous des conditions contrôlées d'humidité.

Les principaux minéraux argileux sont la chlorite Fe-Mg (14 Å (1,4 nm)) l'illite et la septechlorite-Mg (7 Å (0,7 nm)). Des deux chlorites, la septechlorite est thermiquement plus stable. Dans certain échantillons on observe un ou plusieurs des minéraux suivants: sépiolite, smectite, interstratifié (chlorite-smectite) et possiblement des traces de vermiculite. La septechlorite, la sépiotite et la vermiculite semblent dériver directement de produits de l'évaporation dans des conditions hypersalines, ou résultent de la diagénèse. L'absence dans un échantillon provenant des Second Red Beds, à l'ouest de la bordure du bassin d'évaporite, de septechlorite pourtant présente partout ailleurs vient renforcir ce concept. Les proportions et les types de minéraux argileux présents dans la zone(s) minéralisée semblent exprimer l'étendue du développement des conditions hypersalines. L'illite et la chlorite 14 Å (1,4 nm) sont d'origine régionale (détritique).

DiLabio, R.N.W.

DRIFT PROSPECTING NEAR GOLD OCCURRENCES AT ONAMAN RIVER, ONTARIO AND OLDHAM, NOVA SCOTIA; in Geology of Canadian Gold Deposits, ed. R.W. Hodder and W. Petruk, Canadian Institute of Mining and Metallurgy, Special Volume 24, p. 261-266, 1982.

In a continuing program of mapping glacial dispersal trains, near-surface till samples were collected down-ice from a copper-silver-gold prospect at Onaman River, Ontario, and down-ice from the past-producing gold district at Oldham, Nova Scotia. The program is designed to aid exploration by illustrating glacial dispersal from various types of known occurrences and by identifying postglacial processes that control drift composition at a detailed scale.

Native gold was mined at Oldham from arsenopyrite-bearing saddle reef quartz veins in a dome in Early Paleozoic slates of the Meguma Group. Gold abundances greater than 10 ppb in till form a dispersal train at least 1900 m long. Gold abundances between 40 and 100 ppb occur in clusters up to 600 m down-ice from gold-bearing bedrock. Anomalous arsenic abundances in till form a broad train 1100 m long that is significantly different in shape from the gold train.

At Onaman River, subeconomic amounts of Cu-Ag-Au occur in quartz lenses in Archean mafic volcanic rocks. A dispersal train defined by the distribution of mineralized boulders and increased abundances of Cu, Ag and Zn in till extends 600 m down-ice from mineralized bedrock. Gold abundances between 10 and 70 ppb do not define this dispersal train, but occur instead in clusters 300 to 600 m down-ice from mineralized bedrock. In vertical sections in the upper 2 m of copper-rich till, Au abundances vary

sympathetically with Ag and Cu levels; however, there seems to be no preferential site of Au enrichment in the mineral portion of the soil profile.

Several of the mineralized boulders at Onaman River are richer in Au and Ag than the mineralized bedrock from which they were derived. Although some of the high Au and Ag assays were caused by biased sampling of sulphide-rich portions of the boulders, many were caused by leaching of sulphide minerals from the boulders, which left a limonitic boxwork that is enriched in Au and Ag. A few of the Au-rich boulders may have been derived from an unknown bedrock source.

DiLabio, R.N.W. and Coker, W.B.

GEOCHEMISTRY OF PEAT ASSOCIATED WITH URANIFEROUS BEDROCK IN THE KASMERE LAKE AREA, MANITOBA; in Prospecting in Areas of Glaciated Terrain – 1982, ed. P.H. Davenport; Canadian Institute of Mining and Metallurgy, p. 179-194, 1982.

Research in northwestern Manitoba began in response to the discovery of uraniferous spring waters in a bog in a small drainage system where recent lake sediments and lake water are enriched in U and where airborne eU and eU/eTh radiometric anomalies are strong. Two peat bogs 2 km apart were sampled in a preliminary program and found to contain highly elevated contents of U and low contents of Zn, Cu, Pb, Ni, Co, Mo, As, Fe and Mn; the source of the U is unknown. This paper presents results of the complete sampling program, which was expanded to include bogs in background areas and bogs adjacent to four types of subeconomic U occurrences. The program was designed to relate the geochemistry of peat to that of lake sediments, drift, and bedrock; and to evaluate peat as a sampling medium for detailed exploration in permafrost terrain where outcrops are sparse.

In all the peat bogs, maximum trace element concentrations were found in the most humified basal peat. Paleoclimatic reconstructions for this region indicate that either the metals accumulated in the peat between 5500 and 3500 years B.P. when permafrost may have been absent, or alternatively, each summer since 6000 years B.P. as the peat thickened and became progressively humified in the thawed active layer. In each model, the onset of permafrost is assumed to stop humification and trace element accumulation.

In general, trace element concentrations in the peat are good indications of the local bedrock geochemistry, and by inference, the local till geochemistry. In areas where U and other elements are enriched in the bedrock, peat is also enriched in those elements. Conversely, peat is not enriched in trace elements where the bedrock is not, except at the initial site, where highly uraniferous peat (1000 to 6000 ppm on a dry weight basis) apparently is associated with bedrock containing about 100 ppm U. It is proposed that the active layer of the peat bogs acts as a "leaky filter" for trace elements moving through the bogs in small streams and groundwater.

The use of peat as a sampling medium for evaluation of data on lake sediment geochemistry in the boreal forest is recommended, keeping in mind that false anomalies in peat are common. Peat geochemistry could also be a useful adjunct to till geochemistry when uraniferous till is traced into peat bogs.

DiLabio, R.N.W., Rencz, A.N., and **Egginton, P.A.**

BIOGEOCHEMICAL EXPRESSION OF A CLASSIC DISPERSAL TRAIN OF METALLIFEROUS TILL NEAR HOPETOWN, ONTARIO; Canadian Journal of Earth Sciences, v. 19, p. 2297-2305, 1982.

Picea mariana (black spruce), **Abies balsamea** (balsam fir), **Juniperus communus** (juniper), **Acer saccharum** (sugar maple), **Populus tremuloides** (aspen), grasses, and their till substrate were sampled at a site of zinc mineralization in marble of the Grenville Province of southeastern Ontario. A classic dispersal train derived from the mineralization is defined by the distribution of mineralized boulders and by the areal extent of till that is enriched in zinc and cadmium; it is 70-200 m wide and at least 400 m long.

The spatial distributions of zinc levels in leaf tissue of **P. mariana, A. Balsamea,** and grasses are also effective maps of the dispersal train. This results from strong relationships between plant metal levels and till metal levels across the full range of till metal levels. Metal levels in tree rings show a persistent decrease from older to younger wood.

Des échantillons de **Picea mariana** (épinette noire), **Abies balsamea** (sapin baumier), **Juniperus communus** (génévriers), **Acer saccharum** (érable à sucre), **Populus tremuloides** (peuplier fauxtremble), d'herbes et du till supportant ces plantes ont été prélevés sur un prospect de zinc dans du marbre situé dans la province de Grenville dans le sud-est de l'Ontario. Un halo secondaire de dispersion classique lié à la minéralisation est défini par la distribution des blocs erratiques minéralisés et par la zone couverte par le till riche en zinc et en cadmium; il est de 70-200 m de large et d'au moins 400 m de longueur.

Les distributions spatiales des teneurs en zinc, dans les tissus de **P. mariana, A. balsamea** et dans les herbes, rapportées sur des cartes concordent avec le halo secondaire de dispersion. Ceci résulte de relations très étroites entre les teneurs du métal dans les plantes et celles du till sur toute la gamme des teneurs du métal dans le till. Les teneurs du métal dans les anneaux des arbres décroissent régulièrement en passant du bois le plus âgé vers le plus jeune.

Dixon, J.

UPPER OXFORDIAN TO ALBIAN GEOLOGY, MACKENZIE DELTA, ARCTIC CANADA; in Arctic Geology and Geophysics, ed. A.F. Embry and H.R. Balkwill, Canadian Society of Petroleum Geologists, Memoir 8, p. 29-42, 1982.

Over 2500 m of upper Oxfordian to Albian terrigenous clastic rocks are known to be present in the subsurface of the Mackenzie Delta area. These rocks were deposited during at least six major depositional-episodes. Marine conditions prevailed during most of the episodes, with one major phase of alluvial sedimentation in the late Valanginian-early Hauterivian. The source of clastic sediment was predominantly from a southerly direction but during the late Hauterivian-early Barremian and Aptian a local northerly source probably existed. During the late Oxfordian to Aptian depositional-episodes, the basin margin tended to oscillate across the NE-SW-trending Eskimo Lakes Arch. A major basin expansion occurred at the end of the Aptian and the Mackenzie Delta area became the site of mid- to outer-shelf mud deposition during the Albian.

Nielsen, E. and **Dredge, L.**

QUATERNARY STRATIGRAPHY AND GEOMORPHOLOGY OF A PART OF THE LOWER NELSON RIVER, MANITOBA; Geological Association of Canada, Guidebook to Field Trip 5, Winnipeg, Manitoba, 55 p., 1982.

Dredge, L.A.

RELICT ICE-SCOUR MARKS AND LATE PHASES OF LAKE AGASSIZ IN NORTHERNMOST MANITOBA; Canadian Journal of Earth Sciences, v. 19, p. 1079-1087, 1982.

In northern Manitoba, intersecting grooves 300-1800 m long are ice-scour marks created by the dragging of iceberg keels along rises in the bed of a glacial lake whose water plane was at about 305 m asl. The lake was bounded by glacial ice on its northern and eastern margins. The occurrence of scours on topographic divides indicates that a single extensive lake, thought to be a northern extremity of Lake Agassiz, occupied the area as far north as Seal River at the time the ice scours were formed. The lake extended as far west as Sprott Lake and eastwards into the Hudson Bay Lowlands into an area later occupied by Tyrrell Sea. The preservation of the scour marks suggests that the lake drained suddenly.

Ice-scour marks are easily recognized on air photographs and provide a means of identifying areas that have been inundated by glacial lakes. Scours in emerged marine sediment are generally obliterated by littoral processes.

Dans le nord du Manitoba, des cannelures entrecroisées d'une longueur de 300 à 1800 m sont des marques d'érosion glaciaire résultant du raclage par les quilles des icebergs le long des pentes dans le lit d'un lac glaciaire dont le plan d'eau était à environ 305 m au dessus du niveau de la mer. Les marges nord et est du lac étaient entourées par le glacier. La présence des marques d'érosion dans les aires de partage des eaux indique qu'un seul grand lac, que l'on croit être une extrémité nord du lac Agassiz, couvrait la région aussi loin vers le nord que la rivière Seal au moment de la formation des marques d'érosion par la glace. Le lac s'étendait vers l'ouest jusqu'au lac Sprott et vers l'est dans les basses-terres de la baie d'Hudson dans une région occupée ultérieurement par la mer de Tyrrell. La préservation des marques d'érosion suggère que le lac s'est drainé soudainement.

Les marques d'érosion glaciaires sont faciles à reconnaître sur les photographies aériennes et fournissent un moyen d'identifier les régions qui furent inondées par des lacs glaciaires. Les marques d'érosion dans les sédiments marins émergés sont généralement effacées par les processus littoraux.

Duke, J.M. and **Bonardi, M.**

CHROMIAN ANDRADITE FROM REAUME TOWNSHIP, ONTARIO; Canadian Mineralogist, v. 20, p. 49-53, 1982.

Chromian andradite occurs as minute (10^{-2} mm) green crystals filling hairline fractures in a serpentinized, chromite-rich poikilitic wehrlite in Réaume township, northeastern Ontario. The garnet contains as much as 10.5% Cr_2O_3; the grains are zoned, with the rims being more chrome-rich than the cores. Their compositions may be described almost entirely in terms of the end members andradite (57 to 89 mole %), uvarovite (1.7 to 37 mole %), and grossularite (3.6 to 9.1 mole %). The formula calculated from the average composition is $(Ca_{3.01}\ Mg_{0.05})\ (Fe^{3+}_{1.30}\ Cr_{0.50}\ Al_{0.14}\ Ti_{0.03})\ (Si_{2.94}\ Al_{0.06})\ O_{12}$, and the cell edge calculated from the X-ray-diffraction powder pattern is 12.061(3) Å. The garnet is a product of the breakdown of magmatic chromite and calcic clinopyroxene, possibly during prograde regional metamorphism.

On trouve une andradite chromifère en très petits cristaux (10^{-2} mm) verts le long de microfissures dans une wehrlite poecilitique serpentinisée et riche en chromite du canton de Réaume, situé dans le secteur nord-est de l'Ontario. Le grenat contient jusqu'à 10.5% de Cr_2O_3; la bordure en contient plus que le centre. Sa composition s'exprime presque entièrement par les pôles andradite (de 57 à 89%, base molaire), uvarovite (de 1.7 à 37%) et grossulaire (de 3.6 à 9.1%). Sa composition globale moyenne est $(Ca_{3.01}\ Mg_{0.05})\ (Fe^{3+}_{1.30}\ Cr_{0.50}\ Al_{0.14}\ Ti_{0.03})\ (Si_{2.94}\ Al_{0.06})\ O_{12}$ et l'arête de la maille, calculée à partir du cliché de diffraction X sur poudre, est égale à 12.061(3) Å. Le grenat est un produit de décomposition de chromite et de clinopyroxène magmatiques; la décomposition se serait déroulée au cours d'une épisode de métamorphisme régional prograde.

Dyke, A.S., Dredge, L.A., and **Vincent, J-S.**

CONFIGURATION AND DYNAMICS OF THE LAURENTIDE ICE SHEET DURING THE LATE WISCONSIN MAXIMUM; Géographie physique et Quaternaire, v. XXXVI, no. 1-2, p. 5-14, 1982.

Prior to 1943 the Laurentide Ice Sheet was considered to have three major domes centered in Keewatin, Labrador, and Patricia (Tyrrell, 1898a,b; 1913). Flint (1943) argued that these centres were of only local and temporary importance and favoured a single-domed ice sheet. Despite the lack of supporting geological evidence, and despite the proposition of a Foxe Dome in the interim (Ives and Andrews, 1963), the single-dome concept was not seriously challenged until the late 1970's and, in fact, is still strenuously supported (Hughes et al., 1977; Denton and Hughes, 1981). This paper extends and modifies recent conclusions that the Laurentide Ice Sheet had more than one dome at the Late Wisconsin maximum. We propose a model incorporating five domes (M'Clintock, Foxe, Labrador, Hudson, and(?) Caribou) based on the position of ice divides, ice flow patterns, drift composition, late-glacial features, post-glacial isostatic recovery and free-air gravity anomalies. Our Labrador and Hudson domes closely correspond to Tyrrell's Labradorean and Patrician ice sheets; our Caribou and M'Clintock domes together with the Franklin Ice Complex over the Queen Elizabeth Islands north of the Laurentide Ice Sheet, correspond to Tyrrell's original Keewatin Ice Sheet. The style of glaciation of the Foxe Basin region was not known to Tyrrell, but our reconstruction of the Foxe Dome is in close agreement with the original proposal of Ives and Andrews. Like Tyrrell, our reconstruction is based on field evidence obtained through extensive mapping; the single dome model continues to be unsupported by geological data.

Avant 1943, on croyait que l'inlandsis laurentidien était constitué de trois dômes principaux centrés sur le Keewatin, le Labrador et le District de Patricia (Tyrrell, 1898a et b et 1913). Flint (1943) a plaidé que ces centres avaient seulement une importance locale et temporaire et il a plutôt favorisé le concept d'un inlandsis à dôme unique. Malgré l'absence de preuves géologiques, et malgré la proposition subséquente de l'existence du Dôme de Foxe (Ives et Andrews, 1963), le concept du dôme unique n'a pas été

sérieusement remis en question avant la fin des années 70. Il est d'ailleurs encore vigoureusement appuyé par certains (Hughes et al., 1977; Denton et Hughes, 1981). Cet article complète et modifie des travaux récents qui affirment que l'inlandsis laurentidien était en réalité constitué de plus d'un dôme au cours du pléniglaciaire du Wisconsinien supérieur. Nous proposons un modèle, basé sur la position des lignes de partage des glaces, les patrons de l'écoulement glaciaire, la composition des sédiments glaciaires, les formes tardi-glaciaires, les patrons du relèvement isostatique postglaciaire et les anomalies gravimétriques à l'air libre, qui fait appel à cinq dômes (ceux de M'Clintock, de Foxe, du Labrador, d'Hudson et (?) de Caribou). Nos dômes du Labrador et d'Hudson correspondent étroitement aux calottes labradoriennes et patriciennes de Tyrrell. Les dômes de Caribou et de M'Clintock avec le complexe glaciaire de Franklin sur les Îles de la Reine-Élizabeth, au nord de la calotte laurentidienne, correspondent à la calotte originelle du Keewatin de Tyrrell. Le style de glaciation de la région du bassin de Foxe n'était pas connu de Tyrrell, mais notre reconstitution du Dôme de Foxe est en accord avec la proposition initiale de Ives et Andrews.

Cumming, G.L., **Eckstrand, O.R.**, and Peredery, W.V.

GEOCHRONOLOGIC INTERPRETATIONS OF Pb ISOTOPE RATIOS IN NICKEL SULFIDES OF THE THOMPSON BELT, MANITOBA; Canadian Journal of Earth Sciences, v. 19, p. 2306-2324, 1982.

Lead isotopes in nickel sulfides from seven deposits in the Thompson Belt appear to record events of four distinct ages. The earliest and most prominent of these may represent the emplacement of the nickel ores and their ultramafic hosts.

Typical massive and disseminated low-lead nickeliferous sulfides were selected for analysis, and several partitioning techniques were used in order to obtain information about the range of isotope ratios in different phases and fractions of the samples. The data were interpreted in terms of the isotopic systematics discussed by Gale and Mussett.

Data from four deposits produce two well defined, parallel "primary" isochrons whose calculated mean slope corresponds to an age of 2320 ± 30 Ma. Interpretation of this date as the time of emplacement of the nickel deposits and their ultramafic hosts is consistent with geological evidence that points to a post-Archean, pre-Hudsonian age. The 2320 Ma date may be consistent, within probable error limits, with the age inferred from Rb/Sr data (2100 Ma) for deposition of metasedimentary rocks of the Thompson Belt, into which the ultramafic lenses were intruded (Brooks and Theyer).

The other isotopically recorded events occurred at 2015 ± 15 Ma (possibly early folding of the Thompson Belt supracrustal rocks), 1620 ± 25 Ma (probably a late retrograde stage of the Hudsonian Orogeny), and 1125 ± 60 Ma (possibly a thermal event associated with emplacement of the Mackenzie dyke swarm).

Les isotopes du plomb contenus dans les sulfures de nickel de sept gisements de la zone de Thompson révèlent l'existence d'évènements géologiques qui sont apparus à quatre âges différents. Le premier et le plus important parmi eux peut représenter la venue du nickel et la mise en place des roches-hôtesses ultramafiques.

Des sulfures nickélifères typiquement massifs et disséminés, de faible teneur en plomb, ont été choisis pour l'analyse, et plusieurs techniques de séparation furent utilisées dans le but de connaître la gamme des rapports isotopiques pour différentes phases et fractions d'échantillons. Les résultats furent interprétés conformément à la systématique isotopique discutée par Gale et Mussett.

Les données provenant de quatre gisements fournissent deux isochrones "primaires" parallèles bien définies dont la pente moyenne calculée donne un âge de 2320 ± 30 Ma. L'interprétation de cette date comme étant le moment de la mise en place des gisements de nickel et de leurs roches-hôtesses ultramafiques concorde avec les observations géologiques suggérant un âge post-archéen et anté-hudsonien. L'âge 2320 Ma peut être envisagé comme comparable, à l'intérieur des limites d'erreur, à l'âge mesuré par le Rb/Sr (2100 Ma) pour la déposition des roches métasédimentaires de la zone de Thompson, lesquelles sont pénétrées par des lentilles ultramafiques (Brooks et Theyer).

Les autre évènements révélés par l'analyse des isotopes se sont produits il y a 2015 ± 15 Ma (probablement une phase ancienne de plissement des roches supracrustales de la zone de Thompson), 1620 ± 25 Ma (probablement une phase régressive tardive de l'orogénèse de l'Hudsonien) et 1125 ± 60 Ma (probablement une activité thermale associée avec la mise en place du réseau de dykes du Mackenzie).

Evans, S.G.

THE DEVELOPMENT OF BIG SLIDE, NEAR QUESNEL, BRITISH COLUMBIA, BETWEEN 1953 AND 1982; Geoscience Canada, v. 9, p. 220-222, 1982.

Big Slide is an active extensive landslide complex located on the east side of the Fraser River, 11.7 km north of Quesnel, British Columbia. The landslide is developed in Pleistocene glaciolacustrine sediments and is a classic example of a retrogressive flow slide. The retrogressive behaviour of the landslide is documented between 1953 and 1982, and the rate of scarp retreat varies between 6 and 12 m/yr. This rate of retrogression is one of the highest recorded in the literature.

Evans, S.G.

LANDSLIDES AND SURFICIAL DEPOSITS IN URBAN AREAS OF BRITISH COLUMBIA: A REVIEW; Canadian Geotechnical Journal, v. 19, p. 269-288, 1982.

Landslides in surficial deposits occur commonly in the urban environment of British Columbia. Three groups of surficial materials are especially prone to slope failure. These are glaciomarine sediments, glaciolacustrine deposits, and glacial till that mantles steep mountain slopes. The geological and geotechnical characteristics of these three materials are examined and discussed.

The sensitivity, metastable fabric, and geological heterogeneity of glaciomarine sediments control their landslide behaviour. A regional variation in glaciolacustrine deposits is suggested. The Southern Interior and Columbia deposits are dominated by silt varves and those of the Northern Interior by clay varves. The silts are sensitive and collapsible under certain moisture and loading conditions. The effect of urbanisation on these silts in the semiarid Southern Interior is considerable. The retrogressive behaviour of slides in silts and clays in urban areas is also examined.

Open-slope and channelled debris flows in till mantles are discussed. They occur mainly on steep slopes in the Coast Ranges as a response to heavy, relief-induced rainfall. The effect of urbanization on slope stability is also discussed.

Des glissements de dépôts de surface se produisent fréquemment en milieu urbain en Colombie britannique. Trois groupes de matériaux de surface sont particulièrement sujets à glissement. Ce sont les sédiments glacio-marins, les dépôts glacio-lacustres et les moraines glaciaires qui recouvrent des pentes rocheuses abruptes. Les caractéristiques géologiques et géotechniques de ces trois matériaux sont examinées et discutées.

La sensibilité, la structure métastable et l'hétérogénéité géologique des sédiments glacio-marins contrôlent leur comportement lors de glissements de terrain. Une variation régionale des dépôts glacio-lacustres est suggérée. Les dépôts de la Columbia et du sud intérieur de la province sont dominés par des varves silteuses, ceux du nord-intérieur par des varves argileuses. Les silts sont sensibles et compressibles dans certaines conditions d'humidité et de charge. L'effet de l'urbanisation sur ces silts dans la région intérieure sud à climat semi aride est considérable. Le caractère rétrogressif des glissements dans les silts et les argiles en zone urbaine est aussi examiné.

Les coulées de débris dans les pentes et couloirs dans les couvertures de moraines sont discutées. Elles se produisent surtout dans des pentes abruptes dans les chaînes cotières à la suite de pluies intenses produites par le relief. L'effet de l'urbanisation sur la stabilité des pentes est aussi discuté.

Fabbri, A.G., Kasvand, T., and Masounave, J.

ADJACENCY RELATIONSHIPS IN AGGREGATES OF CRYSTAL PROFILES; in Proceedings of the 6th International Conference on Pattern Recognition, October 1982, p. 1207.

Foscolos, A.E., Reinson, G.E., and **Powell, T.G.**

CONTROLS ON CLAY-MINERAL AUTHIGENESIS IN THE VIKING SANDSTONE, CENTRAL ALBERTA. I. SHALLOW DEPTHS; Canadian Mineralogist, v. 20, p. 141-150, 1982.

The Viking Formation of east-central Alberta is a shallow-marine shelf deposit containing two prominent, laminated to massive, sandstone units interbedded with laminated shaly siltstones and bioturbated muddy sandstones. The sandstone units differ markedly in detrital mineralogical composition: the shallower unit is a lithic arkose containing abundant feldspar, but very little glauconite; whereas the deeper unit is a sublitharenite containing minor feldspar and abundant glauconite. Mechanical analyses of the sandstones indicate a higher percentage of clay minerals in the lithic arkose than in the sublitharenite. X-ray analysis shows that, in the shallower sandstone, glauconite, kaolinite and chlorite are the main clay minerals, along with quartz, whereas the deeper sandstone contains, in addition to the above mentioned minerals 2:1 mixed-layer silicate. A SEM analysis reveals that kaolinite booklets and some quartz overgrowth dominate the authigenic minerals in the shallower sandstone while the deeper one contains mainly quartz overgrowth and 2:1 layer silicates with some kaolinite. In the latter sandstone, wherever authigenic calcite is present, authigenic layer-silicates are absent.

La formation Viking du centre-est de l'Alberta, dépôt de plateforme marine de faible profondeur, contient deux unités imposantes de grès laminé à massif, avec intercalations de siltstones argileux laminés et de grès boueux bioturbés. Les grès se distinguent par la composition minéralogique de leurs détritus: l'unité la moins profonde est une arkose lithique contenant du feldspath en abondance, mais très peu de glauconie; l'unité la plus profonde est une sublitharénite qui contient très peu de feldspath et beaucoup de glauconie. Par analyse mécanique, on montre que l'arkose lithique contient une proportion plus forte de minéraux argileux que la sublitharénite. Une analyse diffractométrique X indique que, dans l'unité la moins profonde, glauconie, kaolinite et chlorite sont les minéraux argileux principaux, accompagnés de quartz; par contre, l'unité de grès profonde contient en plus un phyllosilicate mixte 2:1. Une analyse au microscope électronique à balayage montre de la kaolinite en livrets et du quartz en surcroissance comme minéraux authigènes prédominants dans le grès peu profond, tandis que le grès profond montre surtout du quartz en surcroissance et des phyllosilicates 2:1 avec kaolinite. En présence de calcite authigène dans cette unité, les phyllosilicates sont absents.

Walford, P.C. and **Franklin, J.M.**

THE ANDERSON LAKE MINE, SNOW LAKE, MANITOBA; in Precambrian Sulphide Deposits, H.S. Robinson Memorial Volume, ed. R.W. Hutchinson, C.D. Spence and J.M. Franklin, Geological Association of Canada, Special Paper 25, p. 481-523, 1982.

The Anderson Lake orebody occurs in highly metamorphosed Aphebian volcanic rocks of the Snow Lake area, Manitoba. This relatively copper-rich massive sulphide deposit has a typical footwall alteration pipe including a large upper muscovite zone and a vertically extensive chlorite zone. These intense alteration zones are surrounded by a less intense staurolitic alteration zone. The pipe extends down to a sub-concordant alteration blanket in the footwall rhyolite. This lower alteration has a chlorite-rich centre which is locally albite-bearing at its core, developed near the departure point of the pipe, and a more distal, alkali-depleted, iron-enriched staurolite zone. The hangingwall mafic volcanic rocks are not altered near the deposit, but the immediate hangingwall felsic epiclastic rock is muscovite-rich, and may be altered.

The deposit occurs in the lowest and chemically most primitive unit in the mine sequence. The base of the mine sequence is occupied by a major synvolcanic tonalite sill. The felsic rocks increase in K/Na ratios, Ba content and phenocryst content upward in the sequence; they comprise more than 50% of the volcanic products. The mafic rocks are dominantly high-alumina basalt, with minor andesite. The compositional characteristics of the volcanic accumulation, and abundance of felsic rocks are similar to those of a subduction-generated continental margin environment.

Metal-rich fluids for the deposit are believed to have formed by heating of intrastratal water within the lower unit of volcanic rocks by the subvolcanic tonalite intrusion. These waters were probably expelled from the lower concordant zone through syn-volcanic faults and hydrothermal fracture zones, on to the sea floor. Rapid cooling, and local mixing with sea water drawn down into the pipe zone resulted in metal precipitation.

Campbell, I.H., Coad, P., **Franklin, J.M.,** Gorton, M.P., Hart, T.R., Sowa, J., and Thurston, P.C.

GRANT 80: RARE EARTH ELEMENTS IN FELSIC VOLCANIC ROCKS ASSOCIATED WITH Cu-Zn MASSIVE SULPHIDE MINERALIZATION; in Geoscience Research Grant Program, Summary of Research, 1981-82, Ontario Geological Survey, Miscellaneous Report 103, p. 20-28.

A study of host felsic volcanic rocks and alteration pipes associated with Cu-Zn massive sulphide deposits has produced no evidence of REE mobility in the felsic volcanic rocks adjacent to massive sulphide deposits. However they

can be mobile in the alteration pipes below the orebodies. Where REE mobility has been observed, all of the REE are leached from the system, but the middle REE, centered on Tb, are preferentially removed producing $(Yb/Tb)_n$ ratios greater than 1. Eu^{2+} has been found to be more mobile than the +3 REE, resulting in a marked increase in the size of the Eu anomaly where alteration is intense. Other "immobile" elements such as Th, Zr, Y and Hf may also be mobile in the alteration pipe.

Preliminary data suggest that REE mobility increases with the size of the deposit. Thus REE mobility is potentially a method of identifying large massive sulphide deposits at an early stage in exploration.

Franklin, J.M. and **Thorpe, R.I.**

COMPARATIVE METALLOGENY OF THE SUPERIOR, SLAVE AND CHURCHILL PROVINCES; in H.S. Robinson Memorial Volume, Precambrian Sulphide Deposits, ed. R.W. Hutchinson, C.D. Spence and J.M. Franklin, Geological Association of Canada, Special Paper 25, p. 3-90, 1982.

The Slave, Superior and Churchill provinces of the Canadian Shield contain major copper-zinc, gold, nickel and iron deposits, primarily in volcanic-dominant 'greenstone' belts of Archean and Proterozoic age. In addition, sandstone-hosted and carbonate-hosted lead-zinc occurrences are present in shelf-sedimentary sequences such as the Wollaston belt and Belcher Island fold belt. Other significant deposit types, not treated here in any detail, include unconformity-related and clastic-hosted uranium deposits, silver and lead-zinc veins in cratonic-cover sequences, deposits associated with alkaline rocks and pegmatites, and the Chibougamau copper-vein deposits.

All massive sulphide deposits are of the Cu-Zn type, with Pb:Zn less than 0.1. Most occur in the second or higher cycles of multi-cyclic volcanic sequences, and many occur in the lower half of their host cycle. Most of the principal districts have prominent subvolcanic intrusions at the base of the host cycle. These are interpreted to represent a local thermal energy source that generated high temperature ($\sim$350°C) geothermal systems containing the metalliferous source fluids.

Gold deposits occur primarily in areas of prominent crustal instability, such as intravolcanic rift zones. Although most of the gold in intrusion- and volcanic-hosted deposits occurs in veins, and evidently formed at high crustal levels at least a short time after host-rock deposition, a few iron-formation hosted deposits may be syngenetic. Little evidence is available in the epigenetic deposits to indicate local re-concentration of gold from anomalously rich nearby strata; rather the gold was derived from lower crustal environments, by development of high temperature hydrothermal fluids in a very low water-rock regime. The fluids were focussed by intravolcanic, tensional faults.

Iron deposits are not directly related to massive sulphide-generating hydrothermal fluids. Their low base metal content and large areal extent require a large volume of relatively low temperature transporting fluid. Very large-volume sea-water circulation through volcanic rocks, driven by heat from the cooling pile, may have supplied the required iron-rich fluid. Superior-type iron-formation appears to be developed primarily in intracratonic rifts.

Frisch, T. and Dawes, P.R.

THE PRECAMBRIAN SHIELD OF NORTHERNMOST BAFFIN BAY: CORRELATION ACROSS NARES STRAIT; in Nares Strait and the Drift of Greenland: a Conflict in Plate Tectonics, Meddelelser om Grønland, Geoscience 8, p. 79-88, 1982.

The northern rim of the North American craton outcrops in the Baffin Bay – Nares Strait region where it forms large parts of southeastern Ellesmere Island and northwestern Greenland. Between 76°N and 78°N the Precambrian Shield comprises high-grade gneiss and metasediments which show a comparable chronological history in Ellesmere Island and Greenland. Two major features that emphasise the close relationship between the Shield on either side of Nares Strait are the presence of marble-rich metasedimentary tracts and a distinctive suite of late Archaean granitic to basic plutonic rocks which have locally been transformed by intense Proterozoic (probably Hudsonian) deformation into complexly folded orthogneisses.

Marble-rich tracts are common throughout southeastern Ellesmere Island: in northwestern Greenland they are restricted to Inglefield Land north of 78°N. The regional structure suggests that the marble-rich tracts constitute a single marble province and that those on opposite sides of Smith Sound at Cape Isabella (Canada) and Sunrise Pynt (Greenland) may well represent on-strike parts of the same belt of supracrustal rocks.

Correlation of the distinctive features of the Shield in southeastern Ellesmere Island and northwestern Greenland is entirely consistent with there having been no major strike-slip movement along Nares Strait.

Dawes, P.R., **Frisch, T.**, and **Christie, R.L.**

THE PROTEROZOIC THULE BASIN OF GREENLAND AND ELLESMERE ISLAND: IMPORTANCE TO THE NARES STRAIT DEBATE; in Nares Strait and the Drift of Greenland: a Conflict in Plate Tectonics, Meddelelser om Grønland, Geoscience 8, p. 89-104, 1982.

Onshore geological investigations in the Smith Sound region are now so advanced as to allow correlation between Canada and Greenland to be made with confidence.

The Precambrian Shield is unconformably overlain by unmetamorphosed Proterozoic strata (Thule Group) that are best preserved in Greenland, where they attain a thickness of at least 4.5 km. Less than 1100 m are present in southeastern Ellesmere Island, but the succession is so similar to the lower part of the Greenland succession that unit to unit correlation of both sedimentary and volcanic rocks is possible. This correlation strongly supports the concept of a single intracratonic basin (Thule Basin) spanning the southernmost part of Nares Strait. In Greenland the basin is well defined and its northern margin is at about 78°15'N. In Ellesmere Island paucity of outcrop provides less definition but the northern margin lies between Baird Inlet (78°30'N) and Bache Peninsula (79°N).

The lithological and thickness correlation of the Proterozoic successions on the opposite shores of the Smith Sound region strongly suggests that any tectonic movement along the Nares Strait lineament has not resulted in major net transcurrent displacement of Greenland and Ellesmere Island.

Kretz, R., Garrett, D., and **Garrett, R.G.**

Na-K-Li GEOCHEMISTRY OF THE PRESTIGE PLUTON IN THE SLAVE PROVINCE OF THE CANADIAN SHIELD; Canadian Journal of Earth Sciences, v. 19, p. 540-554, 1982.

In the southwestern Slave Province (Canadian Precambrian Shield), a cluster of 14 muscovite-biotite granite plutons dated at about 2.6×10^9 years was emplaced into a thick succession of Archean greenstone, graywacke, and argillite known as the Yellowknife Supergroup. One of the medium-sized plutons (the Prestige pluton), with an outcrop area of 14 km^2, consists of equal portions of quartz, plagioclase, and potash feldspar, and minor muscovite, biotite, and apatite. The presence of muscovite, andalusite, and sillimanite in the metamorphic aureole indicates that the pluton was emplaced at a depth of about 9 km (2.5 kbar (250 MPa)) and a temperature of about 600°C. The texture is complex, as shown especially by muscovite, which occurs as large crystals, as small oriented inclusions in plagioclase, and as fine-grained aggregates along grain boundaries.

The mean density of the Prestige granite is 2.641 g cm^{-3}, which is less than that of the country rock by a factor of 0.96. The mean alkali content is 2.5 wt.% Na, 4.3 wt.% K, and 700 ppm Li (80 samples). Na and K are normally distributed; Li is strongly skewed. Analysis of variance shows that 50-80% of the element variability occurs on a small scale (within 0.25 km^2 cells). Some of this variability was possibly produced by chemical transport reactions such as:

$$2\ H^+ + 3\ K\ \text{feldspar} = 1\ \text{muscovite} + 6\ \text{quartz} + 2K^+$$

which may also account for some of the textural complexity.

Large-scale trends within the Prestige pluton could be detected for K and Li but not for Na. Thus the western half is relatively poor in K, and the narrow margin of the pluton is relatively rich in Li. These trends may be attributed to inhomogeneity within the granite prior to emplacement or to a large-scale migration of alkalies that occurred during the formation of the associated pegmatite dikes.

Virtually all of the physical and chemical data that are available for the Prestige pluton are consistent with a model that supposes the granite body was in a totally crystalline, but plastic, condition while it migrated to higher crustal levels, in response to buoyant forces.

Dans le sud-ouest de la province des Esclaves (Bouclier précambrien du Canada), un groupe de 14 plutons de granite à muscovite-biotite, daté à environ $2,6 \times 10^9$ années, a été mis en place dans une séquence épaisse de roche verte archéenne, de grauwacke et d'argillite, appelée le supergroupe Yellowknife. Un des plutons de dimension moyenne (le pluton Prestige), affleurant sur une superficie de 14 km^2, est composé en proportions égales de quartz, plagioclase, feldspath potassique et d'une quantité mineure de muscovite, biotite et apatite. La présence de muscovite, d'andalousite et de sillimanite dans une auréole métamorphique indique que le pluton a été mis sur place à une profondeur d'environ 9 km (2,5 kbar (250 MPa)) et à une température d'environ 600°C. La texture est complexe, comme le montre particulièrement la muscovite qui se présente en gros cristaux, et les minuscules inclusions orientées dans le plagioclase et les agrégats fins en bordure des grains.

La moyenne de la densité du granite du pluton Prestige est 2,641 g/cm^3, elle est inférieure à celle de la roche encaissante par un facteur de 0,96. Les teneurs moyennes des éléments alcalins sont 2,5% par poids pour Na, 4,3% par poids pour K et 7700 ppm pour Li (80 échantillons). La distribution du Na et du K est normale, celle du Li varie considérablement. L'analyse de variance démontre que 50-80% de la variabilité des éléments se manifeste à petite échelle (à l'intérieur de cellules de 0,25 km^2). Une partie de cette variabilité est probablement due à des réactions de transfert chimique telle que:

$$2\ H^+ + 3\ \text{feldspath-K} = 1\ \text{muscovite} + 6\ \text{quartz} + 2\ K^+$$

lesquelles expliquent également en partie la complexité texturale.

Des tendances à grande échelle dans le pluton Prestige peuvent être mises en évidence pour le K et le Li, mais pas pour le Na. Ainsi la moitié ouest est relativement pauvre en K et la bordure étroite du pluton est relativement riche en Li. Ces tendances peuvent être attribuées à une hétérogénéité qui existait dans le granite avant la mise en place du pluton ou à une migration à grande échelle des éléments alcalins qui se serait produite durant la phase de formation des dykes associés de pegmatite.

En fait, l'ensemble des données physiques et chimiques disponibles pour le pluton Prestige concorde avec un modèle qui suppose que la masse de granite était totalement cristallisée, mais demeurait à l'état plastique, durant la phase de migration vers les niveaux crustaux supérieurs, répondant aux forces de flottabilité.

Grasty, R.L.

DIRECT SNOW-WATER EQUIVALENT MEASUREMENT BY AIR-BORNE GAMMA-RAY SPECTROMETRY; Journal of Hydrology, v. 55, p. 213-235, 1982.

A direct air-borne technique to measure snow-water equivalent that utilizes the buildup of scattered gamma-radiation from ^{40}K with increasing snow-water equivalent has been successfully tested. The variations in the shapes of the potassium, uranium and thorium gamma-ray spectra were determined from measurements on large radioactive concrete pads, using plywood sheets to simulate a uniform snow-water equivalent layer. The air-borne system was calibrated by flying at different altitudes over two test areas and converting the aircraft altitude to an equivalent layer of water. A series of nine flights at different altitudes over an area of unknown radioactivity gave results consistent with snow-water equivalent ground measurements of 142 mm and also with air-borne results from the standard two-flight technique. The single-flight technique has the advantage over the two-flight method that no ground soil-moisture measurements are necessary, no pre-snow flight is required and navigation problems in duplicating the two flight lines are avoided.

Grasty, R.L., Bristow, Q., Cameron, G.W., Dyck, W., Grant, J.A., and **Killeen, P.G.**

PRIMARY CALIBRATION OF A LABORATORY GAMMA-RAY SPECTROMETER FOR THE MEASUREMENT OF POTASSIUM, URANIUM AND THORIUM; in Proceedings of the Symposium on Uranium Exploration Methods, Review of the NEA/IAEA R&D Programme, Paris, June 1-4, 1982, p. 699-713, 1982.

This paper describes how primary potassium, uranium and thorium standards can be prepared from potassium carbonate, radium chloride and from a thorium salt, manufactured in 1906, which has now reached radioactive equilibrium. Experiments utilizing prepared potassium and thorium samples of different density show how the calibration constants derived from the primary standards can be modified to allow samples of different densities to be measured reliably.

Hacquebard, P.A. and Avery, M.P.

PETROGRAPHY OF THE HARBOUR SEAM IN THE DONKIN RESERVE AREA OF THE SYDNEY COALFIELD, NOVA SCOTIA; in "Coal, Phoenix of the 80's"; Proceedings of 64th Annual Meeting, Chemical Institute of Canada – Coal Symposium, v. 1, p. 79-86, 1982.

In the Donkin Reserve area the Harbour seam intersections in eleven boreholes vary in thickness from 1.65-3.87 m. A petrographic profile of each intersection has been constructed from conventional cores or sidewall cores, and the accuracy of seam representation by the latter is illustrated. The profiles show the vertical variations in maceral composition, pyrite distribution and vitrinite reflectance, and also provide information on the predicted coke stability.

Within each profile there are significant changes in the petrographic composition, which have lateral continuity, but when considered on an average seam basis only minor variations occur. The "total reactives" vary between 77 and 87%, indicating that a bright coal high in vitrinite is present. Of greater importance are the considerable differences in rank, as manifested by Ro variations of 0.90-1.10%, with the greater values occurring at greater depth and towards the east. This trend is paralleled by an increase in the predicted coke stability factor from 30 to 56. Considerable variation in pyrite distribution is also observed, with a general reduction in content from west to east.

Ackermand, D., **Herd, R.K.**, and Windley, B.

CHEMOGRAPHIC RELATIONSHIPS IN SAPPHIRINE-BEARING ROCKS OF THE LIMPOPO BELT, SOUTHERN AFRICA; in International Symposium on Archean and Early Proterozoic Geologic Evolution and Metallogenesis, Sept. 3-11, 1982, p. 11.

Silica deficient metasedimentary rocks in which sapphrine coexists with several minerals in various parageneses occur in lenses or as thin layers within the Messina Layered Intrusion. Following the intrusion of some tholeiitic dykes, the Messina Layered Intrusion was emplaced into a sequence of supracrustal rocks (↶3.2 b.y.). The intrusion consists of poorly exposed chromite layered anorthosites, leucogabbros and gabbros. After the intrusion of some granitic rocks there was a widespread period of deformation and a high-grade metamorphism (↶1.9 b.y.).

In the investigated rocks the average X(Fe) of the minerals vary in the order cordierite (0.04 < chlorite < phlogopite < sapphirine (0.04-0.14) < enstatite < kornerupine < gedrite < spinel (0.08-0.22). The textural relations and the plots of the microprobe data of coexisting minerals in the system $MgO-Al_2O_3-SiO_2-(H_2O)$ are consistent with the sequence of reaction as follows: (A) Korn + Sill = Cord + Coru; (B) Korn + Spi ⇋ Ged (En) + Sapph; (C) Korn ⇋ Cord + Sapph ± Ged (En); (D) Ged ⇋ En + Cord ± Sapph; (E) En + Spi ⇋ Chl + Sapph; (F) En + Sapph ⇋ Cord + Spi; (G) En + Sapph ⇋ Chl + Cord; (H) Cord + Sapph ⇋ Chl + Coru; (I) Sapph ⇋ Chl + Coru + Spi. The above data when represented on a petrogenetic grid-based on experimental data (Seifert; 1974 and 1975) – gives the sequence of reactions indicating a prograde metamorphism (temperature increase of 750°C and above with minimum pressure of 4 Kbars) followed by a retrograde metamorphism (700°C and lower with maximum pressure of 3 Kbars).

Hoffman, P.F., Card, K.D., and **Davidson, A.**

THE PRECAMBRIAN: CANADA AND GREENLAND; in Perspectives in Regional Geological Synthesis, Planning for The Geology of North America; Geological Society of America, DNAG Special Publication 1, p. 3-6, 1982.

The rifted Precambrian shield of Canada and Greenland was formed by the convergence and consolidation of at least four Archean cratons, each with a complex history, within an anastomosing system of Early Proterozoic orogens, probably the sites of former oceans. The resulting composite craton, Proto-Laurentia, was apparently assembled in less than 100 m.y., between 1.9 and 1.8 b.y. In the Middle Proterozoic, the southeast margin of the craton was extensively intruded by batholiths and related volcanics, culminating with the Grenville orogeny at about 1.1 b.y., which has been interpreted as the Andean side of a continental collision (Dewey and Burke, 1973). Late Proterozoic rocks, almost absent from the shield, include deposits of the Laurentian margin in the Appalachian and Cordilleran orogens, and exotic rocks unrelated to Laurentia, such as the Pan-African Avalon Zone of the Appalachians.

Hood, P.J.

MINERAL EXPLORATION: TRENDS AND DEVELOPMENTS IN 1982; Canadian Mining Journal, v. 104, no. 1, p. 14-45, 1982.

This article reviewed the following topics for the year 1982:

1. General state of mineral exploration business for 1982.
2. New capabilities of the airborne geophysical contractors and notable airborne surveys that they carried out in 1982.
3. New commercially-available airborne geophysical instrumentation including data processing and compilation systems.
4. New commercially-available ground geophysical and geochemical instrumentation including new services offered.

In the 1982 review, the characteristics of commercially-available airborne magnetometers were tabulated.

Hood, P., Irvine, J., and Hansen, J.

THE APPLICATION OF THE AEROMAGNETIC GRADIOMETER TECHNIQUE TO GOLD EXPLORATION IN THE VAL D'OR MINING CAMP, QUEBEC; Canadian Mining Journal, v. 103, no. 9, p. 21-39, 1982.

Increasing interest is being shown by the mineral exploration industry in the aeromagnetic gradiometer technique mainly because of its value in unravelling areas of complex geology. One of the most interesting applications to date has been in delineating the drift-covered geological formations and structural features of the Val d'Or area of Quebec, which is an area famous for its gold mines. In 1980 a combined aeromagnetic VLF EM gradiometer survey of the Val d'Or sheet (NTS 32 C/4) was flown at a height of 150 m by the GSC and the results were published in January 1982 as 4 coloured maps using the Applicon plotter, namely total field, vertical gradient, VLF EM total field and quadrature. The main anomalies delineated by the earlier 1948 total field survey flown with a 800 m flight line spacing correspond well

with those of the 1980 survey, but most of the fine detail is missing. The resolution of the vertical gradient map is much superior and many of the intrusive plugs with which gold is associated e.g. Bevcon, Lamaque, Sigma, Siscoe can be readily identified. The important Cadillac Break is delineated both on the aeromagnetic and on the VLF EM maps. Aeromagnetic gradiometer surveys were offered commercially for the first time in 1982 so that this greatly improved geological mapping tool is now available to the mineral exploration industry.

Kalkreuth, W.D.

RANK AND PETROGRAPHIC COMPOSITION OF SELECTED JURASSIC-LOWER CRETACEOUS COALS OF BRITISH COLUMBIA, CANADA; Bulletin of Canadian Petroleum Geology, v. 30, no. 2, p. 112-139, 1982.

Rank and composition of Jurassic-Lower Cretaceous coals from four localities in the Crowsnest and Peace River Coalfields of British Columbia are described. The coals obtained from the Crowsnest Coalfield represent so called "needle" coals from the Elk Formation of the Kootenay Group, whereas coals of the Peace River Coalfield were obtained from the Gorman Creek and Bickford Formations of the Minnes Group and from the Gething Formation of the Bullhead Group.

Rank, determined by vitrinite reflectance measurements, ranges from subbituminous C in the Crowsnest Coalfield to medium volatile bituminous in the Peace River Coalfield.

Composition was determined by maceral analysis. Results indicate that, in general, coals from the Elk Formation in the south and from the Gorman Creek and Bickford Formations in the north are characterized by moderate to high concentrations of macerals of the liptinite group (alginite, sporinite and cutinite) and very small amounts of semifusinite and inerts. This maceral composition, together with occurrences of boghead (algal-rich) and cannel (spore-rich) layers associated with mainly unstructured vitrinite, is interpreted as an indication of a reed swamp to open-water swamp depositional environment.

In certain parts of the Peace River Coalfield, increase of rank with depth (Hilt's Law) is masked by maceral composition. In some sections there is no rank change with increase in depth; instead, vitrinite reflectances are controlled by the total amount of liptinites in a given coal sample. The reflectance of vitrinite decreases gradually with increase in liptinite content. This effect is interpreted as being caused by diffusion of bituminous substances out of the liptinite macerals into the surrounding vitrinites.

Coking and liquefaction properties of the coal are discussed. It can be demonstrated that low- to intermediate-rank coals from the Crowsnest and Peace River Coalfields, characterized by high amounts of so-called reactive macerals (vitrinite and liptinite), are excellent feed coals for liquefaction. They are, however, too low in rank and too rich in reactive macerals to produce a strong coke. Good coking properties are predicted for the higher-rank coals from the Peace River Coalfield, which are characterized by increasing amounts of inert macerals.

Kalkreuth, W. and Chornet, E.

PEAT HYDROGENOLYSIS USING H_2/CO MIXTURES: MICROPETROLOGICAL AND CHEMICAL STUDIES OF ORIGINAL MATERIAL AND REACTION RESIDUES; Fuel Processing Technology, v. 6, p. 93-122, 1982.

The transformation of crude peat (peat in natural aqueous medium) has been studied under hydrogenolysis conditions using CO and H_2 mixtures as reducing agent. Batch autoclave experiments were conducted with a moderately humified peat at reaction temperatures up to 400°C.

Micropetrological and chemical studies on untreated and treated peat as well as on THF extracted residues show that the different organic components present in peat undergo changes very similar to those observed during coal liquefaction. Liptinitic components are rapidly converted and do not appear in the unconverted residues above 275°C. The huminitic components regularly increase their reflectivity and appear to have been coalified to the stage of subbituminous coal A, from that point on being the major contributors to the newly formed vitroplast. The latter is observed for the first time following the hydrogenolysis treatment at 300°C. Beyond this temperature the vitroplast undergoes severe alterations becoming a bitumen-like material.

In the presence of anthracene oil as organic carrier solvent, the hydrogenolysis reactions using CO and H_2 result in the formation of mesophase at temperatures as low as 380°C. Coke-like structures can thus be formed from peat.

Belinbo, K., **Kalkreuth, W.**, and Chornet, E.

ANISOTROPIC COKE-LIKE STRUCTURES PRODUCED BY CARBONIZATION OF RESIDUES DERIVED FROM AQUEOUS-PHASE HYDROGENOLYSIS OF PEAT WITH SYNGAS; Fuel Processing Technology, v. 6, p. 75-81, 1982.

Solid residues from hydrogenolysis of peat were analysed as a feedstock for coke production. Under specific hydrogenolysis conditions, the residues exhibited a reflectance similar to that of a highly volatile bituminous coal and were found to pass through a metaplastic transition phase. The oxygen content of the residues decreased significantly with increases in the severity of the hydrogenolysis treatment, going from 34.3% (m.a.f.) in the original peat to less than 14%. These factors contributed to the development of optically anisotropic structures in the coke produced by carbonization of the hydrogenolysis residues.

Killeen, P.G.

GAMMA-RAY LOGGING AND INTERPRETATION; in Developments in Geophysical Exploration Methods, Volume 3, Applied Science Publishers Ltd. (Elsevier), p. 95-150, 1982.

Gamma-ray logging has evolved from a qualitative estimation of the variation of natural radioactivity with depth in a borehole, using a Geiger-Muller detector, to a sophisticated quantitative logging technique which yields information on the identification and amount of the radio-elements present, as well as data on the likely geologic history of mobilisation of these radioelements in the rock. To extract this additional information, a keener appreciation of the natural radioactive decay series, the isotopes involved, their half-lives, the energies of their gamma-rays and the interaction of these gamma-rays with the rock through which they travel is necessary. This has led to the development of improved data acquisition systems (digital logging systems), new methods of data processing (application of digital time series analysis – inverse filtering), the introduction of gamma-ray spectral logging, and improvements in variety and type of detectors to enhance the logging measurements and facilitate the new data processing techniques. Many of the new developments relate primarily to uranium exploration problems but they also have ramifications in other geologic applications of gamma-ray logging.

Killeen, P.G.

NEW SCINTILLATION DETECTORS: A REVIEW OF COMPARISONS OF BISMUTH GERMANATE, CESIUM IODIDE AND SODIUM IODIDE; in Proceedings of the Symposium on Uranium Exploration Methods, Review of the NEA/IAEA R&D Programme, Paris, June 1-4, 1982, p. 639-652, 1982.

Two studies comparing bismuth germanate scintillation detectors ($Bi_4Ge_3O_{12}$, commonly referred to as BGO) to sodium activated cesium iodide CsI(Na) and thallium activated sodium iodide NaI(Tl) detectors have been completed, with particular reference to their use in borehole gamma ray spectral logging. The results are also of interest for other potential applications such as in field portable gamma ray spectrometers and scintillometers. The comparisons were conducted independently by the Geological Survey of Canada at the Ottawa model borehole calibration facilities, and by Bendix Field Engineering Co. at the Grand Junction calibration facilities of the U.S. Department of Energy.

It appears that BGO, and to a lesser extent CsI(Na) detectors offer considerable advantages for uranium exploration and evaluation, especially where small detector sizes are necessary, such as in slim hole logging.

Killeen, P.G. (with Hallenburg, J.K., Furlong, V.L.R., and Duray, J.)

BOREHOLE LOGGING FOR URANIUM EXPLORATION – A MANUAL; International Atomic Energy Agency, Technical Report Series No. 212, 279 p., 1982.

Intensive worldwide efforts in uranium exploration over the past four years have been stimulating research on and development of new exploration techniques and field equipment. It is widely recognized that borehole logging is one of the most effective ways of estimating uranium resources, and its popularity has grown considerably. Logging for uranium, which once was an auxiliary technique subordinate to chemical analysis and drilled core examination, has become one of the most powerful and efficacious methods of measuring, directly or indirectly, uranium at depth. Borehole logging provides, rapidly and economically, most of the sub-surface information needed by the exploration geologist. This includes in-situ analysis, lithological identification, stratigraphic correlation, and information on density and moisture. Logging is important not only in exploration but in mine development and grade control, in mining operations and in production. Tens of millions of metres will be drilled and logged by exploration firms and governmental organizations in Member States each year in the search for nuclear fuel.

Kornik, L.J.

AEROMAGNETIC GRADIOMETER RESULTS IN THE WOLLASTON LAKE AREA, SASKATCHEWAN, CANADA; in Proceedings of Uranium Exploration Methods, Paris, 1982, OECD Nuclear Energy Agency and IAEA, 1982.

The NEA/IAEA study area in the Wollaston Lake region of northern Saskatchewan, Canada was surveyed with the inboard vertical gradiometer system designed and developed by the Geological Survey of Canada. The area occurs over the south-eastern fringe of the Athabasca basin where the search for uranium mineralization is made more difficult by the presence of extensive glacial overburden, lakes, swamps and the overlying Athabasca Group. The high sensitivity of the digital results permits the manipulation and enhancement of these data with computers. The computer coupled with the Applicon colour-jet plotter opens new horizons with the availability of rapid visual displays of the computer output in coloured map format. The application of frequency filters enables a separation of different portions of the magnetic spectrum and the enhancement of different geological structures and features. A pseudo-geological map showing lithologies, fault and alteration zones in the sub-Athabasca basement can be produced. The data also enable the vertical extent of some of the lithological features to be determined. In addition the distribution of magnetic material in the Quaternary glacial deposits overlying the non-magnetic Athabasca Group can be mapped.

Mayr, U. and de Vries, C.D.S.

RECONNAISSANCE OF TERTIARY STRUCTURES ALONG NARES STRAIT, ELLESMERE ISLAND, CANADIAN ARCTIC ARCHIPELAGO; Nares Strait and the Drift of Greenland: a Conflict in Plate Tectonics, Meddelelser om Grønland, Geoscience 8, p. 167-175, 1982.

In the coastal area of Ellesmere Island between Copes Bay in the south and Cape Baird in the north, at least three phases of Tertiary structural deformation can be distinguished. These are: 1) Paleocene uplifting, 2) Eocene thrusting and 3) strike-slip faulting, probably not younger than Miocene.

Uplifting is documented by remnants of a coarse, oligomictic, alluvial conglomerate of Tertiary age. In the southern and central part of the area the conglomerate is over-thrusted by Lower Palaeozoic rocks. Conjugate strike-slip faults are present on Darling Peninsula and northern Judge Daly Promontory. Sinistral displacement along the Judge Daly fault zone is estimated tentatively at 19 km.

Thrusting and strike-slip faulting in the Nares Strait area probably correspond to the main phase of the Eurekan orogeny.

Higgins, A.K., **Mayr, U.**, and Soper, N.J.

FOLD BELTS AND METAMORPHIC ZONES OF NORTHERN ELLESMERE ISLAND AND NORTH GREENLAND; in Nares Strait and the Drift of Greenland: a Conflict in Plate Tectonics, Meddelelser om Grønland, Geoscience 8, p. 159-166, 1982.

The Innuitian tectonic province extends in its eastern part through northern Ellesmere Island and across North Greenland. The mid- to late Palaeozoic Ellesmerian orogeny produced NE-SW to E-W trending fold belts and metamorphic zones in the strata of the Franklinian geosyncline. The late Cretaceous-Tertiary Eurekan orogeny deformed the Carboniferous-Tertiary rocks of the Sverdrup and Wandel Sea Basins, and overprinted or accentuated the older structures of the Franklinian geosyncline. The locations of the south limit of Ellesmerian folding, and of fold belts of comparable style, deformation intensity and metamorphic grade on the two sides of the Nares Strait lineament are consistent with models of left-lateral displacement in the range 0-50 km. Models of displacement greater than 50 km introduce increasingly improbable mismatches of fold belts and metamorphic zones.

McMechan, M.E. and **Price, R.A.**

SUPERIMPOSED LOW-GRADE METAMORPHISM IN THE MOUNT FISHER AREA, SOUTHEASTERN BRITISH COLUMBIA – IMPLICATIONS FOR THE EAST KOOTENAY OROGENY; Canadian Journal of Earth Sciences, v. 19, p. 476-489, 1982.

Middle Proterozoic (↶1500-1350 Ma) Belt-Purcell strata exposed in the Purcell and southwestern Rocky Mountains were affected by at least three distinct episodes of deformation and regional metamorphism. The oldest episode (1300-1350 Ma) apparently terminated Belt-Purcell sedimentation and involved folding, regional metamorphism, and granitic intrusion. The second episode (800-900 Ma) occurred during deposition of the Windermere Supergroup and involved uplift, block faulting, and low-grade regional metamorphism. Mesozoic-Cenozoic metamorphism, deformation, and plutonism overprinted the results of the earlier deformation and metamorphism.

Illite crystallinity and muscovite polymorph ratios indicate that Purcell strata in the Mount Fisher area are in the lower greenschist to prehnite-pumpellyite facies of regional metamorphism. In the Steeples and Fisher blocks this metamorphism is related to structures that formed during the Late Cretaceous – Paleocene deformation. However, in the Sand Creek block the regional metamorphism is related to the development of a spaced cleavage that is folded by a Late Cretaceous – Paleocene nappe. Regional considerations suggest that this cleavage formed during the 1300-1350 Ma episode of deformation and metamorphism.

The "East Kootenay orogeny" as currently defined embraces the two older episodes of tectonism. It is proposed that the term East Kootenay orogeny be restricted to designate the 1300-1350 Ma episode and that the term "Goat River orogeny" designate the 800-900 Ma episode of tectonism. The East Kootenay and Goat River orogenies appear to be correlative with the Racklan and Hayhook orogenies recognized in the northern Canadian Cordillera.

Les strates de la Ceinture-Purcell d'âge Protérozoïque moyen (↶1500-1350 Ma) affleurant dans les chaînons de Purcell et les Rocheuses du sud-ouest ont été modifiées par au moins trois épisodes distincts de déformation et de métamorphisme régional. L'épisode le plus ancien (1300-1350 Ma) est apparament associé à la phase finale de sédimentation dans la Ceinture-Purcell et inclut une phase de plissement, de métamorphisme régional et d'intrusion granitique. Le second épisode (800-900 Ma) est apparu durant la sédimentation du supergroupe Windermere et est associé avec un soulèvement, une apparition de blocs faillés et un métamorphisme régional de faible intensité. Le métamorphisme, la déformation et le plutonisme du Mésozoïque-Cénozoïque ont oblitéré les marques laissées par les déformations et le métamorphisme antérieur.

La cristallinité de l'illite et les rapports des polymorphes de la muscovite indiquent que les strates du Purcell dans les régions du Mont Fisher correspondent à un faciès de métamorphisme régional se situant entre le schiste vert faible et préhnite-pumpellyite. Dans les blocs Steeples et Fisher le métamorphisme est relié aux structures qui se sont développées durant la déformation au Crétacé supérieur – Paléocène. Cependant, dans le bloc Sand Creek le métamorphisme régional est relié à la formation d'un clivage écarté lequel est plissé par une nappe d'âge Crétacé supérieur – Paléocène. Des considérations régionales suggèrent que ce clivage s'est développé durant l'épisode de déformation et métamorphisme de 1300-1350 Ma.

"L'orogenèse du Kootenay-Est" telle qu'habituellement définie inclut les deux épisodes les plus anciens de diastrophisme. Il est suggéré que l'expression orogenèse du Kootenay-Est soit utilisée pour désigner uniquement l'épisode de 1300-1350 Ma et que l'expression "orogenèse du Goat River" soit appliquée à l'épisode de diastrophisme de 800-900 Ma. Les orogenèses du Kootenay-Est et du Goat River semblent être en relation avec les orogenèses du Racklan et du Hayhook reconnues dans la Cordillère du nord du Canada.

McMechan, M.E. and **Price, R.A.**

TRANSVERSE FOLDING AND SUPERPOSED DEFORMATION, MOUNT FISHER AREA, SOUTHERN CANADIAN ROCKY MOUNTAIN THRUST AND FOLD BELT; Canadian Journal of Earth Sciences, v. 19, p. 1011-1024, 1982.

A northeast-facing panel of Middle Proterozoic (Purcell Supergroup) strata occurs beneath Cambrian and Devonian strata along the east side of the Rocky Mountain Trench in the Mount Fisher area. Anomalous northeast-trending folds, faults, and cleavage that formed during Cretaceous-Paleocene deformation occur in this panel in the northern part of the area. The dominant structure in the southern part is the northwest-trending Lizard segment of the (Mesozoic) Hosmer nappe, which folds an older north-trending cleavage that probably formed during the East Kootenay Orogeny (1300-1350 Ma). Thickness and facies variations in Purcell strata and changes in the level of erosion beneath the sub-Devonian unconformity imply that many of the important structural boundaries in the Mount Fisher area and also the normal faults along the southern Rocky Mountain Trench follow the locus of older structures that were active in the Middle Proterozoic and the early Paleozoic.

The anomalous northeast-trending structures in the Mount Fisher and adjacent areas formed because the underlying Hosmer thrust developed across a major, pre-Devonian, northwest-facing drape fold, the Dibble Creek monocline. Ramps connecting bedding-glide zones were deflected across the monocline, and strata were gravitationally compressed to form northeast-trending folds, faults, and cleavage as they were displaced up the monocline along the Moyie – Dibble Creek fault.

Un pan rocheux faisant face au nord-est est formé de strates du Protérozoïque moyen (supergroupe de Purcell) affleure sous des strates cambriennes et dévoniennes longeant la bordure est du Sillon des Rocheuses dans la région du Mont Fisher. Les directions anormales nord-est pour des plis, des failles et des clivages se sont développées lors d'une phase de déformation au Crétacé-Paleocène qui a affecté le pan rocheux dans le secteur nord de la région. La principale structure du secteur sud est le segment Lizard avec direction nord-ouest appartenant à la nappe Hosmer (mésozoïque) et dont les plis et clivages plus anciens présentent une direction nord, lesquels se sont développés lors de l'orogenèse du Kootenay-Est (1300-1350 Ma). Les variations de la puissance et du faciès des strates du Purcell et les modifications du niveau de la surface d'érosion sous la discordance sub-dévonienne supposent que plusieurs frontières structurales importantes dans le région du mont Fisher, et en plus que les failles normales le long de la partie sud du Sillon des Rocheuses, suivent l'orientation des anciennes structures qui furent actives au Protérozoïque moyen et au Paléozoïque inférieur.

Les structures anormales avec direction nord-est dans les régions du Mont Fisher et celles adjacentes découlent du développement de la nappe de charriage Hosmer sous-jacente au travers un pli de revêtement avec regard vers le nord-ouest, le monoclinal Dibble Creek. Les rampes reliant les zones de surface de décollement furent déviées au travers le monoclinal et les strates furent comprimées par gravité pour former des plis, des failles et du clivage avec direction nord-est au fur et à mesure du développement du monoclinal le long de la faille Moyie – Dibble Creek.

Monger, J.W.H. and Cowan, D.S.

CONTINENT OCEAN TRANSITION NEAR 49°N: CORDILLERAN FOLD AND THRUST BELT TO JUAN DE FUCA PLATE; Geological Society of America, Abstracts with Program, v. 14, no. 7, p. 569, 1982.

Different structural styles in the Rocky Mountain Belt (RMB) may reflect different natures of strata involved in late Mesozoic-early Tertiary eastward thrusting; in Canada, upper Proterozoic to Paleogene strata produced thin, imbricated, listric thrust sheets, whereas in the N.W., U.S., mid-Proterozoic strata responded with a single, major sole thrust. West of RMB, polyphase deformation, metamorphism, granitic intrusion and gneiss doming superimposed on the overlap of western upper Paleozoic to Middle Jurassic volcanogenic allochthonous terranes onto parautochthonous and autochthonous Precambrian and Paleozoic strata, perhaps reflect crustal collision in about mid-Jurassic time, and continued compression until crustal extension in Eocene time possibly related to transcurrent movements. In Canada, the Intermontane Belt (Int. B.) consists of volcanogenic, allochthonous terranes, that possibly lie entirely west of sialic, autochthonous basement. Farther west, there are fundamental differences. Although some rock units, such as the predominantly metamorphic core of the North Cascades, extend into the southeastern Coast Plutonic Complex (CPC), the latter is mainly granitic. Several Precambrian to Lower Cretaceous terranes, juxtaposed along major mid-Cretaceous thrusts, are on the west side of the Cascades and San Juan Islands. In Washington, after Eocene basalts were emplaced against the continent in the Paleocene, subduction of the Juan de Fuca Plate (JDFP) gave rise to an accretionary prism exposed in the core of the Olympic Mountains. In Canada, a single upper Paleozoic-lower Mesozoic terrane (Wrangellia) extends from the western CPC almost to the present continental margin and is bounded on the west by a late Mesozoic accretionary prism. Subduction of the JDFP gave rise to Neogene and Holocene volcanism.

Monger, J.W.H., Price, R.A., and **Tempelman-Kluit, D.J.**

TECTONIC ACCRETION AND THE ORIGIN OF THE TWO MAJOR METAMORPHIC AND PLUTONIC WELTS IN THE CANADIAN CORDILLERA; Geology, v. 10, p. 70-75, February 1982.

The Omineca Crystalline Belt and Coast Plutonic Complex are the two major regional tectonic welts in the Canadian Cordillera in which were concentrated intense deformation, regional metamorphism, granitic magmatism, uplift, and erosion. The welts, which formerly were thought to result from subduction of Pacific Ocean lithosphere beneath the western edge of North America, can now be viewed partly as the result of tectonic overlap and/or compressional thickening of crustal rocks during collisions between North America and two large, composite, allochthonous terranes that were accreted to its ancient western margin. The inner composite terrane, Terrane I, includes four smaller terranes that apparently were together by the end of Triassic time. The outer composite terrane, Terrane II, comprises two terranes, amalgamated by Late Jurassic time. The Omineca Crystalline Belt formed mainly from mid-Jurassic time onward, during and following the collision of Terrane I with North America. This belt straddles the zone of overlap of autochthonous and allochthonous terranes, and its characteristic metamorphism and structure are superimposed on both. The Coast Plutonic Complex formed mainly in Cretaceous to early Tertiary time during and following the attachment of Terrane II to the new, Jurassic, continental margin. It lies along the boundary of Terrane I and Terrane II and involves elements of both terranes. The collisions took place within the overall setting of the North American plate moving relatively westward into various Pacific plates from Jurassic time onward and in conjunction with subduction of Pacific Ocean lithosphere.

Monger, J.W.H., Clowes, R.M., **Currie, R.,** Hoy, T., Hyndman, R.D., Preto, V.A., **Price, R.A.,** Riddihough, R.D., Simony, P.S., **Wheeler, J.O., Woodsworth, G.J.,** and **Yorath, C.J.**

TRANSECT B2: SOUTHERN CANADIAN CORDILLERA, NORTH AMERICAN CONTINENT-OCEAN TRANSECT PROGRAM; Geological Society of America, Abstracts with Programs, v. 14, no. 7, p. 569, 1982.

Transect B2 extends from the Alberta plains to the Juan de Fuca plate. Easternmost, the Rocky Mountain Belt (RMB) consists of a Proterozoic to Upper Jurassic rift and passive margin sequence and an Upper Jurassic to Paleogene cordillera-derived clastic wedge displaced eastwards at least 200 km on imbricate listric thrust faults. The Omineca Crystalline Belt (OCB) west of it is characterized by mid-Mesozoic to early Tertiary polyphase deformation, metamorphism and intrusion, superimposed on the zone of overlap of upper Paleozoic to mid-Mesozoic allochthonous terranes onto parautochthonous (?) mainly Paleozoic sediments and the distal part of the ancestral continental margin. The Intermontane Belt (Int. B.) comprises mainly a lower Mesozoic allochthonous magmatic arc-subduction complex, parts of which can be traced into the OCB, Mesozoic granites and mid-Cretaceous, Eocene and Neogene continental volcanics. Westwards, across the right-lateral Fraser River Fault Zone lies the Coast Plutonic Complex (CPC), dominated by late Mesozoic and early Tertiary granitic intrusions emplaced in the east into lower Mesozoic oceanic strata and upper Mesozoic arc-related clastic rocks, and in the west into strata similar to those of the Insular Belt (Ins. B.) and coeval volcanic rocks. Neogene and Holocene volcanic and intrusive rocks represent the northern extension of the Cascade volcanic chain. The Ins. B. comprises the late Paleozoic and early Mesozoic arc:rift:arc sequence forming exotic Wrangellia, and, farthest west, a late Mesozoic accretionary prism possibly related to magmatism of the CPC. Offshore structures reflect subduction of the Juan de Fuca plate beneath Vancouver Island. Depth to Moho ranges from 40 km under the plains through 50 km under the western RMB to 36 km under the Int. B. and 30 km or less under the CPC and Ins. B.

Mott, R.J. and **Jackson, L.E., Jr.**

AN 18 000 YEAR PALYNOLOGICAL RECORD FROM THE SOUTHERN ALBERTA SEGMENT OF THE CLASSICAL WISCONSINAN "ICE-FREE CORRIDOR"; Canadian Journal of Earth Sciences, v. 19, p. 504-513, 1982.

Radiocarbon dates of 18 300 ± 380 years BP (GSC-2668) and 18 400 ± 1090 years BP (GSC-2670) on moss fragments from the clay near the base of a core from Chalmers Bog, Alberta indicate that the classical Wisconsinan "Ice-free Corridor" was in existence in the foothills of southern Alberta by this time. Palynological studies show sparse, herbaceous, tundra-like vegetation probably prevailed at this time in the area surrounding the

small lake formed in the abandoned glacial spillway. Later, shrubs became more prominent to form a shrub tundra environment. Sometime before 8220 years BP (GSC-2851) tgrees began to invade the area and the **Pinus contorta** dominated coniferous forest extant in the area today began to form. Bog and fen vegetation invaded the shallow lake basin about this time as well to form the bog that occupies the basin to the present day.

Des âges au radiocarbone de 18 300 ± 380 années avant le présent (GSC-2668) et de 18 400 ± 1090 années avant le présent (GSC-2670) sur des morceaux de tourbe provenant de l'argile près de l'extrémité d'une carotte d'échantillonnage de la Tourbière Chalmers, en Alberta, indiquent que le Corridor Exempt de Glaciation du Wisconsin classique existait à cette époque dans les foothills du sud de l'Alberta. Des études palynologiques montrent qu'à cette époque une végétation clairsemée, herbacée, de type de toundra, prédominait dans la région entourant le petit lac formé dans le chenal des eaux de fonte du glacier abondonné. Plus tard, les arbustres devinrent plus abondants pour développer un milieu d'une toundra à arbustres. Les arbres commencèrent à envahir la région quelque temps précédant 8220 années avant le présent (GSC-2851) et le **Pinus contorta** se répandit dans une forêt à prédominance de conifères laquelle recouvre aujourd'hui la région. Une végétation de tourbière et de marais a envahi le bassin lacustre peu profond à cette époque et par la suite forma la tourbière qui occupe actuellement le bassin.

Mott, R.J., Anderson, T.W., and **Matthews, J.V., Jr.**

POLLEN AND MACROFOSSIL STUDY OF AN INTERGLACIAL DEPOSIT IN NOVA SCOTIA; Géographie physique et Quaternaire, vol. XXXVI, n^{os} 1-2, p. 197-208, 1982.

Overburden removal for quarrying operations at the Milford Gypsum Quarry, East Milford, Nova Scotia, exposed 2 m of compacted and distorted peat and organic clays with abundant plant remains, associated with inorganic and laminated clays and sands. The nonglacial sediments were underlain by a grey till-like deposit and overlain by more than 20 m of red till. Wood (**Larix** sp.) from the nonglacial sediments produced a radiocarbon date of >50,000 years BP (GSC-1642). Pollen analysis of the organic sediments shows a basal assemblage characterized by a variety of hardwood pollen genera including **Fagus, Ulmus, Acer, Quercus** and **Tilia.** Higher in the sequence **Betula** pollen increases and becomes the dominant pollen type. Towards the upper part of the organic unit, **Picea** and **Abies balsamea** replace the hardwood genera. **Alnus** is the most abundant pollen type at the top of the sequence. Wood, seeds, moss and Coleoptera remains add to the environmental reconstruction. The evidence as a whole leads to the conclusion that the latter part of an interglacial interval, probably the Sangamon, is represented. Hardwood forests dominated by a variety of thermophilous hardwood genera attest to a climate at least as warm as the present in the area. As the climate deteriorated, **Betula** became dominant. Continued cooling induced a transition to coniferous forests in which **Picea** and **Abies balsamea** predominated.

L'enlèvement des formations superficielles, lors d'excavations dans la carrière de gypse d'East Milford en Nouvelle-Écosse, a mis à jour 2 m de tourbe et d'argile organique compactées et déformées, ainsi que d'abondants restes végétaux, associés à des argiles et sables inorganiques et laminés. Les sédiments non glaciaires reposaient sur un dépôt gris ayant l'apparence de till et étaient recouverts par une couche de plus de 20 m de till rouge. Du bois met de la séquence. Des restes de bois, de graines, de mousses et de de >50 000 ans BP (GSC-1642). L'analyse pollinique des sédiments organiques montre à la base un assemblage caractérisé par du pollen provenant de divers genres de feuillus, dont **Fagus, Ulmus, Acer, Quercus** et **Tilia.** Le pollen de **Betula** augmente vers le haut dans la séquence et devient le type dominant. Dans la partie supérieure de la séquence organique, **Picea** et **Abies balsamea** remplacent les bois durs. **Alnus** est le type de pollen le plus abondant au sommet de la séquence. Des restes de bois, de graines, de mousses et de Coléoptères aident à reconstituer l'environnement. Dans l'ensemble, les preuves permettent de conclure que la séquence date de la dernière partie d'un interglaciaire, probablement le Sangamonien. Les forêts de feuillus, dominées par une variété de genres thermophiles, témoignent d'un climat au moins aussi chaud que le climat actuel dans la région. À mesure que le climat s'est détérioré, les **Betula** ont proliféré. Le refroidissement continu a provoqué une transition vers les forêts de conifères dans lesquelles ont prédominé **Picea** et **Abies balsamea.**

Norford, B.S.

DEVONIAN STRATIGRAPHY AT THE MARGINS OF THE ROCKY MOUNTAIN TRENCH, COLUMBIA RIVER, SOUTHEASTERN BRITISH COLUMBIA; Bulletin of Canadian Petroleum Geology, v. 29, no. 4, p. 540-560, 1981.

Studies at Fairmont Ridge and Mount Forster (type section of the Mount Forster and Starbird Formations) allow refinement of facies relationships and depositional histories inferred for the Cedared, Burnais, Harrogate (all Eifelian), Mount Forster (probably entirely Eifelian but upper beds possibly Givetian) and Starbird (lower Frasnian) Formations.

In Middle Devonian time, a western landmass postulated near the then site of the Purcell Arch constrained a shallow gulf against the emerged Western Alberta Ridge. Restricted circulation of the warm sea led to deposition of the Burnais evaporites. The evaporites were limited westward by detritus from the western landmass and the detritus similarly formed a barrier to the Harrogate Formation sediments when rising sea level in later Eifelian time allowed development of open-marine carbonates in the gulf. There is no faunal evidence of Givetian time. Givetian rocks may not have been deposited in the region or, if deposited, may have been eroded before the onset of Frasnian sedimentation.

The Rocky Mountain Trench crosses the Windermere High that is characterized by very attenuated Lower Paleozoic strata beneath the Sub-Devonian Unconformity. The present location of the High, astride the Trench, indicates that little transverse movement has taken place along the Rocky Mountain Trench in this part of British Columbia.

Norford, B.S.

THE INTERNATIONAL (IUGS) WORKING GROUP ON THE CAMBRIAN-ORDOVICIAN BOUNDARY; in The Cambrian-Ordovician boundary: sections, fossil distributions, and correlations, ed. M.G. Bassett and W.T. Dean, National Museum of Wales, Geological Series No. 3, Cardiff, p. 7-8, 1982.

Nowlan, G.S.

CONODONTS AND THE POSITION OF THE ORDOVICIAN-SILURIAN BOUNDARY AT THE EASTERN END OF ANTICOSTI ISLAND, QUÉBEC, CANADA; Canadian Journal of Earth Sciences, v. 19, p. 1332-1335, 1982.

Conodonts have been recovered from a section spanning the Ordovician-Silurian boundary at the eastern end of Anticosti Island. They indicate that the systemic boundary lies slightly above or at the top of a pisolitic limestone bed. This placement of the boundary compares closely with that based on a previous interpretation of brachiopod faunas from the same section, and also with the position of the systemic boundary based on conodonts elsewhere on Anticosti Island. The conodonts are the first to be reported from the eastern end of Anticosti Island.

Nowlan, G.S.

PALEOGEOGRAPHIC, BIOSTRATIGRAPHIC AND TECTONIC IMPLICATIONS OF LATE ORDOVICIAN CONODONTS IN THE APPALACHIANS OF EASTERN CANADA; in International Symposium on the Ordovician System, Abstracts for Meetings, University of Oslo, Paleontological Contributions, No. 280, p. 40.

Diverse conodont faunas from sparsely fossiliferous deep water sediments of the Grog Brook (7600 m) and Matapedia (up to 4000 m) groups in New Brunswick and Quebec are latest Ordovician in age based on the presence of **Amorphognathus ordovicicus** and **Gamachignathus ensifer.** Eastern exposures of the Matapedia Group (White Head Formation, 750 m) near Percé yield conodonts of Midcontinent Province affinity. In contrast, faunas from both Grog Brook and Matapedia groups in more westerly exposures near Matapedia are of mixed provincial affinity. Representatives of the North Atlantic Province **(Hamarodus, Icriodella, Periodon** and **Protopanderodus)** occur together with taxa representing shallow to deep water environments of the Midcontinent Province **(Rhipidognathus, Phragmodus).** The conodont-bearing beds are interpreted as distal debris flows that originated at the basin margin and brought Midcontinent Province elements down slope to mix with indigenous North Atlantic Province forms. The Grog Brook Group was formerly believed to underlie the Matapedia Group but faunal evidence suggests at least partial equivalence. This conclusion is corroborated by the degree of thermal alteration of conodonts from the two units; those from the Grog Brook Group are almost unaltered (CAI 1½) whereas those from immediately adjacent strata of the Matapedia Group are altered to CAI 4 or 5. It is suggested that either late Ordovician-early Silurian thrusting uplifted the Grog Brook Group or that part of the Grog Brook Group was deposited on a tectonic high and the higher grade Matapedia strata were moved eastward during Acadian (Devonian) thrusting.

Nowlan, G.S.

EARLY SILURIAN CONODONTS OF EASTERN CANADA; in Third European Conodont Symposium (ECOS III) Abstracts, Institutes of Mineralogy, Paleontology and Quaternary Geology, University of Lund, Sweden, Publication No. 238, 1982.

During the last few years extensive collections of conodonts have been obtained from Lower Silurian strata of eastern Canada. Three areas of markedly different depositional history have been examined:

1. The Anticosti Basin, Québec,
2. South of the Anticosti Basin,
3. South of the Matapedia-Aroostook Anticlinorium.

Okulitch, A.V.

THE SHUSWAP METAMORPHIC COMPLEX IS NOT A METAMORPHIC CORE COMPLEX; Geological Society of America, Abstracts with Programs, v. 14, no. 4, p. 221, 1982.

The Shuswap Complex consists of three terranes, each with unique stratigraphy and orogenic evolution, separated by major faults of diverse nature. The Monashee Terrane is a para-autochthonous part of the North American craton formed during Proterozoic orogenesis and rapidly uplifted during the Paleogene. The Monashee Décollement, a regional thrust fault active during the Middle Jurassic, separates this terrane from the Shuswap Terrane, a high grade extension of the late Proterozoic to early Mesozoic sedimentary prism bordering the craton. The Okanagan Terrane, straddling the 49th parallel from the Okanagan Valley to the Kootenay Arc, contains the exhumed roots of a Mesozoic magmatic arc built upon North American continental and transitional crust that includes obducted late Palaeozoic exotic assemblages.

The Eastern Cordillera is best viewed as an Alpine orogen formed by westward drift of North America into a continent of accreted elements. Continental crust, attenuated during two episodes of Proterozoic rifting, and its bordering sedimentary prism suffered shortening during two phases of collision. The first phase restored attenuated crust to about its original configuration while deforming western-most parts of the bordering prism (Jurassic events in the Shuswap and Okanagan Terranes). The second phase thrust restored crust, the deformed prism and platformal strata eastward (Cretaceous-Palaeocene formation of nappes of the foreland fold and thrust belt). Relaxation of compressive stress led to gravitational collapse and tectonic denudation of the nappes (Eocene exposure of the three terranes). The presence of middle crust at the surface is only explicable by compressive mechanisms. No extensional regime can produce the required uplift. Core complexes in the southwestern states might be re-examined to ascertain if they formed as Mesozoic nappes cores denuded in the Neogene.

Pedder, A.E.H.

CHOSTOPHYLLUM, A NEW GENUS OF CHARACTOPHYLLID CORALS FROM THE MIDDLE DEVONIAN OF WESTERN CANADA; Journal of Paleontology, v. 56, no. 3, p. 559-582, 1982.

Six new and three previously established species **(Cyathophyllum waskasense** Whiteaves, 1892, **C. petraioides,** Whiteaves, 1892 and **Alaiophyllum goryanovi** Pedder, 1973) are referred to a new genus, which, as presently known, is confined to Middle Devonian strata of western Canada. **Chostophyllum metula** n. sp., from the Hare Indian Formation (late Givetian part), is the type species. Other new species are **C. coniculus, C. humense** and **C.** n. sp. 2 from the upper Hume Formation (late Eifelian), **C. slavorum** from the Pine Point Formation (Givetian), and **C.** n. sp. 1 from the Ramparts Formation (late Givetian).

Pedder, A.E.H.

THE RUGOSE CORAL RECORD ACROSS THE FRASNIAN/FAMENNIAN BOUNDARY; Geological Implications of Impacts of Large Asteroids and Comets on the Earth, ed. L.T. Silver and P.H. Shultz, Geological Society of America, Special Paper 190, p. 485-489, 1982.

Lists of all the known late Frasnian and Famennian rugose coral species have been prepared. The late Frasnian list includes 148 comparatively shallow and ten deeper water (cephalopod facies) species. At the most, only six (4%) of the shallow water species survived the Frasnian/Famennian faunal break, whereas three or four (30 or 40%) of the deeper water species survived the same event.

Pedder, A.E.H. and McLean, R.A.

LOWER DEVONIAN CYSTIPHYLLID CORALS FROM NORTH AMERICA AND EASTERN AUSTRALIA WITH NOTES ON THE GENUS **UTARATUIA**; Geologica et Palaeontologica, v. 16, p. 57-110, 1982.

Material, representing 15 species, is described from the Blue Fiord Formation of Ellesmere Island, Road River and Michelle Formations of Yukon Territory, McColley Canyon Formation of Nevada, Point Hibbs Formation of Tasmania, and the Garra Formation of New South Wales. 2 genera and 10 species are new (see under >>Contents<<); their probable ages are determined primarily from conodonts. Associated faunas are identified, enabling 13 of the species to be assigned to 10 named communities.

Poulton, T.P.

PALEOGEOGRAPHIC AND TECTONIC IMPLICATIONS OF THE LOWER AND MIDDLE JURASSIC FACIES PATTERNS IN NORTHERN YUKON TERRITORY AND ADJACENT NORTHWEST TERRITORIES; Arctic Geology and Geophysics, ed. A.F. Embry and H.R. Balkwill, Canadian Society of Petroleum Geologists, Memoir 8, 1982.

The stratigraphic relations in the Lower and Middle Jurassic rocks of northern Yukon and adjacent parts of Northwest Territories indicate deposition on a broad shelf trending northeast-southwest along the contemporary North American cratonic margin. Previous interpretations of a two-sided marine trough extending generally north-south across northern Yukon (i.e. Porcupine Plain – Richardson Mountains Trough) are not substantiated.

Re-examination of the stratigraphic evidence in northern Yukon and Alaska does not indicate the presence of a source-landmass in northern Alaska and northwestern Yukon (i.e. Keele-Old Crow Landmass) in Early and Middle Jurassic times. The first major supply from such a sediment source, in northern Alaska, is in the Late Jurassic. Northerly rather than southerly sources are indicated for older Jurassic rocks in northern Alaska.

Transcurrent movement in either direction on the Kaltag Fault can neither be supported nor rejected by the Jurassic record in northern Yukon. Hypotheses of counter-clockwise rotation of northern Alaska away from Arctic Canada are not supported in view of the lack of volcanism in the Jurassic and Early Cretaceous of northern Yukon, i.e. in the proposed pivotal area of rotation of such hypotheses. The boreal character of Middle Jurassic marine faunas of northern Alaska firmly allies them with those of the Canadian Arctic.

Powell, T.G.

PETROLEUM GEOCHEMISTRY OF THE VERRILL CANYON FORMATION: A SOURCE FOR SCOTIAN SHELF HYDROCARBONS; Bulletin of Canadian Petroleum Geology, v. 30, no. 2, p. 167-179, 1982.

A variety of maturation indicators from 55 wells have been used to construct a maturation facies map for the base of the Cretaceous sediments on the Scotian Shelf. The Verrill Canyon Formation is largely mature in the Sable subbasin and contains terrestrially derived (Type III) organic matter. This organic matter is largely gas-prone except for an area in the northern part of the Sable subbasin where it has some oil potential. This oil potential is minor, however, because of the relatively low content of organic matter (C% = 1.20 ± 0.29%) in the Verrill Canyon sediments.

On the basis of analysis of gasoline-range and aromatic hydrocarbons from sediment and oil/condensate samples, the Verrill Canyon Formation is considered to be the source of hydrocarbon reservoirs in the Logan Canyon, Verrill Canyon, Mic Mac and Missisauga Formations. The composition of the hydrocarbon product is related to the degree of maturation of the source rock. Oils and condensates occurring in the Logan Canyon Formation in the West Sable and Cohasset structures are more mature than those in stratigraphically older and deeper reservoirs. This maturity reflects vertical migration of those hydrocarbons from the deep Verrill Canyon source. Variations in maturation of the source have been found to have a profound effect on the composition of gasoline-range and aromatic fractions of the generated hydrocarbons.

Powell, T.G., Creaney, S., and **Snowdon, L.R.**

LIMITATIONS OF USE OF ORGANIC PETROGRAPHIC TECHNIQUES FOR IDENTIFICATION OF PETROLEUM SOURCE ROCKS; The American Association of Petroleum Geologists Bulletin, v. 66, no. 4, p. 430-435, 1982.

Organic petrographic and organic geochemical studies have been conducted on 58 sediment samples of differing ages and depositional environments. In this study, interpretations of petroleum source-rock potential, based on data from transmitted-light microscopy, show a poor correlation with those derived from chemical data. This lack of correlation arises from the failure to distinguish consistently between hydrogen-poor and hydrogen-rich amorphous organic matter and inability to detect hydrogen-rich components (exinite and resinite) in coal fragments. Interpretations based on data from reflected-light microscopy show a better correlation with those derived from chemical studies, but difficulties still remain. These difficulties arise from inability, except on the basis of fluorescence intensity, to distinguish hydrogen-rich from hydrogen-poor organic matter in a finely dispersed state.

Price, R.A.

THE GEOTECTONIC SIGNIFICANCE OF THE CORDILLERA FORELAND THRUST AND FOLD BELT OF CANADA; Geological Society of America, Abstracts with Programs, v. 14, no. 7, p. 593, 1982.

The foreland thrust and fold belt, a NE-tapering wedge, locally >20 Km thick, comprises miogeoclinal, platformal and foreland basin rocks that have been scraped off the under-riding North American plate, and attached to an over-riding tectonic collage of foreign terranes that "collided" with and became attached to North America. It is an accretionary prism that was tectonically prograded northeastward across the western margin of the North American craton in two major episodes. The outboard part of the Cordilleran miogeocline (continental terrace wedge) was over-ridden by a tectonic collage of oceanic terranes, and descended to depths of >25 Km during mid-Jurassic prograde synkinematic regional metamorphism, before heating restored its latent buoyancy. The ensuing Late Jurassic-Early Cretaceous compression within the miogeocline led to outward verging thrusting on either side of a central uplift and to tectonic loading and isostatic flexure of the lithosphere beneath the foreland basin where molasse accumulated. Mid-Cretaceous granitic plutons that rose through this tectonically thickened suture zone cut the outward verging structures on both sides of it. During the second episode, accretion of another collage of oceanic terranes, outboard from the first, involved oblique, right-lateral convergence. Much of the Late Cretaceous-Paleocene overthrusting in the southern Canadian

Rockies was transformed northward into right-lateral strike-slip along the Tintina-Northern Rocky Mountain Trench (T-NRMT) transform fault zone. Volcanism which occurred along the newly formed suture (Coast plutonic complex) during the northeasterly subduction of the Farallon plate, continued during the northerly subduction of the Kula plate; but convergence across the overthrust belt ended; and Early and Middle Eocene ductile crustal stretching occurred in the zone of en echelon overlap between the T-NRMT and the Fraser River fault zone. Late Eocene termination of this crustal stretching and transform faulting, may mark the return of the Farallon plate.

Price, R.A.

INTERNATIONAL LITHOSPHERE PROGRAM OUTLINED; Geotimes, v. 27, p. 24-27, 1982.

Price, R.A.

MID-PROTEROZOIC TO OLIGOCENE TECTONIC EVOLUTION, NORTHEASTERN WASHINGTON AND ADJACENT BRITISH COLUMBIA; Geological Society of America, Abstracts with Programs, v. 14, no. 4, p. 225-226, 1982.

The Cordilleran miogeocline, a westward prograded continental terrace wedge (CTW), formed outboard from the rifted margin of the Precambrian continental craton, mainly during three episodes that are recorded by thick unconformity-bounded tectonostratigraphic assemblages of Middle and Late Proterozoic and Early Paleozoic age.

The external part of the CTW underwent synkinematic intermediate-pressure prograde regional metamorphism while being overridden by a composite allochthonous terrane in Middle Jurassic time; but it was uplifted and thrust over the allochthonous terrane before both were intruded by mid-Cretaceous epizonal granites.

During a Late Cretaceous-Paleocene oblique collision with a second composite allochthonous terrane, the first allochthonous terrane and the overlapping deformed external part of the CTW converged with the continental craton, and the rest of the CTW was detached from its basement and thrust over the craton to form the Cordilleran foreland thrust and fold belt.

Early and Middle Eocene magmatism was accompanied by regional right-hand shear and ductile crustal stretching as the outer composite accreted terrane moved northwestward relative to the rest of North America along two transform fault systems that end with a right-hand en echelon overlap in south-central British Columbia. Ductile boudinage of the hot metamorphic infrastructure was accompanied by lystric normal faulting in the cold suprastructure. The supracrustal rocks moved into the neck zones between the crustal boudins, and metamorphic core complexes emerged as tectonically denuded northeast-trending domal culminations with K-Ar mica cooling ages of about 50 Ma.

Three contrasting episodes of polyphase orogenic deformation appear to be part of an essentially continuous process of oblique convergence and collision between North America and various allochthonous terranes that were swept against it as a result of subduction of oceanic lithosphere along the eastern margin of the Pacific basin.

Price, R.A.

CORDILLERAN OVERTHRUST BELT IN SOUTHERN CANADA – ITS REGIONAL TECTONIC IMPLICATIONS, AND ITS ROLE IN HYDROCARBON GENERATION AND ENTRAPMENT; American Association of Petroleum Geologists Bulletin, v. 66, no. 5, p. 620, 1982.

Palinspastic reconstructions based on balanced sections that are constrained by deep crustal structure, as outlined by seismic refraction, gravity anomaly, magnetic anomaly, and geomagnetic depth sounding studies, show that: (1) the Cordilleran miogeocline, a northeast-tapering wedge of craton-derived sedimentary strata, more than 15 km thick, accumulated outward from the rifted(?) edge of a 35-km thick slab of early Proterozoic continental crust, on a basement of oceanic crust and/or attenuated continental crust; (2) the miogeocline was compressed, detached from underlying crustal rocks, and displaced more than 200 km northeast as two successive collages of small allochthonous terranes from the adjacent ocean basin collided with North America; (3) the overthrust belt is a tectonically prograded shallow accretionary prism that formed during the subduction of the basement of the miogeocline, as supracrustal rocks were scraped off the underriding continental craton and accreted to the overriding miogeoclinal prism; (4) subsidence and molasse sedimentation in the northeastward-migrating foreland basin were a result of isostatic flexure of the lithosphere in response to the weight of the encroaching accretionary prism, and of the molasse itself; and (5) burial of source rocks, and hydrocarbon generation, migration and entrapment are indirect results of the subduction of the lithosphere that formerly lay beneath the miogeocline.

The first collision (Late Jurassic and Early Cretaceous Columbian orogeny) involved outward-verging thrusting and folding on either side of the uplifted core of the miogeocline, and produced a thick wedge of molasse (Kootenay-Blairmore) that extended over the western part of the craton. Mid-Cretaceous granitic plutons truncate Columbian structures. The second collision (latest Cretaceous and Paleocene Laramide orogeny) marked the final phase of convergence during which the reservoir structures associated with northeast-verging listric thrust faults and folds developed in the Canadian Rockies. Source rocks were buried to depths of 13 km under the Lewis thrust sheet in southeastern British Columbia, and 5 or 6 km under the plains, as a wedge of Laramide molasse (Brazeau-Paskapoo) was prograded northeastward in front of the overthrust belt.

Intracontinental transform faulting, involving 450 km of right-hand strike slip on the Tintina-Northern Rocky Mountain Trench fault system, was partly taken up by thrust faulting in the Rocky Mountains south of 56°N lat. during the Laramide orogeny, but during the Eocene it was linked to the en echelon Fraser River fault zone by ductile stretching of the intervening lithosphere. This stretching is expressed, over an area of about 150,000 km^2 in south-central British Columbia and adjacent parts of the United States, at a shallow level, by listric normal faults and Eocene dike swarms, and at a deep level, by boudinage of the whole crust. Supracrustal rocks moved into the necked zones between the boudins as the metamorphic core complexes emerged in northeast-trending domal culminations with K-Ar mica cooling ages of about 50 Ma. A different pattern of regional extension, involving uplift and partial unroofing of deeply buried source rocks in the southern part of the over-thrust belt and adjacent foreland basin, was established in early Oligocene time.

Porter, J.W., **Price, R.A.**, and McCrossan, R.G.

THE WESTERN CANADA SEDIMENTARY BASIN; Philosophical Transactions of the Royal Society of London, Series A, v. 305, p. 169-192, 1982.

The Western Canada Sedimentary Basin, a simple north easterly tapering wedge of sedimentary rocks more than 6 km thick, extends southwest from the Canadian Shield into the Cordilleran foreland thrust belt. Its internal structure and the lateral variations in its shape reflect a long and complex history of development involving a foreland basin that was superimposed on a cratonic platform and continental terrace wedge. This history, which is inextricably linked to the evolution of the Canadian Cordillera, can be outlined succinctly with reference to the unconformity-bounded transgressive-regressive stratigraphic sequences established by Sloss (Bull. geol. Soc. Am. 74, 93 (1963)), each of which has a distinctive character in Western Canada.

The continental terrace wedge was established with the deposition of the Proterozoic Purcell (1500-1350 Ma) and Windermere (850-600 Ma) sequences, but the first record of the platformal phase is the early Palaeozoic transgressive onlap of the early Proterozoic (>1750 Ma) crystalline basement by the Sauk sequence. Early Palaeozoic subsidence of the margin of the craton may have been due to cooling of the lithosphere after renewed stretching at the ancient rifted western margin of the Precambrian craton, and to isostatic flexure of the lithosphere under the weight of the sediment that had accumulated at the margin in the oceanward prograding continental terrace wedge.

During a subsequent Middle Ordovician to Middle Jurassic phase, the cratonic platform became differentiated into an intersecting network of epeirogenic arches with intervening basins. Development of the basins was as much a result of erosion and uplift of the arches between transgressive-regressive cycles as it was a result of differential subsidence of the basins during the cycles. The cause of the long (>300 Ma) episode of intermittent epeirogenic movements that produced the basins and arches is a major unsolved problem.

The foreland basin developed in two stages, in Middle Jurassic to early Cretaceous and late Cretaceous to Palaeocene time, as a result of collisions between North America and two pieces of a tectonic collage of oceanic terranes that were accreted to its western margin. During these two collisions, the continental terrace wedge, which had accumulated outboard from the rifted margin of the continental craton, was compressed and displaced over the western margin of the craton. Part of the supracrustal cover was scraped off the craton and accreted to the overriding mass to form a wedge of imbricate thrust fault slices that was tectonically prograded over the margin of the continental craton. Isostatic flexure of the continental lithosphere in response to the tectonic loading imposed on it by the displaced continental terrace wedge and the accretionary wedge of thrust slices produced the migrating moat in which the outwash of clastic detritus from the evolving thrust belt was trapped to form the foreland basin.

Rimsaite, J.

ALTERATION OF RADIOACTIVE MINERALS IN GRANITE AND RELATED SECONDARY URANIUM MINERALIZATIONS; in Ore Genesis – The State of the Art, ed. G.C. Amstutz et al., Springer-Verlag, p. 269, 1982.

Natural losses of uranium and other constituents from partly altered uraninite, uranothorite, pyrochlore and allanite in granitic rocks of Precambrian age (100-1100 Ma) were documented using a scanning electron microscope coupled with an energy dispersive spectrometer and an electron microprobe. Migration and precipitation of the liberated uranium along fractures and reactions between uranium and other ions to form secondary uranium-bearing minerals were studied in polished thin sections using microbeam techniques. Mode of formation of the most common secondary uranium ore minerals: autunite, torbernite, phosphuranylite, thorogummite and uranophane is discussed in relation to supergene enrichment and formation of secondary uranium mineralizations in weathered granites. The purpose of this paper is to describe natural decomposition of primary radioactive minerals in granitic rocks, as well as migration and redeposition of the liberated uranium and other ions on the basis of field and laboratory studies.

Rimsaite, J.

CHEMICAL AND ISOTOPIC EVOLUTION OF RADIOACTIVE MINERALS IN REMOBILIZED VEIN-TYPE URANIUM DEPOSITS, SASKATCHEWAN, CANADA; in Vein-type and similar uranium deposits in rocks younger than Proterozoic, International Atomic Energy Agency, Vienna, 1982, p. 35.

Mineralogical and isotopic studies of vein-type uranium deposits revealed the presence of several generations of radioactive mineral assemblages that formed and survived under specific environmental conditions. Aqueous solutions, percolating along the rejuvenated fractures, dissolved radioactive and radiogenic minerals in one part of the deposit and redeposited them in the other part of the deposit in a different crystalchemical form during a time span of several hundred million years. The following secondary mineral assemblages and their spatial and temporal evolution have been studied: (1) Secondary pitchblende rims formed on sulphides, arsenides, carbonates and quartz between 870 and 200 million years ago; (2) Uraniferous mixed-layer phyllosilicates along fractures in altered rocks where uranium was trapped in the interlayer of montmorillonite component about 400 million years ago; and (3) Reactions between mobilized uranium and other ions, such as silica, sulphur, carbon and water to form coffinite, uranyl-bearing silicates, carbonates, sulphates and hydrocarbons continue at the present time. It is concluded that, by changing chemical-mineralogical compositions and adapting suitable crystal structures, uranium can survive under diverse environmental conditions.

Szymanski, J.T., Owens, D.R., **Roberts, A.C.**, **Ansell, H.G.**, and Chao, G.Y.

A MINERALOGICAL STUDY AND CRYSTAL-STRUCTURE DETERMINATION OF NONMETAMICT EKANITE, $ThCa_2Si_8O_{20}$; Canadian Mineralogist, v. 20, p. 65-75, 1982.

Nonmetamict ekanite, ideally $ThCa_2Si_8O_{20}$, of chemical composition very similar to the metamict gemstone ekanite originally found in Sri Lanka (Ceylon), has been discovered in the Tombstone Mountains, Yukon Territory. The physical and optical properties are described and the X-ray powder pattern is given. Crystalline ekanite is tetragonal, space group $I\bar{4}22$, with a 7.483(3), c 14.893(6) Å. The structure has been solved and refined to R = 3.57% from 1319 independent reflections obtained from multiple data sets with Mo$K\alpha$ radiation. The structure is closely related to that of the family with general composition ThK(Na,Ca)Si_8O_{20}, which crystallizes in space group $P4/mcc$ and which has been misnamed "ekanite" for many years. True crystalline ekanite has a body-centred unit cell whose dimensions agree closely with that of the material obtained on heating metamict ekanite to above 650°C. The metal

co-ordination is remarkably similar in the two types of structures; Th is 8-co-ordinated in a square antiprism of oxygen atoms at 2.405(5) Å, and Ca has four nearest oxygen neighbors [2.342(5) Å] in a very distorted tetrahedron and four second-nearest neighbors [2.688 (5) Å] near the midpoints of the faces of the tetrahedron. Sheets of metals at $z = 0, \frac{1}{2}$ are separated by a puckered silicate layer that extends infinitely in x, y. The structure is characterized by zeolite-like channels through the silicate layers, where non-structural water can become entrapped.

L'ékanite non métamicte, en théorie $ThCa_2Si_8O_{20}$, de composition chimique très semblable à l'ékanite gemme métamicte trouvée pour la première fois à Sri Lanka (Ceylan), a été découverte au mont Tombstone (Yukon). On décrit les propriétés physiques et optiques et l'on en donne le diagramme de poudre aux rayons X. L'ékanite cristalline est tétragonale, et fait partie du groupe spatial $I\bar{4}22$, avec a 7,483(3), c 14,893(6) Å. On en a résolu la structure, affinée jusqu'à $R = 3{,}57\%$ sur 1319 réflexions indépendantes obtenues à partir de multiples séries de données avec rayonnement de Mo$K\alpha$. Sa structure est étroitement associée à celle de la famille de composition générale ThK(Na,Ca) Si_8O_{20}, qui cristallise dans le groupe spatial $P4/mcc$ et qu'on a appelée, à tort, "ékanite" pendant de nombreuses années. La véritable ékanite cristalline possède une maille centrée dont les dimensions sont presque identiques à celles de la matière obtenue lorsqu'on chauffe à plus de 650°C l'ékanite métamicte. Il faut remarquer que la coordinence autour des métaux est la même dans les deux types de structures: le Th, en coordinence 8, se trouve entouré d'atomes d'oxygène distants de 2,405(5) Å et formant un anti-prisme à base carrée; le Ca a quatre premiers voisins très proches [2,342(5) Å] en tétraèdre difforme et quatre seconds voisins [2,688(5) Å] près de points intermédiaires des faces du tétraèdre. Les feuillets de métal à $z = 0, \frac{1}{2}$ sont séparés par une couche déformée de silicate. La structure est caractérisée, comme celle des zéolites, par des canaux qui traversent les couches de silicate, où l'eau non structurale peut être piégée.

Roddick, J.A.

ON GRANITE LOGIC; Transformists' Petrology, Theophrastus Publications, S.A. Greece, p. 87-104, 1982.

Examination of the most often used criteria for determining that a plutonic body had a magmatic origin shows them to be clearly inadequate, mostly for obvious reasons. The popular criteria are few: sharp contacts and crosscutting relationships; dikes emanating from a pluton; wall-rock deformation; migmatites; fine-grained margins; homogeneity (and heterogeneity); foliation or its absence; strontium isotope ratios; oscillatory zoning; synneusis structure; euhedralism; and volcano-pluton relationships. Most of these criteria are so easily discredited that their general acceptance is astonishing. Because granitoid rocks are the most abundant in the earth's crust, their origin is too important to be decided on flimsy logic. Although well known as a problem that is finally settled every twenty years, the granite problem is often dismissed with the simple assumption of magmatic origin. That assumption then becomes the base for elaborate interdependent hypotheses. Until the origin of granite is truly understood a large part of geological science has no reliable foundation.

Ruzicka, V.

STUDIES ON URANIUM METALLOGENIC PROVINCES IN CANADA; Proceedings of the Symposium on Uranium Exploration Methods, Review of the NEA/IAEA R&D Programme, Paris, June 1-4, p. 143, 1982.

Studies on uranium metallogenic provinces in Canada consist of basic descriptive investigations (lithostratigraphic, structural, mineralogic, geochemical); development of conceptual genetic models of various types of uranium deposits; and delineation of environments favourable for occurrence of uranium deposits. Results of these observations are in turn used for evaluation of undiscovered uranium resources.

Des études sur les provinces métallogéniques uranifères au Canada consistent en la description des donnees géologiques de base (lithostratigraphiques, structurales, minéralogiques et géochimiques), en le développement de modèles génétiques pour les types divers de gîtes d'uranium et en la délimitation des milieux favorables pour la présence des gîtes d'uranium. Les résultats de ces observations sont par la suite utilisés pour l'évaluation des ressources uranifères non découvertes.

Schwarz, E.J. and Laverdure, L.

PALEOMAGNETISM AND MAGNETIC FABRIC OF THE GALLEN MASSIVE SULFIDE DEPOSIT, ROUYN-NORANDA, CANADA; Economic Geology, v. 77, p. 1667-1671, 1982.

Twenty oriented drill cores were collected from the outcrop of the Gallen massive sulfide deposit in the Rouyn-Noranda area in order to investigate remanent magnetization and anisotropy of magnetic susceptibility in the deposit. The purpose was to obtain information on the emplacement of the deposit. Electrical resistivity is high enough to allow 60-Hz alternating fields (AF) to be used for stability testing of the remanent magnetization. For thermal demagnetization, the heating chamber was first evacuated and then filled with argon. Alternating field demagnetization in a peak field of 30 mT yielded well-grouped stable directions carried by relatively high coercivity magnetite. The mean direction and pole position are: 137, +50, and 43°W, 2°S, dm=9°, dp=6°, respectively. The pole position falls on the 1,750- to 1,700-m.y. part of the apparent polar wander curve for North America, suggesting that the magnetization was acquired after the probable Archean formation of the deposit. The anisotropy of susceptibility (generally <8%) suggests preferential alignment of the long axes of the magnetite grains almost parallel to the stable remanence direction and its azimuth parallels the local structural trend. These observations suggest that the magnetic fabric is of Hudsonian age, thus implying Hudsonian deformation of this area of the Archean Superior province.

Schwarz, E.J., Clark, K.R., and Fujiwara, Y.

PALEOMAGNETISM OF THE SUTTON LAKE PROTEROZOIC INLIER, ONTARIO, CANADA; Canadian Journal of Earth Sciences, v. 19, p. 1330-1332, 1982.

Thirty-eight cores were collected from eight sites in the Sutton Lake Proterozoic inlier, which is thought to be an extension of the Circum-Ungava Belt. Six sites from a 100 m

thick diabase sill yielded essentially single-component magnetization averaging $D = 35°$, $I = -54°$, $k = 39$, $\alpha_{95} = 11°$. The diabase dips north at 4° and shows only minor alteration (epidote and chlorite). The other two sites were in a fine-grained dark layer within the sill and in a dike. No end points were observed for these sites upon alternating field and thermal demagnetization. The six diabase sites yielded a north pole at 67°E, 3°S, dm = 15, dp = 11. This pole position is similar to that obtained for the youngest volcanic suite (Flaherty Formation) of the Belcher Islands and to that obtained for red beds of the La Grande 4 outlier, suggesting a time-stratigraphic correlation between these units.

Trente-huit carottes prélevées sur huit sites localisés dans la fenêtre protérozoïque de lac Sutton que l'on croit représenter le prolongement de la ceinture Peri-Ungava. Six sites dans un filon-couche de diabase de 100 m en épaisseur ont donné essentiellement la composante unique d'aimantation avec les valeurs moyennes pour $D = 35°$, $I = 54°$, $k = 39$, $\alpha_{95} = 11°$. Le pendage de la diabase est de 4° nord et elle ne montre qu'une faible altération (épidote et chlorite). Les deux autres sites se trouvent dans une couche foncée à grain fin à l'intérieur du filon-couche et dans un dyke. Les directions finales n'ont pas été déterminées pour ces sites lors de la désaimantation par champs alternatifs et traitements thermiques. Les six sites dans la diabase ont indiqué un pôle nord à 67°E, 3°S, dm = 15, dp = 11. La position de ce pôle est semblable à celle obtenue pour la plus récente séquence volcanique (formation Flaherty) des Îles Belcher et à celle obtenue pour les formations rouges de l'avant-butte de la Grande 4, suggérant une corrélation stratigraphique-temps entre ces unités.

Arbour, G. and **Schwarz, E.J.**

ARCHEOMAGNETIC INTENSITY STUDY OF INDIAN POTSHARDS FROM QUEBEC, CANADA; Journal of Geomagnetism and Geoelectricity, v. 34, p. 129-136, 1982.

Eight potshards from the archeological site of Pointe du Buisson near Montreal were used to derive the variation in local geomagnetic intensity in the period between 500 B.C. and 1400 A.D. (seriation dates) and to compare the results to those obtained for Indian potshards from Southwestern Ontario. Each shard yielded two or three specimens suitable for treatment using the double heating method of Thellier. The results are complicated probably on account of the presence of chemical remanence and the high temperature results above 400 or 500°C are usually erratic. Selection criteria applied to the individual results were based on the quality of the Thellier plots and on within-shard consistency. Some of the results for seven shards were retained and shard averages and age averages computed with their standard deviations were applicable. These results were plotted against age, and the results from the sole earlier study on Canadian Indian shards were added to examine all data available for Canada. These data show good agreement in the position of average values, and, in spite of the large scatter, the data tentatively suggest a slight increase in geomagnetic intensity in Ontario-Quebec between 900 and 1700 A.D., and a decrease between 500 B.C. and 500 A.D.

Schwarz, E.J. and **Buchan, K.L.**

UPLIFT DEDUCED FROM REMANENT MAGNETIZATION: SUDBURY AREA SINCE 1250 Ma AGO; Earth and Planetary Science Letters, v. 58, p. 65-74, 1982.

Two contacts between Sudbury norite and northwest-trending diabase dikes and two contacts between the overlying micropegmatite and northwest dikes were investigated in order to estimate the depth of burial of the present erosion surface at the time of dike emplacement. A zone of hybrid paleomagnetic direction representing the vectorial sum of an older host component and an intrusion component of decreasing highest blocking temperature and intensity with distance from the intrusion was sought. Subtracting the calculated thermal effect of the intrusion from this highest blocking temperature yields the temperature of the host at the time of magma emplacement. Dividing this host temperature by an estimated paleogeothermal gradient yields the burial depth of the present erosion (or sampling) surface at the time of magma emplacement. Remanence direction in one of the dikes and norite contact zones is not typical for the Sudbury dike swarm of 1250 Ma age, and this contact is not further considered. An earlier published result for a norite-dike contact was reconsidered because of complicated dike geometry and included in this study. In one of the four usable contacts the hybrid zone is represented by three samples, in another by one sample, and in the remaining two only the contact zone width could be used. The final host temperature results are based on 4 individual calculations and show fair consistency with mean values of 287° (s.d. 13°) and 267° (s.d. 11°) calculated without and with a correction for viscosity of the host remanence respectively. Using a gradient of 26°C/km for 1250 Ma ago indicates a burial depth of 9.5 ±2 km at that time. The fair consistency encourages the use of the method to deduce quantitatively the history of vertical motions of Precambrian terranes, the detail obtained being dependent on the presence of hybrid zones and of intrusions of various ages.

Sen Gupta, J.G.

FLAME AND GRAPHITE FURNACE ATOMIC ABSORPTION AND OPTICAL-EMISSION SPECTROSCOPIC DETERMINATION OF YTTRIUM AND THE RARE-EARTH CONTENTS OF SIXTEEN INTERNATIONAL REFERENCE SAMPLES OF ROCKS AND COAL; Geostandards Newsletter, v. 6, no. 2, p. 241-248, 1982.

A simplified calcium oxalate and ferric hydroxide coprecipitation procedure was applied for quantitative separation and concentration of yttrium and the rare-earth elements from eight USGS (STM-1, RGM-1, QLO-1, SCo-1, MAG-1, SDC-1, BHVO-1, SGR-1), three French (MA-N, AN-G, BE-N), four South African (NIM-35/71-38/71) reference rocks and one NBS coal (1632) before determination by flame and graphite furnace atomic absorption and optical-emission spectroscopy. The results agree or fall near mid-range of other published values, where available. The chondrite normalized distribution patterns are generally smooth and conform to the shapes of other analyzed samples of similar nature.

Sen Gupta, J.G.

DETERMINATION OF SCANDIUM AND LANTHANUM IN SILICATE ROCKS AND COAL WITH A SIMPLIFIED SEPARATION PROCEDURE AND ATOMIC ABSORPTION SPECTROMETRY; Analytica Chimica Acta, v. 138, p. 295-302, 1982.

Simplified procedures for the quantitative separation and enrichment of scandium and lanthanum in igneous rocks are described. Co-precipitation with calcium oxalate is followed by co-precipitation with hydrated iron(III) oxide. Electrothermal and flame atomic absorption spectrometry are applied. The procedures are verified with synthetic sample solutions and the results for eighteen international reference samples of rocks and coal compare favourably with previously reported data and with data obtained by emission spectrography.

Shilts, W.W.

RELEVÉS SONAR DES SÉDIMENTS DES LACS DU QUÉBEC EN REGARD DES PRÉCIPITATIONS ACIDES; Eau du Québec, v. 15, no. 4, p. 369-375, 1982.

Les relevés Sonar de quelques lacs du Québec produisent une section-profil du fond sédimentaire de ces lacs constitué de sédiments meubles d'origine glaciaire et nonglaciaire. Dans la plupart des lacs, la base de la colonne sédimentaire est constituée de dépôts meubles qui vont du till, de quelques mètres d'épaisseur, au silt argileux, ou au sable, d'origine glacio-lacustre, pouvant atteindre des dizaines de mètres d'épaisseur; ces sédiments sont recouverts de 1 à 5 mètres de gyttja organique qui représente la sédimentation récente au fond de ces lacs. Le rapport du volume des sédiments (S:E) au volume des différents bassins qu'occupent les lacs choisis varie de 6:1 à 1:10. Ce rapport est un paramètre important dans l'évaluation du comportement d'un lac en regard des influx d'eau acide; plus ce rapport est élevé, plus grande est la capacité d'un lac de tamponner l'acidité des eaux souterraines ou de surface qui y affluent.

Sonar profiling of Québec lakes, provides graphic cross sections of the soft glacial and nonglacial sediments that lie beneath lake bottoms. In most lakes 1-5 m of watery organic gyttja, representing modern lake sediment, overlies unconsolidated glacial sediments ranging from a few metres of till to 10's of metres of laminated proglacial clayey silt or sand. In the bedrock depressions that hold lakes, the ratio of sediment volume to water volume (S/W) ranges from 6:1 to 1:10 in the lakes studied. It is thought that the greater its S/W ratio, the greater a lake's capacity to react with and possibly buffer acidified groundwater or surface water.

Shilts, W.W.

QUATERNARY EVOLUTION OF THE HUDSON/JAMES BAY REGION; Naturaliste canadien, v. 109, p. 309-332, 1982.

Divers événements glaciaires ont joué un rôle majeur dans le façonnement et l'évolution du relief dans la région de la baie d'Hudson. Les dépôts de till indiquent au moins six avancées glaciaires importantes dans le sud-ouest de la baie d'Hudson et de la baie James. Il devient évident que la superficie de l'inlandsis laurentidien et de ses prédécesseurs, centrés sur la baie d'Hudson, a été fortement réduite ou même que les masses de glace sont disparues entre ces diverses pulsations glaciaires.

De la fin du 19^{e} siècle (date des premiers relevés géologiques dans la région) jusqu'à nos jours, la configuration, la dynamique et l'odyssée de l'inlandsis laurentidien n'ont jamais fait l'unanimité. De nombreuses discussions ont porté sur l'existence d'un ou de plusieurs centres d'alimentation et de dispersion de la glace et sur les implications paléoclimatiques qui en découlent.

Récemment, suite à des travaux de cartographie et d'échantillonnage rendus nécessaires pour la mise en valeur des régions adjacentes à la baie d'Hudson, il est devenu clair que l'échelle et les réseaux de dispersion glaciaire indiquaient des centres d'écoulement situés dans les régions du Keewatin et du Nouveau-Québec. De plus, il semble peu probable que la glace se soit écoulée à partir d'un centre situé dans le bassin actuel de la baie d'Hudson.

La mise au point de techniques de datation par les acides aminés a permis d'estimer l'âge relatif et absolu des mollusques trouvés dans les dépôts marins interglaciaires ainsi que des erratiques dans les formations graveleuses fluviatiles et le till susjacents dans le bassin des baies James et d'Hudson et les basses-terres adjacentes. Les datations relatives et absolues obtenues par les acides aminés, combinées à des indices stratigraphiques, montrent clairement l'ouverture de la baie d'Hudson au moins une fois et probablement deux fois au cours du Wisconsinien.

Ces conclusions ont des implications importantes pour l'interprétation de l'oxygène isotopique enregistré au fond de la mer, pour la conception de modèles de la dynamique des inlandsis, pour le calcul de la viscosité du manteau déduite des données isostatiques, pour évaluer la répartition des éléments chimiques et minéralogiques des sédiments glaciaires et des dépôts qui en sont dérivés dans et autour du bassin de la baie d'Hudson, et pour la reconstitution des conditions paléoclimatiques qui ont existé durant chaque stade glaciaire.

Repeated glacial events have had a profound effect on the evolution of the landscape and sea bottom of the Hudson Bay region. As many as six major glacial advances are represented by glacial tills in the southwest Hudson and James Bay lowlands, and evidence is mounting that the Laurentide ice sheet and its predecessors, for which Hudson Bay was the geographical centre, were greatly reduced in size or disappeared between several of these glacial pulses.

From the late nineteenth century, when the first geological explorations were carried out around Hudson Bay, till the present, the configuration, dynamics, and history of the last Laurentide ice sheet have been disputed. Many of the arguments have concerned whether the ice sheet had one or several centres of accumulation and outflow and what the paleoclimatic implications of its configuration and history are.

Recently, as a result of mapping and sampling associated with the economic development of regions adjacent to Hudson Bay, it has become evident that the scale and patterns of glacial dispersal indicate that flow from glacial centres in the District of Keewatin and in Labrador-Québec was sustained for significant periods of time. Furthermore, it is unlikely that ice ever flowed from a centre located anywhere within the present basin of Hudson Bay.

With the development of amino acid dating techniques, it has been possible to estimate both relative and absolute ages of the marine molluscs that are found in interglacial marine beds and as erratics in overlying fluvial gravel and till throughout the James Bay/Hudson Bay and lowlands. Relative and absolute amino acid dates, combined with stratigraphic evidence, indicate clearly that Hudson Bay was open at least once, and probably twice during the Wisconsin stage.

These conclusions have important implications for interpretation of the deep-sea oxygen isotope record, for modelling the dynamics of large ice sheets, for calculations of mantle viscosities based on isostatic data, for evaluating the distribution patterns of chemical and mineralogical components of glacial and derived sediments within and peripheral to Hudson Bay, and for reconstructions of paleoclimatic conditions that initiated and persisted through each glacial stage.

Sinclair, W.D.

GOLD DEPOSITS OF THE MATACHEWAN AREA, ONTARIO; in Geology of Canadian Gold Deposits, ed. R.W. Hodder and William Petruk, CIM Special Volume 24, p. 83-93, 1982.

Between 1934 and 1956, nearly 31 million grams of gold were produced in the Matachewan area from deposits on properties belonging to Young-Davidson Mines Limited and

Matachewan Consolidated Mines Limited. In 1979, production from these properties was renewed by Pamour Porcupine Mines Limited.

Most of the gold produced has come from relatively low-grade deposits (3.4 g/t or less) that occur in an east-trending belt of dykes and irregular bodies of trachytic syenite. Although small by comparison, these deposits have some of the characteristics of porphyry copper-molybdenum deposits. The mineralized syenite contains up to 5 per cent disseminated pyrite and is highly fractured and cut by quartz and quartz-carbonate veinlets. Gold occurs as native gold along fractures, in quartz veinlets and as minute inclusions in pyrite. Minor chalcopyrite and trace amounts of scheelite, molybdenite and galena are also present. Mineralization was accompanied by potassic alteration, consisting mainly of potassium feldspar.

Some gold was also produced from small, but higher-grade, deposits in volcanic rocks. These deposits occur near the syenite-hosted deposits and consist of quartz veins and stringers mineralized with pyrite and gold. Minor gold is present in some low-grade, porphyry-type copper-molybdenum occurrences and, locally, in large, isolated quartz veins.

Lead isotope analyses suggest that the gold deposits were formed at about 2700 Ma and were locally remobilized at approximately 2400 Ma, following the Kenoran orogeny. The deposits appear to be genetically related to felsic magmas emplaced in an epizonal environment and deposited from hydrothermal solutions relatively concentrated in S and K_2O.

Snowdon, L.R. and **Powell, T.G.**

IMMATURE OIL AND CONDENSATE – MODIFICATION OF HYDROCARBON GENERATION MODEL FOR TERRESTRIAL ORGANIC MATTER; The American Association of Petroleum Geologists Bulletin, v. 66, no. 6, p. 775-788, 1982.

Petroleum has been found in Canadian frontier basins in reservoirs which have undergone low levels of thermal alteration (vitrinite reflectance <0.6%Ro). Paraffin indices, stable carbon and hydrogen isotope contents, pristane to nC_{17} ratios, and diterpenoid biologic markers have been used to assess the level of maturity of the hydrocarbons in the reservoir independently of the level of maturity of the reservoir itself and of the surrounding shale units. In the Tertiary of the Beaufort-Mackenzie basin, naphthenic oils and condensates have been generated from terrestrially derived organic matter in source rocks juxtaposed with the reservoir at reflectance levels of 0.4 to 0.6%Ro. However, condensates discovered in reservoirs which are thermally immature on the Labrador Shelf have undergone extensive vertical migration and can be classed as conventional mature to overmature condensates. Hydrocarbons discovered in the Lower Cretaceous of the Beaufort-Mackenzie basin and also those of the Scotian Shelf are more or less in place in that they are at a level of thermal alteration about equivalent to that of the reservoirs in which they are trapped. The source for the early oils and condensates is considered to be resinite occurring dispersed in coal fragments.

The proportion of resinite, liptinite, and vitrinite in the organic matter of terrestrial source rocks strongly controls both the level of thermal alteration necessary for the section to function as an effective source rock and the ultimate product (gas, oil, or condensate) which will be generated.

Thompson, P.H. and Bard, J-P.

ISOGRADS AND MINERAL ASSEMBLAGES IN THE EASTERN AXIAL ZONE, MONTAGNE NOIRE (FRANCE): IMPLICATIONS FOR TEMPERATURE GRADIENTS AND P-T HISTORY; Canadian Journal of Earth Sciences, v. 19, p. 129-143, 1982.

Detailed petrography across a metapelitic sequence in the eastern axial zone of the Montagne Noire, France, is the basis for a sequence of isograds marking the first appearance of biotite-cordierite, staurolite, andalusite, and sillimanite. The juxtaposition of low-grade biotite-free rocks against medium-grade rocks at the gently dipping biotite-cordierite isograd is attributed to tectonic telescoping of the metamorphic sequence. Study of mineral assemblages with respect to an AFM reaction sequence indicates the staurolite isograd is related to changes in rock composition, and complex assemblages in the sillimanite zone may be the result of unstable persistence of minerals formed when metamorphic grade was lower. These assemblages are interpreted to contain a record of part of the P-T history during which pressure decreased as temperature increased. P-T profiles show that temperature gradients of 200-300°C/km suggested by previous workers are not required to explain the isograd pattern; gradients of 37°C/km or less are sufficient.

Une étude pétrographique détaillée au travers d'une séquence métapélitique dans la zone axiale est de la Montagne Noire, en France, sert de base pour établir une séquence d'isogrades marquant la première apparition de biotite-cordiérite, staurotide, andalousite et sillimanite. La juxtaposition de roches faiblement métamorphiques et sans biotite contre des roches de métamorphisme moyen le long de l'isograde biotite-cordiérite qui lui est légèrement incliné est attribuée à un télescopage tectonique de la séquence métamorphique. L'examen des assemblages minéralogiques par rapport à une séquence de réaction AFM indique que l'isograde à staurotide est lié aux changements de composition des roches, et que les assemblages complexes dans la zone à sillimanite peuvent résulter de la persistence instable des minéraux formés lorsque l'intensité du métamorphisme était plus faible. Ces assemblages sont considérés comme contenant les renseignements d'une partie de l'histoire P-T lorsque la pression diminuait et la température augmentait. Les courbes P-T montrent que les gradients de température de 200-300°C/km tels que proposés antérieurement ne sont pas nécessaires pour expliquer la distribution des isogrades; des gradients d'au plus 37°C/km sont suffisants.

Longman, C.D., Bluck, B.J., **van Breemen, O.**, and Attalion, M.

ORDOVICIAN CONGLOMERATES: CONSTRAINTS ON THE TIME SCALE; in Numerical Dating in Stratigraphy, ed. G.S. Odin, John Wiley, Chichester, England, p. 807-810, 1982.

van Breemen, O. et al.

GEOCHRONOLOGICAL STUDIES OF THE BOHEMIAN MASSIF, CZECHOSLOVAKIA, AND THEIR SIGNIFICANCE IN THE EVOLUTION OF CENTRAL EUROPE; Transactions of the Royal Society of Edinburgh, Earth Sciences, v. 73, p. 89-108, 1982.

U-Pb zircon and Rb-Sr whole-rock analyses from various gneisses and plutonic rocks of the Moldanubian and Moravo-Silesian zones and the stable foreland of the

Hercynian (Variscan) orogenic belt indicate that most of the crust in Central Europe was first formed during the Cadomian orogeny which straddles the Precambrian-Cambrian boundary. Zircons, however, have a memory of older ages which correspond with those of events known in Fennoscandia. The new radiometric data are consistent with the stratigraphic record in that they do not provide any evidence for a major early Palaeozoic tectonothermal event between the Cadomian and Hercynian orogenies.

Granulites from two localities in the Moldanubian zone yield U-Pb zircon ages of 345 ± 5 Ma; discordant zircon data points indicate that the granulite facies metamorphism was not of long duration. Tectonic units containing these high grade rocks were emplaced amongst amphibolite facies rocks during an event of widespread shearing which has been dated at 341 ± 4 Ma on the basis of a lower U-Pb zircon intercept age from one of the sheared gneisses and 338 ± 3 Ma U-Pb ages from monazites. Rb-Sr muscovite ages of 331 ± 5 Ma from pegmatites axial planar to asymmetrical folds date the last stage of SE-directed simple shear. A Rb-Sr whole-rock isochron of 331 ± 4 Ma from a principal magmatic type of the Central Bohemian pluton confirms the field evidence that the large NE-trending plutons of the Moldanubian zone were emplaced during a late stage of the deformation. The strong disturbance of the U-Pb zircon isotopic system in the sheared gneisses suggests U loss while a high U/Th ratio in monazite from one of these tectonised rocks suggests the simultaneous passage of hydrothermal fluids. Thus a crustal source is indicated for the uranium deposits of the Moldanubian zone.

Critical to any plate tectonic model for the development of the Middle European Hercynides was the existence of an ocean in Early Devonian times which separated a North European continent from a South European continent(s). The northward movement of the South European continent over a shallowly-dipping subduction zone and subsequent continental collision can explain the high T-low P metamorphism and the imbricated tectonic style of the Moldanubian zone and adjacent Moravo-Silesian zone along the southeastern Hercynian foreland. The temporal separation of granulites and granites implies distinct conditions of formation and it has been suggested that the plutonism, following on from the imbrication of the Cadomian crust, was initiated by the subduction of wet oceanic sediments.

Dallmeyer, R.D., **van Breemen, O.**, and Whitney, J.A.

Rb-Sr WHOLE-ROCK AND $^{40}Ar/^{39}Ar$ MINERAL AGES OF THE HARTLAND STOCK, SOUTH-CENTRAL MAINE: A POST-ACADIAN REPRESENTATIVE OF THE NEW HAMPSHIRE PLUTONIC SERIES; American Journal of Science, v. 282, p. 79-93, 1982.

The Hartland granodioritic stock is an undeformed, post-Acadian representative of the New Hampshire Plutonic series that intrudes low-grade Silurian-Devonian (?) metasedimentary rocks in south-central Maine. A nine-point, Rb-Sr whole-rock isochron defines an age of 360 ± 8 m.y. for the pluton (initial $^{87}Sr/^{86}Sr$ = 0.7056 ± 3). Biotite and hornblende from the pluton display undisturbed $^{40}Ar/^{39}Ar$ age spectra with mutually overlapping dates of 362 ± 5 m.y. (seven samples). The undisturbed character of the argon isotopic systems suggests that the $^{40}Ar/^{39}Ar$ ages date times of post-magmatic cooling through temperatures required for retention of argon. Relatively rapid post-crystallization cooling of the stock is suggested, because similar ages are recorded by isotopic systems with very different thermal sensitivities to diffusive loss of radiogenic products. Rapid post-crystallization cooling is also indicated by an absence of subsolidus recrystallization features in the pluton. Together, petrologic and geochronologic data suggest that at ∿360 m.y., the Hartland pluton was emplaced at a relatively shallow depth within the crust (<10 km) and cooled rapidly.

Comparison of the emplacement age defined for the Hartland stock with Rb-Sr whole-rock isochron dates reported for crystallization of other New Hampshire Series plutons suggests continuous Devonian intrusive activity in New England, preceding, during, and following the Acadian orogeny. No geochronologic evidence for separating distinct subseries of intrusion can be provided with presently available data.

Vincent, J-S.

THE QUATERNARY HISTORY OF BANKS ISLAND, N.W.T., CANADA; Géographie physique et Quaternaire, v. 36, no. 1-2, p. 209-232, 1982.

Banks Island is a polar desert where continental ice sheets, spreading from a dispersal centre to the southeast, reached their maximum extent on at least three occasions. The oldest Banks Glaciation affected all but the northwest. The Pre-Banks Sea preceded glacierization while the Post-Banks Sea formed during deglaciation. Following Morgan Bluffs Interglaciation, characterized by a climate similar to that of today, the south, the east, and the Thomsen River basin were covered during Thomsen Glaciation. The Pre-Thomsen Sea preceded the glacierization, while the Big Sea inundated much of the Island during deglaciation. Following the last or Cape Collinson Interglaciation, characterized by a climate warmer than that of the hypsithermal, Laurentide glacial lobes impinged on the coastal areas, during the M'Clure Stade of Amundsen Glaciation. Prince of Wales and Thesiger lobes, emanating from Amundsen Gulf, respectively advanced in Prince of Wales Strait and Thesiger Bay impinging on the east and southwest coasts. At the same time, Prince Alfred Lobe, originating in Viscount Melville Sound, advanced in M'Clure Strait and impinged on the north coast. The Pre-Amundsen Sea preceded the glacierization of the south coast, while the East Coast Sea submerged the east coast up to 120 m, the Meek Point Sea the west up to 20 m and the Investigator Sea the north up to 30 m, during deglaciation. The late Sand Hills Readvance of Thesiger Lobe built a morainic system on the southwest coast. Later, the northeast was covered, during the Russell Stade of Amundsen Glaciation, by Viscount Melville Lobe, emanating from Viscount Melville Sound, and the east coast was drowned up to 25 m by the Schuyter Point Sea. Limits of extent of Laurentide ice in the southwestern Archipelago are proposed for the two stades of the last or Wisconsinan Glaciation.

L'île de Banks est un désert polaire où les islandsis continentaux venant du sud-est ont atteint au moins à trois reprises leur extension maximale. La plus vieille Glaciation de Banks a submergé toute l'île sauf le nord-ouest. La mer pré-Banks a précédé l'englaciation, tandis que la mer post-Banks existait au moment de la déglaciation. Après l'Interglaciaire de Morgan Bluffs, caractérisé par un climat semblable à celui d'aujourd'hui, le sud, l'est et le bassin de la rivière Thomsen ont été submergés au cours de la Glaciation de Thomsen. La mer pré-Thomsen a précédé l'englaciation, tandis que la mer Big a submergé de vastes régions lors de la déglaciation. À la suite du dernier Interglaciaire de Cape Collinson, des lobes de glace laurentidiens ont empiété sur les régions côtières de l'île au cours du Stade de M'Clure de la Glaciation d'Amundsen. Les lobes de Prince of Wales et de Thesiger, émanant du golfe d'Amundsen, ont respectivement progressé dans le détroit du Prince-de-Galles et la baie Thesiger, empiétant sur les côtes orientales et sud-ouest. Au même moment, le lobe de Prince Alfred, a progressé vers l'ouest dans le détroit de M'Clure en empiétant sur la côte nord. La mer pré-Amundsen a précédé l'englaciation de la côte sud, tandis que la mer d'East Coast a submergé l'est jusqu'à 120 m, la mer de Meek Point, l'ouest jusqu'à 20 m et

jusqu'à 120 m, la mer de Meek Point, l'ouest jusqu'à 20 m et la mer Investigator, le nord jusqu'à 30 m, lors de la déglaciation. Un complexe morainique a été édifié sur la côte sud-ouest par l'avancée tardive de Sand Hills du Lobe de Thesiger. Plus tard, le nord-est a été recouvert par le Lobe de Viscount Melville, lors du Stade de Russell de la Glaciation d'Amundsen, et la côte est a été submergée jusqu'à 25 m par la mer de Schuyter Point. On propose également les limites d'avancée du glacier laurentidien, dans le sud-ouest de l'archipel Arctique, au cours des deux stades de la glaciation du Wisconsinien.

Vincent, J-S.

MODÈLE DE SÉDIMENTATION MARINE, GLACIO-MARINE, GLACIAIRE ET INTERGLACIAIRE CYCLIQUE SUR L'ÎLE DE BANKS, ARCTIQUE CANADIEN; Résumés des communications, Annales de l'ACFAS, v. 49, p. 136, 1982.

Lors de l'étude des dépôts quaternaires côtiers, les séries sédimentaires suivantes, associées à trois glaciations, ont été observées. Entre des dépôts interglaciaires on trouve: 1) des sédiments marins devenant plus fins vers le haut; 2) des sédiments glacio-marins devenant plus grossiers vers le haut et interstratifiés avec du till; 3) une nappe de till; 4) des sédiments glacio-marins; et 5) des sédiments marins devenant plus grossiers vers le haut et localement surmontés de dépôts deltaïques. Cette série est interprétée de la façon suivante. Dans des régions côtières, l'écorce terrestre est isostatiquement déprimée à mesure que le glacier se rapproche de l'île et des sédiments marins transgressifs sont mis en place. Avant que la région ne soit recouverte, des dépôts glacio-marins s'accumulent, puis le glacier surmonte les dépôts transgressifs et laisse un till. Par la suite, avec le retrait du glacier et le relèvement isostatique, des dépôts glacio-marins, puis marins régressifs sont mis en place. Ce modèle permet de comprendre les liens qui existent entre l'avancée et le retrait d'un glacier, les mouvements isostatiques et les variations du niveau de la mer. Une question se pose cependant. Quels critères doit-on employer pour séparer les dépôts marins des dépôts glacio-marins?

Vincent, J-S.

THE QUATERNARY STRATIGRAPHY OF THE WESTERN CANADIAN ARCTIC ARCHIPELAGO; Program with Abstracts, v. 7, Geological Association of Canada – Mineralogical Association of Canada, 1982 Joint Annual Meeting, p. 86, 1982.

The western Canadian Arctic Archipelago is situated where continental Quaternary ice sheets, dispersing from the southeast, reached their limit on at least three occasions. On Banks Island, the Worth Point Formation comprises terrestrial preglacial sediments and records the period between the Miocene and the oldest glaciation. Sediments assigned to the Duck Hawk Bluffs, the Nelson River and the Prince of Wales formations were respectively laid down during the Banks, Thomsen and Amundsen glaciations. Sedimentary sequences show that transgressive marine events, resulting from the buildup of ice, preceded each glacial overlap of the island, and that marine regressive events related to glacioisostatic recovery occurred during subsequent ice retreat. Paleoecology of organic sediments of the Morgan Bluffs Formation, between sediments laid down by the Banks and Thomsen glaciers, and of the Cape Collinson Formation, between sediments laid down by the Thomsen and Amundsen glaciers, indicate that interglacial conditions existed between each glacial stage. Deposits on Banks, Victoria and Melville Islands are attributed to two glacial stades of the last Glaciation. During the older M'Clure Stade (early Wisconsin), ice covered most of Victoria Island and flowed into Amundsen Gulf impinging on the southwest and east coast of Banks Island and into M'Clure Strait impinging on the north coast of Banks and the south coast of Melville Island. Following a major retreat, ice advanced about 10 ka (Russell Stade) into eastern Amundsen Gulf and Viscount Melville Sound. This ice impinged on northeastern Banks and southern Melville Island leaving large areas of Victoria Island unglaciated. Although local glaciers may have existed there is no evidence for a Wisconsinan continental ice cover on the western Queen Elizabeth Islands. Glacial sediments are present but are likely related to an extensive pre-Wisconsin glaciation.

Vincent, J-S.

THE QUATERNARY HISTORY OF THE WESTERN CANADIAN ARCTIC ARCHIPELAGO, CANADA; Geological Society of America, Abstract with Programs, v. 14, no. 7, p. 638, 1982.

Continental ice sheets, spreading from dispersal centers to the southeast, reached their limits in the western Archipelago during at least three glacial stages. On Banks I. Late Tertiary and early Quaternary preglacial sediments underlie the oldest glacial sediments, and organic rich nonglacial sediments record interglacial conditions warmer than today between each glacial stage. The Banks Glaciation was the oldest and most extensive. It covered Banks I., except for the northwest, and probably inundated large areas of the western Queen Elizabeth Is. depositing mainland erratics. The subsequent Thomsen Glaciation impinged on the south and east coast of Banks I. and was only strong enough to cover limited southern coastal areas of the western Q.E.Is. Deposits on Banks, Victoria and Melville Is. are attributed to two glacial stades of the last or Amundsen Glaciation. During the older and more extensive M'Clure Stade (early Wisconsin), continental ice covered Victoria I., except for central Prince Albert Pen., and flowed into Amundsen Gulf impinging on the southwest and east coast of Banks I. and into M'Clure Strait impinging on the north coast of Banks I. and the south coast of Melville I. Following a major interstade, ice advanced from the M'Clintock Dome into eastern Amundsen Gulf and Viscount Melville Sound and reached its late Wisconsin limit about 10 ka (Russell Stade). The ice impinged on northeastern Banks I. and southern Melville I. (depositing Winter Harbour Till) leaving large areas of Victoria I. unglaciated. Although local glaciers may have existed, there is no evidence for a Wisconsin continental or other complete ice cover on the western Q.E.Is. Amino acid and ^{14}C analyses of fossil material postdating the M'Clure Stade deposits indicate that this stade likely dates from the early Wisconsin.

Vincent, J-S.

AMINOSTRATIGRAPHY OF QUATERNARY SEDIMENTS, BANKS ISLAND, NORTHWEST TERRITORIES, CANADA; Geological Society of America, Abstract with Programs, v. 14, no. 7, p. 638, 1982.

Quaternary sediments on Banks Island, in the western Canadian Arctic Archipelago, register preglacial events as well as events related to three distinct glacial/interglacial cycles. The current mean annual temperature at Sachs Harbour is -14°C. Amino acid analyses have been completed on both wood from interglacial units and molluscan shells from glacio isostatic seas in order to confirm lithostratigraphic correlations, relatively date events and estimate in a general way the absolute ages of units. D/L ratios of aspartic acid in fossil **Salix** and **Betula** wood from

the second last (Morgan Bluffs) and the last (Cape Collinson) interglacials respectively averaged 0.32 and 0.22, while Holocene wood is 0.07. Attempts at analysing wood from units which span the period between the Miocene and the oldest recognised glacial will also be reported on. D-alloisoleucine to L-isoleucine total (free plus peptide-bound) ratios in fossil **Hiatella arctica** valves and fragments from the pre last interglacial Big Sea averaged 0.19 (0.54 to 0.73-free), while shell fragments from the East Coast Sea postdating the M'Clure Stade (an early Wisconsin ? stade of the last or Amundsen Glaciation) ranged from 0.04 to 0.09 (0.42 to 0.51 free) and valves from the Late Wisconsinan Schuyter Point Sea (Russell Stade of Amundsen Glaciation) had a total ratio of 0.02. In general the analyses have been extremely useful in correlating widely spaced sections.

Vincent, J-S. et Occhietti, S.

LA LITHOSTRATIGRAPHIE DES FALAISES DUCK HAWK, ÎLE DE BANKS, ARCTIQUE CANADIEN; Résumés des communications, Annales de l'ACFAS, v. 49, p. 133, 1982.

On trouve dans les falaises Duck Hawk, à l'ouest de Sachs Harbour sur l'île de Banks, des sédiments glaciaires et non glaciaires mis en place depuis le Miocène. Des dépôts fluviaux, éoliens et lacustres, recelant de la matière organique et datant de la fin du Tertiaire et/ou du début du Quaternaire, sont préglaciaires. Ces dépôts sont surmontés de sédiments glaciaires associés à la plus ancienne des trois glaciations reconnues sur l'île de Banks (Glaciation de Banks) et par des sédiments marins antérieurs ou postérieurs à l'événement glaciaire. Ces dépôts sont à leur tour surmontés par des sédiments associés à l'Interglaciaire de Morgan Bluffs postérieur à la Glaciation de Banks, à la Mer Big qui a recouvert l'ouest de l'île lors de la Glaciation de Thomsen (avant dernière glaciation sur l'île de Banks), et au dernier Interglaciaire du Cap Collinson. Les résultats préliminaires de diverses analyses sédimentologiques, paléoécologiques, paléomagnétiques et géochronologiques (datations aux acides aminés) effectuées sur ces dépôts, parmi les plus vieux du Quaternaire canadien, seront présentés.

McLean, J.R. and **Wall, J.H.**

THE EARLY CRETACEOUS MOOSEBAR SEA IN ALBERTA; Bulletin of Canadian Petroleum Geology, v. 29, no. 3, p. 334-377, 1981.

Marine mudstone deposited in the Early Albian Moosebar sea has been recognized in outcrop sections along the Alberta Foothills from Smoky River to Fall Creek, 160 km (100 mi) northwest of Calgary. The contact between the Moosebar Member of the Malcolm Creek Formation and the underlying Gladstone Formation is abrupt and disconformable, being marked by a thin bed of pebbles and glauconitic mudstone. The upper calcareous member of the Gladstone Formation yielded an interpreted brackish-water fauna in the central and northern Alberta Foothills but an entirely freshwater fauna in the southern Foothills. Equivalent beds in the Gething Formation between Smoky and Wolverine Rivers in the northern Alberta and northeastern British Columbia Foothills appear to be nonmarine, associated with a major deltaic complex. Marine influence again is present in upper beds of the Gething Formation north of the Wolverine River.

The microfaunal assemblages in the Moosebar Member point to an open-marine environment in the Smoky River area changing progressively southward to a brackish-water environment in the central Foothills, and ultimately a fresh-water environment at the southern extremity of the Moosebar Sea near Fall Creek.

The Moosebar Sea transgressed southward along the Early Cretaceous drainage system, forming an extensive estuary during late Gladstone time. During deposition of the Moosebar sediments, the sea extended farther south, probably to about present-day latitude 52° in the Foothills, inundating most of the highlands adjacent to the estuary. Similar events and environments are interpreted for the Alberta Plains region where the Clearwater Formation is equivalent to the Moosebar Member.

Walker, D.A.

APPLICATIONS OF SCANNING ELECTRON MICROSCOPY TO PALEONTOLOGY; in North American Paleontological Convention III, Abstracts of Papers, Journal of Paleontology, March 1982, Supplement to no. 2, p. 29.

Since the introduction of the first commercially available scanning electron microscope (SEM) fifteen years ago the scientific community has graduated from the level of the mildly curious to regarding the SEM as a highly desirable, if not essential, research tool. So too has the SEM developed from a straightforward imaging microscope to a complex combination of electronic devices that permit real-time stereo imaging, detection and imaging of several different electron and x-ray signals, computer analysis of images and computer control of the electron beam and the specimen stage.

If the SEM is operated only as a conventional secondary electron imaging microscope there are several techniques that can be adopted to optimize the performance of the instrument for any application, whether it be a low magnification-long depth of focus or high magnification-high resolution requirement. The SEM user must be fully aware of the function of the electron source, accelerating voltage, lens current, detector voltage, final aperture size, working distance and tilt angle. The individual as well as the combined effect of the aforementioned parameters on image quality must be understood. There are numerous applications of the SEM unique to different fields of palaeontology that make such a tool superior to conventional light microscopy. In considering only the normal secondary electron image the SEM has: (1) greater depth of focus than is possible with any light microscope, enabling the user to obtain completely focussed images of such specimens as conodonts, ostracods and foraminifera and (2) greater magnification range than light microscopes, enabling the user to obtain high resolution images of such specimens as diatoms, acritarchs and pollen.

Jambor, J.L., Laflamme, J.H., and **Walker, D.A.**

A RE-EXAMINATION OF THE MADOC SULFOSALTS; The Mineralogical Record, March-April, 1982, p. 93-100.

New microprobe analyses of the Madoc sulfosalts have confirmed some of the original results and have substantially modified others. The most significant changes are revisions to the formulas for sterryite and guettardite. Sterryite has been found to be consistently silver-bearing and has the probable formula $Pb_{10}Ag_2(Sb,As)_{12}S_{29}$, whereas the formula originally proposed was $Pb_{12}(Sb,As)_{10}S_{27}$. Guettardite, previously assigned the composition $Pb_9(Sb,As)_{16}S_{33}$, has been found to approximate $Pb_8(Sb,As)_{16}S_{32}$. The analyses indicate that playfairite, as well as Madoc dadsonite, contains small amounts of chlorine.