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ABSTRACTS OF PUBLICATIONS IN SCIENTIFIC JOURNALS BY OFFICERS OF THE GEOLOGICAL SURVEY OF CANADA IN 1980

RÉSUMÉS DE PUBLICATIONS PAR LES CHERCHEURS DE LA COMMISSION GÉOLOGIQUE DU CANADA POUR 1980

Agterberg, F.P.

LOGNORMAL MODELS FOR SEVERAL METALS IN SELECTED AREAS OF CANADA; Proceedings 26e Congrès Géologique International, Paris, 1980, Colloque C1: Ressources Minérales, p. 83-90, 1980.

The theory of exponential and lognormal models for tonnage-grade relationships is briefly reviewed. The exponential model can be regarded as an approximation to the lognormal model. Sample data may fit the lognormal model well as is illustrated by applications to copper, lead and zinc in the Canadian Appalachian Region, and to gold, copper and zinc in the Abitibi area of the Superior Province on the Canadian Shield.

On donne un aperçu de la théorie des modèles exponentiel et log-normal pour la relation entre tonnage et teneur. On peut considérer le modèle exponentiel comme une approximation du modèle log-normal. Des données d'analyse d'échantillons peuvent suivre correctement le modèle log-normal, et des exemples en sont donnés pour des applications au cuivre, plomb et zinc de la Région canadienne des Appalaches, et à l'or, cuivre et zinc de l'Abitibi de la Province supérieure du Bouclier canadien.

Agterberg, F.P., and **Gradstein F.**

A STATISTICAL MODEL FOR THE CLUSTERING OF BIOSTRATIGRAPHIC EVENTS; 26th International Geological Congress, Symposium Quantitative Biostratigraphy, Paris, 1980.

Stratigraphic events defined by the highest or lowest occurrence of fossils in a group of wells or sections can be ordered into an optimum sequence by using one of several existing statistical methods. These methods are based on the matrix F of relative frequencies by which the events are observed to succeed one another in the wells. The relative position of the events in the optimum sequence is an "average" of all of the relative positions encountered. It is also useful to estimate a vector D for distances between successive stratigraphic events along a relative time axis. For this purpose, the matrix F is transformed into a matrix Z consisting of z-values (probits-5) for the observed relative frequencies. The elements of D are obtained by averaging the differences between successive rows of A after weighting each z-value according to the number of pairs of events from which it was calculated. The events can be clustered by using the estimated distances between them. This gives results similar to those of the assemblage zone approach in biostratigraphy. New methodological developments for this statistical model consist of the calculation of standard deviations of the estimated distances and a comparison of the observed sequences of the wells to the vector D. The computer program prepared for the statistical model has been used to erect a zonation for our Cenozoic benthonic and planktonic foraminiferal record (209 taxa) in 22 wells on the Canadian Atlantic continental margin between latitudes 43° and 60°. A northern and a southern optimum sequence have been recognized containing 40 to 60 taxa, respectively, about half of which are in common. The northern and southern probabilistic zonations each consist of eight clusters of Paleocene through Pliocene/Pleistocene age.

Aitken, J.D.

SEDIMENTATION OF THE HELIKIAN LITTLE DAL GROUP, MACKENZIE MOUNTAINS; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 40, 1980

The Little Dal Group (LD) is an unbroken sedimentary succession up to 2 km thick, in paraconformable contact with the underlying Katherine Group (Hk).

Deposition began in the NW, onlapping SE. The basinal assemblage of deepwater limestone rhythmites with stromatolite reefs (1) is separated from the platform assemblage of grainstones and lime mudstones (2) by a belt of stacked stromatolite biostromes (3). Filling of the basin led to deposition of oölites and supratidal platy dolomites of the grainstone unit (4). The latter formed a southeast-migrating barrier behind which the gypsum unit (5) accumulated. Renewed clastic influx is recorded by the peritidal rusty shale unit (6). The richly stromatolitic upper carbonate unit (7) consists largely of shallowing upward, detrital-carbonate and carbonate cycles.

Faulting and local basalt eruption mark the end of Little Dal deposition; in the absence of lava, the event is marked by a new influx of sand (locally gravel). It is suggested that the lava (8) and postlava carbonates with clastics be removed from the Little Dal Group and viewed as initiating the "copper cycle" (C), which continued with deposition of the cupriferous Redstone River (9) and Coppercap (10) Formations.

Anderson, T.W.

HOLOCENE VEGETATION AND CLIMATIC HISTORY OF PRINCE EDWARD ISLAND, CANADA; Canadian Journal of Earth Sciences, v. 17, p. 1152-1165, 1980.

The vegetation and climate of the Holocene of Prince Edward Island are reconstructed from pollen analysis of four **Sphagnum** peat bogs, Portage and East Bideford Bogs in the west and Mermaid and East Baltic Bogs in the east. The discussion is based largely on percentage data supported by pollen influx estimates.

The earliest recognizable vegetation was tundra-like with nonarboreal birch, willow, **Artemisia,** and upland grasses and sedges. The vegetation changed remarkably within a short period, from tundra at 10 000 years BP, to forest–tundra (spruce – nonarboreal birch association) between 10 000 and 8000 years ago, to pine at or shortly

after 8000 years ago. Hemlock arrived 7000 years ago and dominated along with white pine from about 6500–4500 years BP. Beech came in about 3400 years ago and formed part of a hemlock–beech–birch association up until modern times. Sharp increases in weeds and grasses and declines in hemlock, birch and beech denote European settlement approximately 100–150 years ago.

A gradual warming trend is inferred for the period prior to about 8000 years BP, but rapid climatic improvement took place shortly after 8000 years ago corresponding with the pollen transition from spruce to pine. Maximum temperatures (close to 8.5°C) were reached approximately 4000 years ago when the mean annual temperature may have been almost 2.5°C warmer than present. Deterioration of the climate occurred at approximately 3000 and 1500 years ago, coinciding with increases in spruce, Ericaceae and **Sphagnum,** and a decrease in pine.

On reconstruit l'histoire de la végétation et du climat au cours de l'Hococène dans l'île du Prince-Edouard à partir de l'analyse du pollen provenant de quatre tourbières à **Sphagnum,** les marais de Portage et d'East Bideford à l'ouest, et de Mermaid et d'East Baltic à l'est. On base la discussion surtout sur les données en pourcentages appuyées par des estimations d'influx de pollen.

La végétation la plus précoce qu'on reconnaisse était de type toundra avec des loubeaux et des saules non arboréens, la présence d'**Artemisia,** et des herbes et laiches de plateaux. La végétation a changé de façon remarquable durant une courte période de temps de la toundra, il y a 10 000 ans, à la toundra–forêt (association épinette – bouleau non aboréen) entre 8000 et 10 000 ans, et à la forêt de pin vers 8000 ans ou un peu après. La pruche est arrivée il y a 7000 ans et a dominé avec le pin blanc qu'environ 6500–4500 ans avant le présent. Le hêtre est venu il y a environ 3400 ans et forme une partie de l'association pruche–hêtre–bouleau qui persiste encore aujourd'hui. Des augmentations nettes dans le pollen herbacé et des diminutions de la pruche, du bouleau et du hêtre marquent l'arrivée des Européens il y a environ 100–150 ans.

On reconnait une tendance graduelle au réchauffement pour la période antérieure à environ 8000 ans avante le présent, mais une amélioration climatique rapide s'est produite peu après 8000, correspondant à la transition de l'épinette au pin. Les températures maximales (près de 8.5°C) ont été atteintes il y a environ 4000 ans alors que la température moyenne annuelle pouvait être environ 2.5°C plus chaude qu'actuellement. La détérioration du climat s'est produite approximativement entre 3000 et 1500 ans avant le présent, ce qui coincide avec l'augmentation dans la population d'épinettes, d'Ericacées et de **Sphagnum** et la diminution du pin.

Ansell, H.G., Roberts, A.C., Plant A.G., and Sturman B.D.

GITTINSITE, A NEW CALCIUM ZIRCONIUM SILICATE FROM THE KIPAWA AGPAITIC SYENITE COMPLEX, QUEBEC; Canadian Mineralogist, v. 18, p. 201-203, 1980.

Gittinsite is a new calcium zirconium silicate mineral found in pegmatitic lenses in a regionally metamorphosed agpaitic syenite complex at the Kipawa River, Villedieu Township, Témiscamingue County, Québec. It forms chalky, grey-white fine-grained intergrowths with apophyllite that are commonly associated with vlasovite. Other associated minerals are eudialyte, fluorite, graphite, calcite, apatite, opal, agrellite, clinoamphibole, mosandrite, pectolite, microcline and thorite. Colorless in thin section, gittinsite is biaxial negative with $2V_\alpha = 30(10)°$, n_α 1.720(2), n_β 1.736(2), n_υ 1.738(2), extinction on (010) being nearly parallel to the X direction, at an angle of 5–10° to elongation (*c*). Electron-microprobe analysis gave CaO 18.4, ZrO_2 40.3, SiO_2 40.8, total 99.5%. The empirical formula calculated for 7 oxygen atoms is $Ca_{0.98}Zr_{0.98}Si_{2.03}O_7$ or, ideally, $CaZrSi_2O_7$. Gittinsite is monoclinic, *a* 6.878(4), *b* 8.674(4), *c* 4.697(2) Å, β 101.74(4)°, *Z*=2, space group *C*2/m by analogy with thortveitite (*PDF* 19–1125). The calculated density for $CaZrSi_2O_7$ is 3.624 g/cm^3.

La gittinsite, minéral nouveau, est un silicate de calcium et zirconium. On la trouve dans des lentilles pegmatitiques d'un complexe syénitique agpaitique à métamorphisme régional près de la rivière Kipawa (canton de Villedieu, comté de Témiscamingue, Québec). Elle forme avec l'apophyllite de fines intercroissances crayeuses d'un blanc grisâtre associées d'ordinaire à de la vlasovite, mais aussi à d'autres espèces; eudialyte, fluorine, graphite, calcite, apatite, opale, agrellite, clinoamphibole, mosandrite, pectolite, microcline et thorite. Incolore en lame mince, la gittinsite est un minéral à biaxe négatif, $2V_\alpha = 30(10°)$, n_α 1.720(2), n_β 1.736(2), n_υ 1.738(2); son sur (010) extinction, presque parallèle à X, fait un angle de 5 à 10° avec l'allongement (*c*). Une analyse à la microsonde donne: CaO 18.4, ZrO_2 40.3, SiO_2 40.8 pour en total de 99.5. La formule empirique calculée pour 7 atomes d'oxygène est $Ca_{0.98}Zr_{0.98}Si_{2.03}O_7$ ou idéalement, on a, $CaZrSi_2O_7$. La gittinsite est monoclinique, *a* 6.878(4), *b* 8.674(4), *c* 4.697(2)Å, β 101.74(4)°, *Z*=2, groupe spatial *C*2/m par analogie avec la thorveitite (*PDF* 19–1125). Le poids spécifique calculé pour la formule $CaZrSi_2O_7$ est 3.624 g/cm^3 (révisé par la C.G.C.).

Grice, J.D., Gault R.A., and **Ansell H.G.**

EDINGTONITE AND NATROLITE FROM ICE RIVER, BRITISH COLUMBIA; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 57, 1980.

Edingtonite and natrolite crystals have been found in the Ice River alkaline complex, British Columbia. They occur in pockets within nepheline syenite, often associated with each other and always with calcite. Very minor associated species include acmite, ancylite, galena, magnetite, phlogopite, pyrite and zircon. Edingtonite crystals are simple prisms with disphenoids and a basal pinacoid. Partial microprobe analyses yielded BaO=28.65, K_2O=0.32, SiO_2=36.27, Al_2O_3=20.64 with 14.12% H_2O by difference: cell dimensions are *a* 9.583(7), *b* 9.624(7), *c* 6.527(6) Å: it is optically biaxial negative with α 1.535(1), β 1.542(1), γ1.545(1), 2V=62°: D (obs.)=2.73. Natrolite crystals to 16 cm were found. Complex, terminated prisms with a total of 19 crystal forms were measured. Chemical analysis proved this natrolite to be almost a pure end-member.

Ascoli, P., Bujak, J.P., Doeven, P., Gradstein, F.M., and **Williams, G.L.**

MULTIPLE MICROFOSSIL ZONATIONS FOR THE MESOZOIC-CENOZOIC, OFFSHORE EASTERN CANADA; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 40, 1980.

The oldest marine Mesozoic sediments on the Scotian Shelf and Grand Banks are Pliensbachian, making them almost coeval with those in Portugal, England and East Greenland. In the Labrador Sea the first marine transgression is a "mid-Cretaceous event". The transgressions were enhanced by eustatic highstands. Eustatic lowstands of measurable (paleoecological) effect occurred in the Oligocene and Late Miocene time.

The marine sediments of the Scotian Shelf, Grand Banks and Labrador Shelf between 42° and 60°N contain a diverse record of Jurassic, Cretaceous and Tertiary microfossils. In general, dinoflagellates, spores and pollen, planktonic and benthonic foraminifers and coccoliths are common or abundant, whereas ostracods, diatoms, radiolarians, small molluscs, bryozoans, calpionellids, small ammonites, sponge spicules, solitary corals, crinoid stems and charophyte sponangia are relatively rare except in localized horizons. The planktonic foraminiferal stratigraphical record may be one of the most complete in the world, extending from the Middle Jurassic to Recent. Provincialism in the pelagic and sessile groups of organisms can be related to the temporal and spatial distribution of oceanic watermasses and basin compartmentation and type of sediment fill.

Biostratigraphical schemes based on dinoflagellates, spores, planktonic and benthonic foraminifers, nannofossils and ostracods allow a stratigraphical resolution which averages 5×10^6 y. It may be locally higher, especially if based on probabilistic sequences. The limiting factor is the quality and spacing of well samples. At the level of average resolution chronostratigraphical interpretations based on dinoflagellates and foraminifers are reasonably concordant; boundary problems due to insufficient calibration are noteworthy in Jurassic, Paleocene and Neogene strata.

Blasco, S.M., Lewis, C.F.M., and **Bornhold, B.D.**

SURFICIAL GEOLOGY AND GEOMORPHOLOGY OF THE LOMONOSOV RIDGE; EOS, v. 61, no. 17, p. 276, 1980.

High resolution reflection seismic and bathymetric profiling, sediment sampling and seabed photography were conducted from ice station LOREX in April and May of 1979, as the ice flow drifted over the Lomonosov Ridge close to the north geographic pole. A continuous 3KHz, bathymetric-subbottom profile reveals a ridge relief of 2,800 m, the crest rising to within 1,400 m of sea surface. Asymmetric in shape, the Amerasian flank has slopes as steep as 12°, but the Eurasian flank slopes do not exceed 7° along the drift path. The continuous shallow seismic reflection profiles indicate the ridge consists of en echelone fault blocks that give the crest an irregular morphology. Less than 75 m of stratified, unconsolidated sediment, primarily associated with the fault-block tops, appears to have been deposited on the ridge crest prior to faulting. Seabed photographs show these sediments to be undergoing erosion by current scour. The presence of neritic dinoflagellate **Luxidinium propalulum** in reworked seabed material taken from the top of a core recovered from the ridge crest indicates that these sediments may be mid-Cretaceous in age. This suggests that faulting (and separation from the Barents Continental Shelf?) was possibly initiated no earlier than mid-Cretaceous. More than 1,100 m of stratified, unconsolidated sediments infill the Makaron and Fram basins directly adjacent to the ridge. These flat-lying sediments unconformably abut against the ridge flanks.

Bornhold, B. et al.

TERTIARY AND CRETACEOUS PALEOENVIRONMENTS IN THE SOUTHWEST ATLANTIC OCEAN: PRELIMINARY RESULTS OF DEEP SEA DRILLING PROJECT LEG 71; Geological Society of America Bulletin, Part I, v. 91, p. 655-664, 1980.

Boyle, D.R. and **Ballantyne, S.B.**

GEOCHEMICAL STUDIES OF URANIUM DISPERSION IN SOUTH-CENTRAL BRITISH COLUMBIA; Canadian Mining and Metallurgy Bulletin, v. 73, August 1980, p. 89-108, 1980.

Detailed studies have been conducted on the dispersion of uranium in stream waters and sediments around various types of mineralization and hitherto unexplained anomalous areas in the Okanagon Valley and Highland region of south-central British Columbia. These studies were part of the jointly funded and planned Federal-Provincial Uranium Reconnaissance Program of the Geological Survey of Canada and the British Columbia Ministry of Energy, Mines and Petroleum Resources. Statistical analysis of regional data indicates that U in stream waters and sediments varies considerably for different rock types, thus affecting data interpretation. In addition, the data demonstrate a poor correlation between U in stream waters and their associated sediments which can be largely accounted for by variations in climate and water and sediment composition. Regional trends in the distribution of U can be explained in terms of the above secondary factors as well as primary metallization phenomena.

Significant correlations between U and F, and U and Mo can be explained by certain magmatic and mineral-forming processes. U shows little correlation with other base metals.

The dispersion characteristics of U in the vicinity of Miocene "basal type" mineralization, uraniferous pegmatite terranes, anomalous lineaments in granitic terranes and high-background volcano-sedimentary areas are discussed. Highly anomalous U concentrations in waters and sediments may not always be indicative of mineralization, and guidelines for interpretation require a sound knowledge of the geological and secondary processes operative in the area.

Bouvier, J.-L. and **Abbey, Sydney**

SIMULTANEOUS DETERMINATION OF WATER, CARBON DIOXIDE AND SULFUR IN ROCKS BY VOLATILIZATION AND NON-DISPERSIVE INFRARED ABSORPTIOMETRY; Canadian Journal of Spectroscopy, v. 25, p. 126-132, 1980.

A method is described for the simultaneous determination of water, carbon dioxide and sulfur in silicate rocks. The sample, mixed with oxides of vanadium and tungsten, is heated at 950°C under a current of nitrogen. The evolved gases are led through three fixed-wavelength infrared-absorption instruments. The three absorption signals are integrated simultaneously. The method is more rapid than most similar methods that determine only two constituents.

On présente une description d'une méthode pour le dosage simultané de l'eau, du bioxyde de carbone et du soufre dans les roches silicatées. L'échantillon, mélangé avec les oxydes de vanadium et de tungstène, est chauffé à 950°C, sous un courant d'azote. Les gaz dégagés sont amenés au travers de trois instruments d'absorption infrarouge à longueur d'onde fixe. Les trois signaux d'absorption sont intégrés simultanément. La méthode est plus rapide que la plupart des méthodes semblables ne déterminant que deux composants.

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

A MICROPROCESSOR-BASED SOFTWARE-CONTROLLED PORTABLE BOREHOLE-LOGGING SYSTEM; EOS, v. 61, no. 17, p. 415, 1980.

A sophistacated microprocessor-based borehole logging system has been developed by McPhar Geophysics to detailed specifications which had been published earlier by the authors. The equipment, which includes an electrically operated winch with demountable cable reel, an electronics console and a digital tape cartridge recorder, breaks down into packages of less than 35 kg each. The electronics console incorporates a miniature two-pen strip chart recorder, two alphanumeric displays and a miniature keyboard. Industry standard RS232C communications interfaces allow connection of a regular keyboard/printer to the console and connection of a standard modem to the tape recorder for data transfers at up to 9600 baud. Separate operating software systems stored on tape cartridges control on-line data acquisition and recording and off-line data replay and processing.

The initial application is the estimation of uranium grade-thickness products from natural gamma radiation measurements. The battery operated probe contains a caesium iodide detector doped with ^{241}Am to provide a stabilising signal, and a charge-sensitive preamplifier. This transmits high quality signals via a 1000 m shielded twisted pair cable to the electronics console where an A/D converter stores 512 channel spectra. The on-line software decodes spectral windows, applies spectral stripping, corrects for borehole parameters, applies a digital deconvolution filter to the total radiation count profile, and records raw and processed data continuously on tape. Complete spectra can also be recorded. Replay software allows field data to be re-processed with different constants until optimum values have been determined.

Bujak, J.P., Donohoe, H.V., and Grantham, R.

THE GEOLOGICAL HIGHWAY MAP OF NOVA SCOTIA; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 43, 1980.

The Geological Highway Map of Nova Scotia was published in 1980 by the Atlantic Geoscience Society. The front of the map shows the Province drawn at a scale of one inch to ten miles (the same scale as the Nova Scotia Tourism Map) with paved roads, towns, rivers and coastal names superimposed on a geological map of the Province. Roads with extensive bedrock exposures are bordered by red lines and ninety-two numbered localities along roads and adjacent beaches are keyed to short descriptions below the map. Other features on the front side of the map are a Table of Formations, four cross-sections, a legend and a description of how to use the map.

The reverse of the map has three types of information. First, for the non-geologist there is a geological time scale, glossary of geological terms and a suggested reading list. Second, the geological history of Nova Scotia is outlined and includes several maps of the Province intended to illustrate the history, such as one on the Pleistocene glaciations. Third, eight localities or areas in the Province are discussed in detail with included location maps, cross-sections and diagrams. These are intended to act as a guide to an afternoon's or a day's visit to an area, and are also cross-referenced with the map's geological history of Nova Scotia. They include descriptions of the main Precambrian to Triassic rocks of Nova Scotia.

The Geological Highway Map has several uses which include the following. It should prove to be an excellent teaching aid in universities and high schools. Since specific localities are described the map is also useful for planning and running field trips. Above all, however, the map should help people understand the geology of Nova Scotia as they drive the roads or visit adjacent beaches.

Bujak, J.P., and **Williams, G.L.**

DINOFLAGELLATES, THE GRASS OF THE SEA; GEOS, 4 p, Fall 1980.

An article prepared for the general public on the biological and geological uses of modern and fossil dinoflagellates. Aspects discussed include their importance as primary producers and in the modern food chain, their use in biostratigraphy, their significance as precursers of oil and gas and their value in understanding the evolution of early life since they may represent an intermediate stage between the prokaryotes and eukaryotes.

Berggren, W.A., Aubrey, M.-P., **Bujak, J.P.,** Naeser, C.W., and Van Couvering, J.A.

THE TERMINAL EOCENE EVENT AND THE POLISH CONNECTION; 26th International Geological Congress, Paris, 1980.

The Eocene/Oligocene boundary in Europe is marked by major discontinuities in all environments: the "Grande Coupure" in continental mammals; the elimination of semi-tropical elements from high-latitude floras; the virtually complete replacement of the shallow-marine malacoiauna; and an extraordinary downslope excursion of carbonate deposition in deep-ocean basins (drop in the DDC). These phenomena collectively represent the "Terminal Eocene Event" (TEE). In the Carpathian Mountains, the TEE is manifested in the thin but regionally persistent **Globigerina** Marl, a calcareous unit containing abundant cool-water microplankton that occurs within very thick, siliceous, bathyal flysch sequences. In southern Poland, the marl is of very latest Eocene age, within planktonic foraminiferal zone P. 17, calcareous nanoplankton zone NP19/20, and the zone of the dinoflagellate **Homotryblium pallidum.** Zircons from bentonites bracketing and marl are dated by fission-track analysis; at Polany, 2 underlying bentonites are 41.7 and 39.8 Ma, and a Znamirowice 2 overlying bentonites are 34.6 and 28.9 Ma, in sequence. This accords with glauconite K/Ar ages in western Europe by which the Eo/Oligocene boundary age is estimated at 38 Ma. Global correlations indicate that the TEE corresponds to a major glacio-eustatic regression with a duration of about 0.5 Ma, in which a large Antarctic ice cap was formed, the ocean circulation was permanently changed to the psychrospheric condition, and world climate shifted irreversibly toward the modern state.

Bujak, J.P., Downie, C., Eaton, G.L., and **Williams, G.L.**

DINOFLAGELLATE CYSTS FROM THE EOCENE OF SOUTHERN ENGLAND; Special Papers in Palaeontology, Number 240, p. 1-100, 1980.

Dinoflagellate cysts are abundant and diverse in the Eocene of southern England, with many species having restricted stratigraphic ranges. Thirteen dinoflagellate cyst assemblage zones are formally proposed, three in the London Clay, five in the Bracklesham Beds, and five in the Barton Beds. Five genera and twenty species of dinoflagellate cysts are erected, generic transfers are made for sixteen species, and the diagnoses of six genera and four species are emended. One genus and two species of acritarchs are also erected. The new genera are **Cerebrocysta, Dapsilidinium, Hemisphaeridium, Lentinia, Paucisphaeridium,** and **Quadrina.**

Bujak, J.P. and **Williams, G.L.**

THE EVOLUTION OF DINOFLAGELLATES; American Association of Stratigraphic Palynologists, Thirteenth Annual Meeting, Abstracts, 1980.

Two techniques can be used to reconstruct the paths of dinoflagellate evolution. First, the physiology, biochemistry and morphology of living dinoflagellates can be examined. This approach is particularly valuable in understanding the early development of dinoflagellates including their relationship to procaryotic and eucaryotic organisms, and the acquisition of photosynthetic chromatophones. It may also indicate evolutionary pathways along which the armoured dinoflagellates developed, but here it is often difficult to distinguish morphologically primitive and advanced forms when only the present-day biosphere is considered.

The second approach concerns the fossil record. A major problem here is the incompleteness and bias of this record since most recognizable fossil dinoflagellates are cysts. Also, almost all fossil dinoflagellates appear to belong to the Order Peridiniales, only one of several orders that are widespread today. Although probable fossil representatives of the Orders Dinophysiales and Gymnodiniales are known, they are each restricted to a single genus confined to the Jurassic and Cretaceous respectively, providing a tantilizing glimpse of otherwise unrecorded evolutionary lineages. A second problem is that of recognizing fossil dinoflagellates. Some palynomorphs of uncertain affinity (acritarchs) may be fossil dinoflagellates, since it is now known that certain living dinoflagellate taxa produce cysts with similar morphology to certain acritarch genera. Nevertheless, the fossil dinoflagellate record does indicate that post Late Triassic Peridialean dinoflagellate evolution involved a reduction in the number of thecal paltes, with standardization leading to the main tabulation pattern seen in extant dinoflagellates.

Cameron, E.M. and Garrels, R.M.

GEOCHEMICAL COMPOSITIONS OF SOME PRECAMBRIAN SHALES FROM THE CANADIAN SHIELD; Chemical Geology, v. 28, p. 181-197, 1980.

Forty-three elements or constituents have been analysed on eight composites representing 406 samples of Archean (>2.5 Ga) shale and nine composites of 396 samples of Aphebian (1.6 – 2.5 Ga) shale. These samples were obtained from 54 localities in, or flanking, the Superior Province of the Canadian Sheild.

The composition of the Archean samples reflects their origin as products of the rapid deposition of detritus from terrane what was dominantly volcanic and mafic in composition. By contrast, the Aphebian samples are highly mature and were derived from more "granitic" sources.

The C/S ratio for Aphebian shales is close to 0.36, similar to that of modern sediments, which is consistent with the fixing of S by sulphide-reducing bacteria. Only three of the Archean composites contain significant amounts of C and S and for these samples the elements are closely correlated in the ratio 1 : 1. $\delta^{34}S$ values for the Archean composites are close to zero, suggesting a volcanic source. It appears that within Archean greenstone belts the environments most favourable to organic growth and preservation were close to sulphur springs, where sulphur-oxidizing bacteria fixed CO_2. These C- and S-rich Archean samples are also enriched in Cu, Zn, As, Ag, Sn, Sb, Hg and Pb, further suggestive of deposition near volcanic springs.

The Aphebian samples have a whole-rock average $\delta^{34}S$ of +12‰, quite different from the negative values characteristic of the Phanerozoic and Recent sediments. There is a remarkable peak of Hg in shales of this age. Sedimentary differentiation taking place during Aphebian time has produced both Fe-poor and Fe-rich sediments, including Superior-type iron formation.

Campbell, F.H.A. and **Cecile, M.P.**

EVOLUTION OF THE EARLY PROTEROZOIC KILOHIGOK BASIN, N.W.T.; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 44, 1980.

The Kilohigok Basin developed as an intracratonic depression coeval with the Wopmay Orogen and Athapuscow aulacogen in the early Proterozoic. Following initial shallow marine sedimentation, rapid uplift in source areas to the east and south supplied coarse sands and gravels to braided rivers which spread them across the basin. An overthickened succession in the Axial Zone relative to the flanking platformal areas was deposited by continuous, through intermittent subsidence of the zone and consequent avulsion of the braided rivers from the platforms. Waning uplift in the source areas, coupled with basin-wide stabilization, culminated in regional emergence and soil formation, except in the southern Axial Zone. Extra-basinal tectonic uplift to the northwest, possibly related to continental collision, cannibalized earlier sediments and these were gradually spread back into the basin. Calcareous turbidites, derived from and bypassed through the stromatolite complex fringing the southward advancing uplift filled the now-stable Axial Zone and covered the western platform. As regression continued, the stromatolite complex prograded across its deep-water equivalents, and was in turn buried beneath intertidal silts and muds. With continued regression, progressively coarser sediment spread over the basin, terminating with coarse fluvial sands and gravels as deposition in the Kilohigok Basin ended.

Sims, P.K., **Card, K.D.,** Morey, G.B., and Peterman, Z.E.

THE GREAT LAKES TECTONIC ZONE – A MAJOR CRUSTAL STRUCTURE IN CENTRAL NORTH AMERICA; Geological Society of America Bulletin, Part I, v. 91, p. 690-698, 1980.

The Great Lakes tectonic zone is a major Precambrian crustal feature more than 1,200 km long extending eastward from Minnesota into Ontario, Canada. It is a zone of distinctive tectonism, affecting both Archean and early Proterozoic rocks, along the northern margin of the early Proterozoic Penokean fold belt adjacent to the Archean Superior province. The zone coincides with the boundary between two Archean crustal segments recognized in the region: a greenstone-granite terrane (~2,700 m.y. old) to the north (Superior province) and an older (in part 3,500 m.y. old) gneiss terrane to the south. Tectonism along the zone began in the late Archean, during the joining together of the two terranes into a single continental mass, and culminated in the early Proterozoic, when steep or northward-facing overturned folds were formed in the supracrustal rocks, and intense cataclasis and a penetrative cleavage developed in subjacent basement rocks of the greenstone-granite terrane. The Proterozoic deformation took place under low to intermediate pressures.

Movement occurred along the Great Lakes tectonic zone through much of the Precambrian time recorded in the region. in the early Proterozoic, crustal foundering, which was parallel to the zone and was diachronous, initiated the structural basins in which the early Proterozoic sequences of the Lake Superior and Lake Huron regions were deposited. Later, during the Penokean orogeny (~1,850 to 1,900 m.y. ago), compression deformed the sequences in both regions.

Still later, intermittent (~1,850 to 1,100 m.y. ago) crustal extension provided sites for emplacement of abundant mafic igneous rocks. There is no definite evidence that any of the extensional events progressed to the stage of development of oceanic crust; probably the zone has been wholly intracratonal since its inception in late Archean time.

During the Phanerozoic, minor differential movements occurred locally in the Great Lakes tectonic zone, as recorded by the thinning of Cretaceous strata and their subsequent tilting and by historic earthquakes in Minnesota.

Sims, P.K., **Card, K.D.,** and Lumbers, S.B.

EVOLUTION OF THE EARLY PROTEROZOIC BASINS OF THE GREAT LAKES REGION; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 81, 1980.

Proterozoic supracrustal sequences of the Southern Province in the Lake Superior and Lake Huron region, and that extend eastward into the Grenville Province, have similar asymmetrical patterns of stratigraphy and structure. The sequences thicken southward; their thicker parts are deformed, metamorphosed, and intruded by granite plutons. The Proterozoic basins are aligned along an older zone of weakness, the boundary between late Archean greenstone-granite complexes (2700 Ma) of the Superior Province and an early Archean gneiss (3500-3000 Ma) terrane on the south. The two basement segments have differed vastly in tectonic stability, and as a result their boundary behaved as a hinge zone during deposition of the supracrustal rocks and as a tectonic front during subsequent orogenesis. Initial rift-faulting along the basement boundary provided sites for deposition of detritus shed from the inner part of the craton. Pronounced subsidence of the mobile Archean gneiss crust led to deposition of thick turbidite sheets and volcanic rocks in the south. Deposition was terminated by a second, compressional stage during which the supracrustal rocks and their gneiss basement were deformed and metamorphosed together as a result of diapiric doming and lateral transport of the crustal segment against the more rigid greenstone crust. The Southern Province basins evolved in an intracratonic setting, probably far from a continental margin but possibly crossing eastward to such a margin in the Grenville Province.

Chandler, F.W.

GEOLOGY OF THE LATE PRECAMBRIAN SUPRACRUSTAL ROCKS, FURY AND HECLA STRAIT AREA, BAFFIN ISLAND, N.W.T.; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 45, 1980.

For about 150 km along the north shore of the Fury and Hecla Strait, and extending 50 km inland lies a belt of mainly clastic sedimentary rocks. This unmetamorphosed Helikian and/or Hadrynian sequence, about 6000 m thick is divided into five conformable units, described in ascending stratigraphic order. The sequence nonconformably overlies granitic rocks in which radiometric anomalies have been found adjacent to the contact.

The lower redbed formation, 700 m thick, consists in the east of nasal red grit, sandstone and mudcracked siltstone overlain by white quartzite. Separation of these two units becomes difficult westward. At the top of the red grit occurs up to 15 m of southeast-derived, westward-thinning quartz pebble-boulder conglomerate. An associated thin dolomitic sandstone contains rare stromatolites. The upper redbed formation, about 500 m thick, consists of an upward-coarsening discontinuous stromatolitic dolomite unit up to 5 m thick, overlain by 60 m of black shale. The resistant pink quartzite formation up to 2800 m thick, is cross-bedded and rippled. It thins westward and paleocurrents flowed to the southwest. The transition formation, about 1500 m thick is composed of varicoloured shale, siltstone and sandstone. Sedimentary transport was to the southwest. The Autridge Formation is composed of at least 500 m of black shale.

Three mafic sills occur in the sequence, two in the lower redbed formation and one capping the Autridge Formation. Northwest-striking mafic dykes cut the strata.

The sedimentary rocks are unmetamorphosed and dip gently south. East-striking faults, upthrown to the south repeat the basal nonconformity. Paleocurrents and lithologies are similar to those of the Nauyat, Adams Sound and Arctic Bay Formations that lie about 350 km to the north.

Christie, R.L.

GEOLOGICAL CONCEPTS IN THE CANADIAN ARCTIC ISLANDS; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 46, 1980.

The Canadian Arctic Islands were first explored at a time when the Neptunist theory was in vogue. The conceptual frameworks evident in accounts of Arctic geology have changed with advances in the science of geology, and Franklinian Geosyncline, Sverdrup Basin, and other terms that have appeared in the literature mark refinements in the understanding of the geology of the Islands.

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

CAMBRIAN – ORDOVICIAN SEDIMENTS AND THEIR BEARING ON DISPLACEMENT ALONG NARES STRAIT; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 75, 1980.

Cambrian and Ordovician sedimentary rocks of the Arctic Platform and Franklinian Geosyncline lie to the northwest of the exposed Precambrian Shield of Ellesmere Island and Greenland. Rock units thicken and the proportion of clastic material increases to the northwest toward the former basin axes. Facies belts and isopachs trend northeast, and together with the closely comparable stratigraphy on both sides of the Nares Strait suggest that net displacement along the strait since Cambro-Ordovician time is probably small.

Chung, C.F. and **Agterberg, F.P.**

REGRESSION MODELS FOR ESTIMATING MINERAL RESOURCES FROM GEOLOGICAL MAP DATA; Mathematical Geology, v. 12, no. 5, 1980.

Several regression models can be used for explaining discovered occurrences and estimating undiscovered occurrences of mineral deposits of a given type from geological data quantified for equal-area cells. All the models are based on the assumption that the occurrences of mineral deposits in an area are estimable as a function of the mapable geological attributes in the area. Depending upon further assumptions made with respect to the dependent variable, that is, the occurrence of mineral deposits, different regression techniques such as logistic and Poisson regression analysis can be employed. In this paper, a jackknife method was used to estimate the variances of the regression coefficient and the occurrences. The effect of undiscovered deposits on the regression models was considered by treating the known deposits separately (Separate Event Method).

As an illustrative example, the occurrence of volcanogenic massive sulfide deposits has been expressed in terms of the geological framework in parts of the island of Newfoundland. Each of the models provides a similar and relatively stable pattern that explains the occurrence of the known deposits in a study area of 6000 km^2. The methods presented for calculating the variances of the estimated values are meaningful because they can be used to test whether or not an estimated probability or frequency value for any one cell is significantly greater than zero. The logistic model is used to indicate cells outside the study area where undiscovered deposits are likely to occur.

Clague, J.J., Armstrong, J.E., and Mathews, W.H.

ADVANCE OF THE LATE WISCONSIN CORDILLERAN ICE SHEET IN SOUTHERN BRITISH COLUMBIA SINCE 22,000 Yr B.P.; Quaternary Research, v. 13, p. 322-326, 1980.

Radiocarbon dates from critical stratigraphic localities in southern British Columbia indicate that the growth history of the late Wisconsin Cordilleran Ice Sheet was different from that of most of the Laurentide Ice Sheet to the east. Much of southern British Columbia remained free of ice until after about 19,000 to 20,000 yr ago; only adjacent to the Coast Mountains is there a record of lowland glacier tongues in the interval 22,000 to 20,000 yr B.P. A major advance to the climax of late Wisconsin Cordilleran glacier ice in the northern States was not begun until after about 18,000 yr B.P. in the southwest of British Columbia and after about 17,500 yr B.P. in the southeast. The rate of glacier growth must have been very rapid in the two to three millennia prior to the climax, which has been dated in western Washington at shortly after 15,000 yr B.P.

Coker, W.B. and **Franklin, J.M.**

REGIONAL GEOCHEMISTRY AND METALLOGENY, NORTH SHORE OF LAKE SUPERIOR, ONTARIO; Proceedings and Abstracts; 26th Annual Institute on Lake Superior Geology, Univ. of Wisconsin – Eau Claire, Eau Claire, Wisconsin, U.S.A. (May 6-10, 1980).

The Proterozoic and Archean terraces of the northern Lake Superior area include an exceptional variety of lithologies, with an accompanying array of mineral deposit types. Regional lake sediment and water surveys were undertaken to obtain information on the distribution and concentration of selected elements in lakes immediately north of Lake Superior.

Trace element patterns in lake sediment and water closely reflect the chemical characteristics of the major lithologic domains, although glacial overburden and varying limnologic conditions clearly modify the elemental distributions. The trace element patterns in the lake sediments and waters may be divided into three groups.

Conaway, John G.

PROBLEMS ASSOCIATED WITH GAMMA RAY LOGGING FOR THE EVALUATION OF HIGH GRADE URANIUM DEPOSITS; EOS, v. 61, no. 17, p. 415, 1980.

Use of gamma-ray logging as a quantitative evaluation technique in high grade uranium deposits involves some problems which are relatively unimportant at lower grades. These may be divided into problems associated with the intense gamma radiation flux, and problems resulting from the high concentration of heavy uranium atoms (the "Z-effect", where Z is the symbol for atomic number).

Conventional gamma-ray logging equipment is simply not capable of handling the tremendously high count rates involved. Attempts have been made to rectify this situation by using a very small detector, or by using pulse dividing circuitry in the probe to reduce the number of pulses transmitted up the logging cable. Theory indicates, however, that even if each gamma ray is accurately counted, an error in the grade-thickness product computed from the gamma-ray log will result from self-attenuation of the gamma rays by the heavy uranium atoms, and from the different physical properties of the barren zone and ore zone. This error is non-linear with ore grade and with thickness of the ore zone, and thus is not amenable to application of correction factors. The error may be reduced to a tolerable minimum by designing the logging equipment such that it discriminates against gamma rays having energies less than about 1 MeV.

Conaway, P.G. and **Killeen, P.G.**

GAMMA-RAY SPECTRAL LOGGING FOR URANIUM; Canadian Mining and Metallurgical Bulletin; v. 73, p. 115-123, 1980.

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

VARIABLE FORMATION PARAMETERS AND NONLINEAR ERRORS IN QUANTITATIVE BOREHOLE GAMMA-RAY LOG INTERPRETATION; Fiftieth Annual International Meeting and Exposition Society of Exploration Geophysicists, Houston, p. 121-122, 1980.

All standard techniques for quantitative interpretation of borehole gamma-ray logs assume a linear relationship between radioelement grade-thickness product and the area beneath the anomaly on the gamma-ray log. We present results of theoretical and experimental studies which show that significant changes in any formation parameter which affects gamma-ray attenuation can cause this linear relationship to break down, degrading the accuracy of the gamma-ray log interpretation. The extent of such errors depends upon radioelement distribution, instrumental characteristics, and gamma-ray energy distribution, as well as the formation parameter which is causing the problem. We show that under some conditions, variations in rock density and pore fluid can cause serious errors. In addition, relatively well-known inaccuracies associated with self-absorption problems (the Z-effect) in high grade uranium ore deposits are shown to depend on ore distribution as well as grade. These errors are significant not only in uranium exploration and evaluation, but also in other quantitative applications such as coal and potash exploration and evaluation. Use of properly designed instrumentation will reduce or eliminate inaccuracies associated with the Z-effect. Errors due to density and pore fluid are more insidious, but in many cases these may be at least partially remedied by computer processing.

Cranston, R.E.

Cr SPECIES IN SAANICH AND JERVIS INLETS; in Fjord Oceanography, eds., H.J. Freeland, D.M. Farmer, and C.D. Levings, Plenum Publishing Corp., New York, p. 689-692, 1980.

Cranston, R.E. and Murray, J.W.

CHROMIUM SPECIES IN THE COLUMBIA RIVER AND ESTUARY; Limnology and Oceanography, v. 25, no. 6, p. 1104-1112, 1980.

Columbia River and estuary samples were analyzed to determine dissolved Cr species and particulate Cr concentrations. Flocculation and spike experiments were

done to elucidate the processes controlling the distribution of Cr. River water contained an average of 3.2 nM dissolved Cr (98% as CrO_4^{2-}) and 1.8 nM particulate Cr; estuary samples contained an average of 2.4 nM dissolved Cr and 2.8 nM particulate Cr. Dilution plots suggest that Cr_4^{2-} is conservative in the estuary, while flocculation processes increase the Cr (particulate) and Cr (III) concentrations. Up to 28% of the dissolved Cr in river water could be removed by adsorption onto or flocculation with freshly formed particles. Over 70% of added Cr (III) was removed by adsorption onto particles and container walls within 1 h; CrO_4^{2-} spikes behaved conservatively.

Currie, K.L.

A MODIFIED NORM CALCULATION; Canadian Journal of Earth Sciences, v. 17, p. 1342-1350, 1980.

The CIPW norm gives results which closely resemble the mode for basalt and many other quartz-saturated igneous rocks, but which depart widely from the mode for alkaline and peralkaline assemblages. A modified norm, deleting halite, thenardite, sodium metasilicate, potassium metasilicate, sodium carbonate, and larnite, and substituting sodalite, enigmatite, eudialyte, riebeckite, andradite, and Ca-tschermaks molecule ($CaAl_2SiO_6$), gives a good representation of most alkaline and peralkaline igneous rocks while giving results identical to the CIPW system for common rocks. Estimates of silica saturation, differentiation indices, and disposition of alkalies are substantially improved.

La norme CIPW donne des résultats qui ressemblent de près au mode du basalte et de plusieurs autres roches ignées saturées en quartz, mais qui dévient beaucoup du mode dans le cas des assemblages alcalins et peralcalins. Une norme modifée, qui enlève la halite, la thénardite, le métasilicate de solium, le métasilicate de potassium, le carbonate de sodium et la larnite pour substituer la sodalite, l'énigmatite, l'eudialyte, la riebeckite, l'andradite et la molécule Ca-tschermaks ($CaAl_2SiO_6$), donne une bonne représentation pour la plupart des roches ignées alcalines et peralcalines tout en donnant des résultats identiques au système CIPW pour les roches communes. On améliore ainsi de façon substantielle les estimés de saturation en silice, les indices de différenciation et la disposition des alcalis.

Pickerill, R.K., Pajari, G.E. Jr., and **Currie, K.L.**

SEDIMENTATION AND ITS RELATIONSHIP TO TECTONICS ON THE SOUTHEASTERN MARGIN OF THE IAPETUS OCEAN, NORTHEASTERN NEWFOUNDLAND; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 76, 1980.

The Carmanville area, northeastern Newfoundland, records in unusual detail the complexities associated with the sedimentation and tectonostratigraphic evolution of the southeastern margin of the lower Palaeozoic Iapetus Ocean.

Pre-Llandeilian sediments, now represented by the Gander Group, were derived from an easterly continental source and probably formed in a continental slope environment. In Llanvirn-Llandeilo time, dismembered slabs of ultramafics and incumbent resedimented volcaniclastics, mafic pillow lavas and associated hyaloclastites, remnants of which now represent the Gander River ultramafic belt, were obducted onto the continental slope sediments of the Gander Group. The obduction event(s) interrupted normal sedimentation processes and resulted in complex and localized facies distributions; in particular resulting in southwestward thinning lenses of conglomerates rich in ultramafic and mafic debris. Where the allochthonous slabs are absent; sedimentation was uninterrupted.

Sedimentation continued and hundreds of metres of essentially turbiditic clastics (Davidsville Group) accumulated in a prograding submarine fan complex. Petrographic data suggest that the detritus was derived from both the continental terrane and from the obducted slabs of the Gander River ultramafic belt. The succession also includes thin glaciomarine diamictites of Caradocian age. Renewed tectonism in post-Caradoc time involved the sedimentary pile in one or more submarine gravity slides resulting in the Carmanville ophiolitic melange.

Currie, K.L. and **Bostock, H.H.**

THE AGE OF THE ROBERTS ARM GROUP, NORTH-CENTRAL NEWFOUNDLAND: REPLY; Canadian Journal of Earth Sciences, v. 17, p. 804-806, 1980.

Currie, K.L., Pickerill, R.K., and Pajari, G.E. Jr.

EARLY PALEOZOIC PLATE-TECTONIC MODEL OF NEWFOUNDLAND; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 47, 1980.

We assume initial eastward subduction off the coast of the Grenvillian continent, terminated by collision of continent and subduction zone, with westward obduction of oceanic allochthons in Arenig time. This regime was succeeded by oblique westward subduction beneath the "proto Newfoundland", and continued eastward subduction to the south. A projection of the Avalonian continent collided with the subduction zone in Llanvirn time, leading first to eastward obduction, and subsequently to rotation of continental material, eventually producing continent-continent contact and cessation of plate inter action, probably in Caradoc time. Subsequent deformation, plutonism and metamorphism resulted from thermal and isostatic adjustments in collapsed continental rise prisms over-ridden by obduction. In addition to explaining many of the geological features of Newfoundland the model predicts (1) a clock-wise rotation of 30 degrees of southeastern Newfoundland relative to northwestern Newfoundland in mid-Ordovician time, and (2) about 50 km of left-lateral displacement on the Lobster Cove Fault.

Davies, E.H. and Norris, Geoffrey

LATITUDINAL VARIATIONS IN ENCYSTMENT MODES AND SPECIES DIVERSITY IN JURASSIC DINOFLAGELLATES; in The Continental Crust and Its Mineral Deposits, ed., D.W. Strangway, Geological Association of Canada Special Paper 20.

Lower, Middle, and Upper Jurassic dinoflagellate cyst assemblages from Arctic Canada are described in terms of diversity and encystment modes and compared with those from offshore eastern Canada and from southern and northern hemisphere localities. Maximum diversities in the Sverdrup Basin occur in the Callovian-Oxfordian and correspond with a marine transgressive peak. Deltaic progradation in the late Jurassic in the Sverdrup Basin ultimately reduced dinoflagellate diversity compared with other regions. In general, boreal Jurassic dinoflagellate assemblages are of relatively low diversity at the species level and are dominated by proximate cysts.

Prior to the Middle Jurassic, however, maximum species diversity appears to occur in the high latitude assemblages, whereas in the Middle and Upper Jurassic assemblages maximum diversities occur in the mid-latitudes where chorate cysts also start to become a more diverse component of the flora. A simple gradational relationship between paleolatitude and dinoflagellate encystment modes and diversity is not substantiated for the Jurassic; facies relationships and other factors are also important controls on assemblage characteristics.

On décrit des assemblages de kystes de dinoflagelles datant du Jurassique inférieur, moyen et supérieur dans l'Arctique canadien en termes de la diversité et des modes d'enkystement en les comparant avec ceux des localités au large de l'est du Canada et des hémisphères nord et sud. Le maximum de diversité dans le bassin de Sverdrup se situe au Callorien-Oxfordien et correspond a un pic dans la trangression marine. La progradation deltaïque à la fin du Jurassique dans le bassin de Sverdrup y a finalement réduit la diversité des dinoflagellés par rapport à d'autres régions. En général, les assemblages de dinoflagellés boréaux du Jurassique sont de diversité relativement faible au niveau de l'espèce et sont dominés par les kystes proximaux.

Toutefois, avant le Jurassique moyen, le maximum de diversité des espèces semble se produite dans les assemblages de latitude élevée, alors qu'au jurassique moyen et supérieur, le maximum de diversité dans les assemblages se retrouve à des latitudes moyennes où les kystes choroïdes semblent aussi devenir une composante plus diverse de la flore. Une relation simple de gradation entre la paléolatitude et l'enkystement et la diversité des dinoflagellés ne semble pas exister pour le Jurassique; les relations de faciès et d'autres facteurs sont aussi des moyens de contrôle importants pour les caractéristiques des assemblages.

Davis, J.I.

ELECTRICAL PROPERTY MEASUREMENTS OF SEA ICE IN SITU USING A WIDEBAND BOREHOLE RADAR AND A TIME-DOMAIN REFLECTOMETER; C-CORE Publication no. 80-5, p. 155-187, 1980.

Two wideband techniques were used to measure the electrical properties of fast sea ice in situ at 1 to 1000 MHz. A monopulse borehole radar was used with the dipole antennas placed vertically in the ice (vertical electrical field). Time-domain reflectometer (TDR) measurements were made using transmission lines placed vertically in the ice (horizontal electric field).

Measurements were made at two sites in the Beaufort Sea in March 1979 – a low-salinity brackish ice site and a first-year sea ice site at which horizontal crystal anisotropy was observed.

For the brackish ice an apparent dielectric constant of 2.6 was observed using TDR. For the sea ice a value of 3.3 was measured, with no dependence on orientation or depth in the ice. The apparent attenuation was also significantly greater. Using borehole radar, the apparent dielectric constant for brackish ice was approximately 3.5, and for the sea ice it was approximately 10 along the direction of minimum radar return. It is postulated that the differences between using the two techniques are due, at least in part, to the orientation of the electric field.

Topp, G.C., **Davis, J.L.,** and **Annan, A.P.**

ELECTROMAGNETIC DETERMINATION OF SOIL WATER CONTENT: MEASUREMENTS IN COAXIAL TRANSMISSION LINES; Water Resources Research, v. 16, no. 3, p. 574-582, 1980.

The dependence of the dielectric constant, at frequencies between 1MHz and 1GHz, on the volumetric water content is determined empirically in the laboratory. The effect of varying the texture, the bulk density, temperature and soluble salt content on this relationship was also determined. Time-domain reflectometry (TDR) was used to measure the dielectric constant of a wide range of granular speciments placed in a coaxial transmission line. The water or salt solution was cycled continuously to or from the specimen with minimal disturbance through porous disks placed along the sides of the coaxial tube.

Four mineral soils with a range of texture from sandy loam to clay were tested. An empirical relationship between the apparent dielectric constant, K_a and the volumetric water content, θ_v which is independent of soil type, soil density, soil temperature, and soluble salt content can be used to determine θ_v, from air dry to water saturated, with an error of estimate of 0.013. Precision of θ_v to within ± 0.01 from K_a can be obtained with a calibration for the particular granular material of interest. An organic soil, vermiculite and two sizes of glass beads were also tested successfully. The empirical relationship determined here agrees very well with other experimenters' results using a wide range of electrical techniques over the frequency range of 20MHz and 1GHz and widely varying soil types. The results of applying the TDR technique on parallel transmission lines in the field to measure θ_v versus depth are encouraging.

Divi, S.R.

MULTIVARIATE STATISTICAL ANALYSIS OF CHEMICAL COMPOSITIONS AND ASSOCIATED LITHOLOGIES OF VOLCANOGENIC STRATABOUND SULPHIDE DEPOSITS IN THE CANADIAN APPALACHIANS; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 48, 1980.

Volcanogenic stratabound sulphide deposits in the Canadian Appalachians vary in their bulk chemical compositions and associated lithologies. Based on associated lithologies, the deposits can be separated into three groups as follows: (1) those in dominantly volcanic rocks, (2) those in mixed volcanic-sedimentary rocks, and (3) those in dominantly sedimentary rocks. The deposits can also be separated, on the basis of composition of associated volcanic rocks, into three groups: (1) mafic volcanic rocks, (2) mixed mafic-felsic volcanic rocks, and (3) felsic volcanic rocks. Among these groups, there is a gradational change that can be quantified in terms of selected rock types. Multivariate statistical analysis has shown that base metal contents of deposits systematically change with corresponding changes in associated lithologies of deposits. In general, deposits associated with volcanic rocks have higher copper grades than deposits associated with sedimentary rocks; the reverse is true for lead and zinc. Furthermore, within the groups of deposits associated with volcanic rocks, copper grades in deposits associated with dominantly mafic rocks are higher than those in deposits associated with dominantly felsic rocks. Lead and zinc grades are highest in deposits associated with felsic volcanic rocks.

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

RELATIONSHIP BETWEEN LEVELS OF COPPER, URANIUM, AND LEAD IN GLACIAL SEDIMENTS AND IN **VACCINIUM ULIGINOSUM** AT AN ARCTIC SITE ENRICHED WITH HEAVY METALS; Canadian Journal of Botany, v. 58, p. 2017-2021, 1980.

Vaccinium uliginosum L. (bog blueberry), its mineral soil substrate, and the till on which the soil is developed were sampled at a site of uranium-copper-lead mineralization in the tundra of the central District of Keewatin. Levels of Cu and U in till result from dispersal of minerals glacially eroded from a metal-rich bedrock source. The pattern strongly expressed for Cu and U up to 1500 m from the source is not readily detectable for Pb.

Concentrations of ashed **Vaccinium uliginosum** growing on till ranged from 0.4 to 980 ppm U, 4.5 to 3973 ppm Cu, and 0.1 to 3964 ppm Pb, values greater than previously recorded for the species. The concentrations of U and Cu

were significantly correlated to metal levels in till with r=0.98 for uranium and r=0.78 for copper. Data did not permit statistical analysis of soil Pb versus plant Pb.

Vaccinium uliginosum L., le substrat minéral de son sol et le till sur lequel le sol s'est développé ont été échantillonnés dans un site de minéralisation uranium-cuivre-plomb situé dans la toundra au centre du district de Keewatin. Les niveaux de Cu et de U dans le till résultent de la dispersion des minéraux, érodés glacialement à partir d'une roche en place riche en métaux. Le patron, qui est très évident pour Cu et U jusqu'à 1500 m de la source, n'est pas facilement décelable dans le cas du Pb.

Les concentrations d'éléments dans les cendres de **Vaccinium uliginosum** croissant sur le till varient de 0,4 à 980 ppm de U, de 4,5 à 3973 ppm de Cu et de 0,1 à 3964 ppm de Pb; ces valeurs sont plus élevées que celles relevées antérieurement chez cette espèce. Les concentrations de U et de Cu montrent des corrélations significatives avec les niveaux des métaux dans le till (r=0.98 U et r=0,78 pour Cu). Les données ne permettent pas l'analyse statistique du Pb dans le sol en relation avec le Pb dans la plante.

Naldrett, A.J. and **Duke, J.M.**

PLATINUM METALS IN MAGMATIC SULFIDE ORES; Science, v. 208, p. 1417-1424, 1980.

Platinum-group elements (PGE) are mined predominantly from deposits that have formed by the segregation of molten iron-nickel-copper sulfides from silicate magmas. The absolute concentrations of PGE in sulfides from different deposits vary over a range of five orders of magnitude, whereas those of other chalcophile elements vary by factors of only 2 to 100. However, the relative proportions of the different PGE in a given deposit are systematically related to the nature of the parent magma. The absolute and relative concentrations of PGE in magmatic sulfides are explained in terms of the degree of partial melting of mantle peridotite required to produce the parent magma and the processes of batch equilibration and fractional segregation of sulfides. The Republic of South Africa and the U.S.S.R. together possess more than 97 percent of the world PGE reserves, but significant undeveloped resources occur in North America. The Stillwater complex in Montana is perhaps the most important example.

Doeven, P.H. and **Gradstein, F.M.**

LATE CRETACEOUS NANNOFOSSIL STRATIGRAPHY AND ASPECTS OF CARBONATE SEDIMENTATION ON THE CANADIAN ATLANTIC MARGIN; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 49, 1980.

The abundance and diversity of nannofossils in the Upper Cretaceous sediments of the Canadian Atlantic margin makes them ideal for biostratigraphic purposes. In the twelve wells examined, eighteen nannofossil events could be recognized in the Albian-Maastrichtian interval, providing a degree of resolution which compares favourable to that in deep sea cores and land sections. There is good agreement between the nannofossil and foraminiferal chronostratigraphical interpretations in the wells. Two carbonate units occur, the Petrel limestone and the Wyandot Chalk. The Petrel limestone is widespread on the Grand Banks and northeastern Scotian Shelf and is predominantly of Turonian age. The Wyandot Chalk, of Late Santonian to Late Campanian-Early Maastrichtian age, is well developed on the Scotian Shelf and generally thinner or absent on the Grand Banks. Geohistory diagrams show accumulation/subsidence ratios of approximately 1-1,5 cm/1000 yr. for the chalk. The Wyandot Chalk has been interpreted as a shelf deposit, similar to the Maastrichtian chalk of N.W. Europe.

The nannofossil assemblages reflect the establishment of a climatic paleo-oceanographic gradient in the Maastrichtian.

Cretaceous-Tertiary boundary beds are often missing, but no simple mechanism is available to explain this hiatus. Randomly occurring hiatuses within the Upper Cretaceous are probably related to salt movements.

Duke, J.M.

NICKEL IN ROCKS AND ORES; in Nickel in the Environment, ed. by J.O. Nriagu, John Wiley & Sons, Inc., p. 27-50, 1980.

Nickel is very inhomogeneously distributed among the rocks of the earth's crust wherein its concentration ranges over at least six orders of magnitude. In this chapter, the distribution of nickel is explained in terms of its behavior during the important igneous, metamorphic and sedimentary rock forming processes. The key factors governing the formation of magmatic sulphide and laterite nickel ores are also described.

Duke, J.M.

PRODUCTION AND USES OF NICKEL; in Nickel in the Environment, ed. by J.O. Nriagu, John Wiley & Sons, Inc., p. 51-65, 1980.

Nickel is currently recovered from two main types of ores: magmatic sulphides and nickeliferous laterites. This chapter reviews the methods used in the production of nickel from each of these deposit types as well as the intermediate and end uses of the metal. Temporal and geographic trends in production and the adequacy of nickel resources to meet future demands are also discussed.

Duke, J.M.

PETROLOGY AND ECONOMIC GEOLOGY OF THE DUMONT SILL, N.W. QUEBEC; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 50, 1980.

The Dumont sill is a lenticular, differentiated, ultramafic to mafic body of komatiitic affinity, and is hosted by Fe-rich tholeiitic lavas within the Abitibi greenstone belt about 60 km N.E. of Rouyn, Quebec. The sill is at least 6600 m long and up to 550 m in true thickness; a representative section is given below. Olivine and chromite are found only in the Ultramafic Zone whereas plagioclase is restricted to the Mafic Zone. Clinopyroxene is the dominant intercumulus mineral in the Lower and Upper Peridotites, and clinopyroxene oikocrysts are zoned with Fe-, Al-, and Cr-rich cores and Ca-rich rims. Cumulus chromite grains are also zoned, the cores being richer in Cr and poorer in Fe than the rims. The Dunite is an extreme olivine adcumulate with only minor intercumulus chromite and clinopyroxene. Magmatic sulphide blebs are observed in many samples of the Dunite and Lower Peridotite. The principal sulphide horizon, occurring near the centre of the Dunite, is 1300 m long, 10 to 30 m thick, and contains an average of 1.5 modal % sulphide. The parent magma of the intrusion was a peridotitic komatiite containing at least 26 % MgO, whereas the least primitive rocks in the uppermost Gabbro crystallized from a liquid containing ~8 % MgO.

Dyck, A.V. and West, G.F.

QUANTITATIVE INTERPRETATION OF WIDEBAND DRILLHOLE EM SURVEYS FOR MINERAL EXPLORATION – A TEST CASE HISTORY; EOS, v. 61, no. 17, p. 415, 1980.

Quantitative interpretation of wideband drillhole electromagnetic surveys in mineral exploration is desirable in order to maximize information return from the survey and it is warranted by the expense of deep drilling. Encouraging results from a Geological Survey of Canada – industry cooperative development program have indicated that the search radius of a drillhole can be significantly extended in such a manner.

In a highly resistive environment, such as crystalline rocks of the Precambrian Shield, simple free-space models can explain certain EM characteristics of massive-sulphide conductors. This has been clearly demonstrated by using computer-based sphere and plate models. The use of these characteristics in the interpretation of survey results from a test-case orebody situated in major base metal mining camp is described, with emphasis on problems frequently encountered in such environments, such as cultural anomalies and EM interactions between conductive targets.

Dyck, A.V., Bloore, M., and Vallee, M.A.

USER MANUAL FOR PROGRAMS PLATE AND SPHERE; Department of Physics, Geophysics Laboratory, University of Toronto, Applied Geophysics Report no. 14, 1980.

A FORTRAN computer program is provided on the DEC VAX 11/780 system to compute the response of any common EM prospecting system to a conductor in the form of a rectangular thin plate or a sphere. Host rock and overburden conductivity are assumed to be negligible, so only simple eddy current induction occurs in the conductor. The program can be run either interactively or in batch mode. Results are provided as listings in data files to be printed or as graphics for output on the Versatec plotter.

Roy, J., Becker, A., **Dyck, A.V.,** and Telford, W.E.

PROTOTYPE E.M. LOGGING TOOL; EOS, v. 61, no. 17, p. 414, 1980.

A prototype electromagnetic logging tool has been built for the Geological Survey of Canada (G.S.C.) by the Mineral Exploration Research Institute (M.E.R.I.). One of the purposes of the tool was to provide information on the presence and localization of geological conductors nearby but not intersected by the borehole. Two constraints of a typical mining exploration borehole (in the Canadian Shield environment) are small hole diameters and limited accessibility. The use of a remote R.M. source e.g. the VLF Navy's transmitters was considered an interesting proposition, the system has been successfully tested in a limited number of mining exploration boreholes with nearby conductors. In these instances the parameters measured are the local field strength at a fixed station on a relative scale, together with the variations of two phase components of the axial field along the borehole.

In an area of low host rock conductivity the system has been operated to a depth greater than one kilometer without noticeable field attenuation. A selected portion of the field test records has been digitized and processed at McGill University. A description of how useful information could be extracted from the data will be presented using an elementary model.

Dyck, W.

URANIUM, RADON, HELIUM AND OTHER TRACE ELEMENTS AND GASES IN WELL WATERS OF PARTS OF THE ST. LAWRENCE LOWLANDS, (OTTAWA REGION) CANADA; Journal of Geochemical Exploration, v. 13, p. 27-39, 1980.

To test the usefulness of groundwater for U prospecting, 130 domestic wells were sampled from a 22,000 km^2 rectangular area extending south and west from Ottawa, Ontario. The waters were analyzed for twenty variables including ten gases and five trace elements.

The dissolved gases give information on subsurface chemical and geological environments. Carbon dioxide highs occur at the contact of granites and limestones; He highs are along major faults; CH_4 and H_2S reveal strongly reducing environments, and O_2 in wells indicates shallow wells or active water turnover. Rn reveals U mineralization and granitic rocks.

The South March U-Cu surface occurrence gives coincident U, Cu, Zn, Pb and Rn highs. A weak U-Rn-Cu high in the Richmond-North Gower area suggests more radioactive subcropping March formation there.

A strong regional He anomaly coincident with the outcropping Rockcliffe Formation and controlled by the Hazeldean Fault is believed to be due to deep-seated He, but its coincidence with a weak regional Cu anomaly, a Rn anomaly in the Bells Corners area, its linear northeast trend, the presence of Helikian U-rich source rocks to the southwest, and northeast-dipping Paleozoic sandstones provide both indications of, and the right environment for epigenetic type U-Cu occurrences.

Dyck, W. and **Boyle, R.W.**

RADIOACTIVE DISEQUILIBRIUM IN SURFICIAL MATERIALS FROM URANIFEROUS ENVIRONMENTS IN NORTHERN SASKATCHEWAN; Canadian Mining and Metallurgical Bulletin, v. 73, p. 77-83, 1980.

Scientists throughout the world have observed radioactive disequilibrium in the uranium decay series. Radiometric and fluorometric determinations of U in plants from the Goldfields district and in sediments and rocks from the Beaverlodge district exhibit marked radioactive disequilibrium. The eU/U ratio in plants rooted in mineralized ground shifts from greater than unity to less than unity for those rooted in background soils. A similar shift is observed in the transition from rocks to stream sediments and to lake sediments in the Beaverlodge district.

Results of a Rn-Ra-U survey of lake bottoms in the Key Lake district show that anomalous hydromorphic U from U mineralization is parallelled by anomalous Rn, even though there is much less Ra in the lake-bottom sediments than one would expect from the amount of U present.

Eckstrand, O.R.

SYSTEMATIC Ni:Cu VARIATIONS IN NICKEL SULPHIDE DEPOSITS; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 50, 1980.

Many nickel sulphide deposits in mafic and ultramafic magmatic host rocks have a systematically higher Ni:Cu ratio in the high grade portions, and a lower Ni:Cu ratio in the low grade portions. The Rankin Inlet deposit (N.W.T.) is the best

known example, and exhibits a classic magmatic succession of grade zones downward toward the base of a serpentinized ultramafic sill, as follows:

	Ni	Cu	Ni:Cu
sparse disseminated sulphides	0.4	0.20	2.0
disseminated sulphides	1.9	0.62	3.1
matrix sulphides	5.0	1.04	4.8
massive sulphides (mainly)	8.9	1.24	7.2

Geological evidence seems to indicate that the high grade portions (high Ni:Cu) represent the earliest immiscible liquid sulphide to separate from the silicate melt, whereas the low grade (disseminated) sulphides (low Ni:Cu) separated later. This change from high Ni:Cu to low Ni:Cu sulphide composition is consistent with theoretical modelling (Duke and Naldrett, 1978; Duke, 1979) of sulphides separating progressively out of mafic or ultramafic magma that is simultaneously crystallizing olivine. The observed Ni:Cu variations are therefore considered to result from magmatic differentiation, in this case separation and partial segregation of liquid sulphide in a crystallizing mafic or ultramafic magma.

Certain deposits do have relatively high-grade portions with low Ni:Cu ratio, but many of these are commonly in footwall rocks beneath the main magma hosted sulphide zone, and seem better explained as either late residual, copper-rich sulphide liquid, or the product of tectonic and/or metamorphic remobilization of sulphides.

Eisbacher, G.H.

A CORDILLERAN SUCCESSOR BASIN MOLASSE, WESTERN CANADA; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 51, 1980.

Late Mesozoic oblique compressional tectonics in the north-central Canadian Cordillera involving older ocean floor, island arcs, and sialic basement gave rise to emergence of sediment source areas adjacent to subsiding molasse basins. In the region of the Bowser Basin three distinct pulses of uplift are mirrored by three distinct cycles of molasse. (a) Mid-Jurassic to Lower Cretaceous suturing and transpression along the west side of the Omineca Belt triggered rapid westward progradation of high-gradient deltas and low-gradient paralic sequences of marine and non-marine origin. (b) Late Cretaceous transcurrent faulting and folding restricted sedimentation to fluvial – lacustrine basins. (c) Eocene uplift and volcanism in the Coast Belt touched off a terminal non-marine wedge of coarse reworked conglomerate and ash fall tuffs, whose volume cannot account for the uplifted terrane in Coast Mountains. Much of the erosional product from the Eocene Coast Mountains possibly disappeared into a newly opening Eocene rift basin between Vancouver Island and Queen Charlotte Islands.

Radiometric ages in the source regions and modal composition of molasse sandstones confirm the timing of deformation, uplift and erosion, which in turn reflect progressive crustal shortening from mid-Jurassic to Eocene time.

Ermanovics, Ingo and **Wanless, R.K.**

TIMES OF CRATONIZATION AND ISOTOPIC REJUVENATION IN SUPERIOR PROVINCE OF MANITOBA; EOS, v. 61, no. 17, p. 384, 1980.

Isotopic ages determined from U-Pb zircon, Rb/Sr whole rock isochron, and K/Ar mineral data from Superior Province in Manitoba are tabulated and interpretated in relation to their distribution in subprovinces. Early, pre 2900 Ma, volcanic-plutonic activity is suggested by meagre evidence in most subprovinces.

Reference ages of crystallization or high-temperature isotopic homogenization of felsic plutonic rocks are established from U-Pb zircon and some Rb/Sr whole rock isochron ages for each subprovince. Times of cooling below argon-loss blocking temperatures are obtained from K/Ar biotite ages. Time difference between primary and cooling age is taken as the duration of post-orogenic uplift and appears to be about 250 to 300 Ma for all subprovinces. Earliest retention of radiogenic Sr occurred in Pikwitonei subprovince around 2900 Ma ago and at progressively later times in southern subprovinces. Argon retention in hornblendes exhibits a similar trend from central Sachigo subprovince southward. If Sr and the companion Ar-retention trends reflect stages in uplift then these data indicate a direction of cratonization that in Superior Province progressed from north to south.

The effects of Hudsonian orogeny extend 300 km into Superior Province to the Sachigo-Berens boundary and are recorded by Archean rocks whose rejuvenated K/Ar ages in Sachigo and Pikwitonei become progressively younger toward the Churchill orogen.

Fabbri, A.G.

GIAPP: GEOLOGICAL IMAGE-ANALYSIS PROGRAM PACKAGE FOR ESTIMATING GEOMETRICAL PROBABILITIES; Computers & Geosciences, v. 6, p. 153-161, 1980.

When a geological map pattern identifies conditions favourable to mineralization, the geometric probabilities associated with the pattern can be combined with probabilities associated with the distribution of mineral deposits. A tool for estimating these geometric probabilities is provided by GIAPP which can be used as an aid to mineral appraisal.

GIAPP uses methods of image processing for computing and displaying interactively the results of transformations of geological binary (0-1) images obtained either by optical or mechanical scanning, or by manual digitization. The data-management system developed for image processing also provides headings with name, type, and dimensions, and comments on the history of processing of each image. Through a simple conversational language, logical operations between images and neighborhood transformations are computed by routines developed for one-dimensional arrays of 1024 bits corresponding to individual rows of image data in binary compressed form. Provision is made for either square or hexagonal raster configurations.

Geological maps or textures from thin or polished sections of rocks are displayed on a Tektronix 4014 terminal. They are studied interactively by using criteria developed in pattern recognition and in mathematical morphology for texture analysis.

Fabbri, A.G.

DIGITIZATION AND PROCESSING BY MINICOMPUTER OF LARGE REGIONAL GEOLOGICAL MAPS AND ANCILLARY DATA ON MINERAL RESOURCES; Sixth Annual Machine Processing of Remotely Sensed Data Symposium, Purdue University, June 3-6, 1980.

A systematic procedure is described for the preparation and digitization of geological maps, various geophysical and geomorphological maps, and the distribution pattern of mineral occurrences in a Precambrian terrain area in Northwestern Manitoba, Canada.

The complete task consisting of input preparation, digitization, preprocessing and processing, can be carried out by one person, using a minicomputer equipped with a small graphic tablet digitizer, several display devices, and specially developed Fortran software.

Map patterns of boundaries are transformed into digital images which are mosaics of subimages in registration with each other. From the binary images of boundaries, the pixels occupying the areas of the various map units are labeled and a binary compressed image (one bit per pixel) is extracted for each map unit for additional processing. Logical operations between binary images and neighborhood transformations are computed with the limited degree of parallellism permitted by the word length in the minicomputer (sixteen bits per word). The quantitative characterization of binary geological patterns by parallel processing, is based on concepts of mathematical morphology.

This paper deals with the development of methods for statistical mineral potential estimation from systematically quantified geoscience data. When conditions favourable to mineralization can be identified on geological map patterns, the geometric probabilities associated with these patterns can be combined with the probabilities associated with the distribution of mineral occurrences.

Fader, G., King, L.H., and **Josenhans, H.L.**

SURFICIAL GEOLOGY SOUTH OF NEWFOUNDLAND WITH EMPHASIS ON THE GLACIAL AND POST-GLACIAL HISTORY; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 52, 1980.

A detailed map of the surficial geology of the Laurential Channel and western Grand Banks is presented. The area has been extensively glaciated as evidenced by the fjord-like character of the Laurentian and Hermitage channels and the extensively overdeepened depressions adjacent to the south coast of Newfoundland. An end moraine complex marks the limit of an extensive ice front developed during the Wisconsin advance. Unconsolidated stratified proglacial deposits immediately overlying the moraine 15 nautical miles south of Burin Penninsula are dated at 22,000 B.P. and indicate that the Wisconsin ice advance was fully developed and in an early state of retreat by this time. The presence of iceberg furrows over all of the surficial units within the study area suggest that late glacial ice persisted on Newfoundland and provided many large icebergs which reached the shelf through the numerous fjords that indent the south coast.

Falconer, R.K.H., Newman, P.H., and Ross, D.I.

MARINE GEOPHYSICAL DATA FROM NORTHERN BAFFIN BAY AND KANE BASIN AND ITS BEARING ON THE NARES STRAIT PROBLEM; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 52, 1980.

Marine bathymetric, gravity, magnetic, and seismic reflection and refraction data are presented for the area of northern Baffin Bay and southern Kane Basin. They indicate several sedimentary basins approximately sub-parallel to fault and graben systems of the Thule Basin and Ellesmere Island. Some of the sediments have undergone post-depositional deformation. A basalt intrusion may be present off southeastern Ellesmere Island. The only transform-like feature is a linear sediment filled trough extending from the basalt northward to Smith Sound.

Falconer, R.K.H. and **Pelletier, B.R.**

THE HISTORY OF CANADIAN GOVERNMENT SHIPBORNE GEOLOGICAL AND GEOPHYSICAL RESEARCH IN THE ARCTIC; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 52, 1980.

Systematic research began in the early 1960's with work in the east from hydrographic survey ships and Coast Guard icebreakers. With the expansion of the scientific research fleet in the mid-60's, more work was possible; but it wasn't until 1970 that any significant shipborne work was done in the west. Since 1970, research cruises have taken place almost every year to Baffin Bay in the east and the Beaufort Sea in the west; but the intervening Arctic Island channels are still little studied. Work has been in response to a combination of pure science and resource development needs.

Falconer, R.K.H. and **Srivastava, S.P.**

NARES STRAIT: A CONFLICT BETWEEN PLATE TECTONIC PREDICTIONS AND GEOLOGICAL INTERPRETATION?; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 52, 1980.

The majority of published plate tectonic models concerning movement of Canada and Greenland predict sinistral movement along Nares Strait since late Cretaceous time of 100 to 250 km. Some models also predict an initial gap of up to 150 kms in the late Cretaceous. If the geological and structural data across Nares Strait convincingly preclude such movements, the plate tectonic models must be defective. Is this because (a) the boundary between Canadian and Greenland Plates did not lie along Nares Strait (then where is it?), (b) the plates considered are not rigid and thus their boundaries are not definitive in space and time, (c) the boundary between the plates involved has changed during the evolution of the adjacent oceanic regions, (d) the model parameters derived from adjacent regions are not applicable for Nares Strait region, and (e) Greenland and Canada never separated from each other and Baffin Bay and Labrador Sea were formed by crustal subsidence? These possibilities and their implications on the development of the North Atlantic and Arctic as a whole are examined.

Fahrig, W.F. and **Christie, K.W.**

MAGNETOSTRATIGRAPHY OF THE BORDEN BASIN, BAFFIN ISLAND; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 52, 1980.

Paleomagnetic results have been obtained from a number of formations of the Eqalulik and Uluksan Groups which occur in the Borden Basin, Northern Baffin Island. The lowermost formation, the Nauyat consists of a relatively small number (7 or 8) thick tholeiitic basalt flows. Six of these were sampled and yielded a flat westerly magnetization direction. The overlying red sandstones of the Adams Sound are very stably magnetized in a similar direction. No reversals were encountered in these formations. Red sandstone of the Strathcona Sound (Uluksan Group) exhibits six reversals in the section sampled and the inclination of magnetization is significantly different from that of the Nauyat and Adams Sound. Material from the Arctic Bay, which overlies Adams Sound, was found to be very weakly magnetic and it is doubtful whether reliable data will be obtained from this formation. The paleomagnetism of the Aston Formation on Somerset and Prince of Wales Islands, has also been examined and data from this formation are reported because they may be correlatives of formations

from the Borden Basin. Paleomagnetic results support facies studies indicating that the Borden Basin formed at low paleolatitude.

Fillon, R.H.

HIGH-RESOLUTION SUBBOTTOM, PROFILES ACROSS THE NORTHERN LABRADOR SHELF: DO THEY PROVIDE EVIDENCE OF GLACIERIZATION?; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 53, 1980.

Huntec deep-tow records, 3.5 kHz and 12 kHz echo sounder profiles backed by air-gun reflection and cores delineate 7 mapable acoustic/morphologic units between 57° and 61°N. These include: I- section composed of numerous horizontal reflectors with minimal scattering and smooth microrelief; II- acoustically transparent section with numerous sub-parallel, draped reflectors at its base- it underlies unit I in basin centers; III- section marked by intense scattering, point reflectors and a rough microrelief; IV- section exhibiting strong scattering as in III but with smooth microrelief and obvious terraces; V- outcropping portions of II variably dissected; VI- outcrops of II exhibiting warping, acutely intersecting reflectors and undulating mesorelief; VII- areas of strong macrorelief of hummocks and ridges with wedge or lens-shaped reflectors and strong scattering. Of the 7 units, only the upper meter or less of unit I, 14C dated at <6000BP, is unambiguously postglacial. The remainder of units I and II date between 8400 and 26000BP. Sedimentation rates for the intervals 8400-6000BP and 26000-22000BP of 200cm/kyr compare with <20cm/kyr for post 6000BP – the high rates possibly related to turbid glacial melt-water. Glacigenic interpretations for units III and V – VII also seem plausible, eg. III- ground moraine; V-iceberg furrowing or subglacial melt-water erosion; VI-deformation till; VII- end or lateral moraines. If as a working hypothesis, deposits on the shelf are considered ice-sheet related and if the ^{14}C dates reflect time of deposition, rapid melting is inferred from 26000 to 21000BP and after 12000BP until final deglaciation sometime between 8400 and 60000BP. Concentrations of units I and II suggest principal melt-water sources on the outer shelf rather than inshore.

Fillon, R.H. and Duplessy, J.C.

LABRADOR SEA BIO-, TEPHRO-, OXYGEN ISOTOPIC STRATIGRAPHY AND LATE QUATERNARY PALEOCEANOGRAPHIC TRENDS; Canadian Journal of Earth Sciences, v. 17, p. 831-858, 1980.

A stratigraphic framework for eastern Labrador Sea cores has been developed for the interval 0-90 000 years BP through analysis of oxygen isotopes, volcanic ash, benthonic foraminifera, and the radiolarian **Diplocyclas davisiana.** Benthonic and planktonic foraminiferal isotope stratigraphy and the time scale of Shackleton and Opdyke provide a basis for the approximate dating of a series of marker events which include ash zones at ca. 59 000 and <21 000 years BP; benthonic foraminiferal abundance maxima at ca. 83 000, 75 000, 60 000, 19 000, and 3000 years BP; and **D. davisiana** percentage maxima at ca. 90 000, 73 000, 64 000, 54 000, 45 000 – 32 000, and 10 000 years BP. Incursions of subpolar planktonic foraminifera into the area during parts of isotopic stage 2 (between about 13 000 and 25 000 years BP but probably excluding the 15 000-18 000 years BP glacial maximum interval) and during the isotopic stage 4/5a transition (around 75 000 years BP) suggest that the eastern Labrador Sea was free of sea ice, at least in summer during periods of rapid continental ice sheet growth which lead to the isotopic stage 4 and stage 2 glacial maxima. A larger than normal stage 1/stage 2 difference in the isotopic composition of benthonic foraminifera (1.8‰) implies that this open water and attendant surface cooling was a potential source for colder than modern deep water. In contrast the Norwegian Sea was a reservoir of warmer than modern deep water during the last glacial.

On a développé un cadre stratigraphique pour interpréter les carottes provenant de la partie est de la mer du Labrador dans l'intervalle de 0-90 000 ans avant le présent, en utilisant l'analyse des isotopes d'oxygène, des cendres volcaniques, des foraminifères benthiques et du radiolaire **Diplocyclas davisiana.** La stratigraphie basée sur l'analyse isotopique des foraminifères benthiques et planctoniques et l'échelle chronologique de Shackleton et Opdyke fournissent des repères qui permettent de dater approximativement une série d'èvénements marquants dont les suivants: des zones de cendres à environ 59 000 ans et <21 000 ans avant le présent; une abondance maximum de foraminifères benthiques à environ 83 000, 75 000, 60 000, 19 000 et 3000 ans avant le présent; un pourcentage maximum de **D. davisiana** à environ 90 000, 73 000, 64 000, 54 000, 45 000 – 32 000 et 10 000 ans avant le présent. Les incursions de foraminifères planctoniques sub-polaires dans la région durant certaines parties du stade isotopique 2 (d'environ 13 000à 25 000 ans avant le présent, mais excluant probablement l'intervalle du maximum glaciaire de 15 000 – 18 000 ans avant le présent) et durant la transition du stade isotopique 4 au stade 5a (il y a environ 75 000 ans) suggèrent que la partie est de la mer du Labrador était libre de glace marine, au moins au cours de l'été durant des périodes de croissance rapide des glaciers continentaux qui ont conduit aux maximums glaciaires des stades 4 et 2. Il est possible qu'une différence plus grande que normal de composition isotopique des foraminifères benthiques (1.8‰) entre le stade 1 et le stade 2 implique que cette étendue d'eau libre et le refroidissement superficiel qui en résultait aient été responsables de la présence en profondeur d'eau plus froid qu'actuellement. Par constaste, la mer de Norvège a été un réservoir d'eau profonde plus chaude qu'actuellement au cours de la dernière glaciation.

Fillon, R.H. and Duplessy, J.C.

NORTHWEST LABRADOR SEA OXYGEN ISOTOPE STRATIGRAPHY – SAND INPUT AND PALEOCEANOGRAPHY IN THE EARLY WISCONSINAN; Geological Society of America, 1980 Annual Meeting, Abstracts with Programs, p. 425-426, 1980.

Core HU 75-58 from 1057 m water depth in the northwestern Labrador Sea off southwestern Baffin Island consists of alternating coarse ice-rafted sediment, rich in planktonic foraminifera and fine-grained sediments containing abundant silicious sponge spicules with lesser numbers of foraminifera. A curve of **Neogloboquadrina pachyderma** oxygen isotopic composition encompasses a range of δO18 values+2 to 4+.5‰ Chronostratigraphic interpretation of the curve places the base of the core below Termination II (127,000 B.P.). Bio/lithostratigraphic correlation with eastern Labrador Sea and North Atlantic cores supports this chronology. Average sand input in HU75-58 calculated as $mg/cm^2/yr \times 10^3$ is almost identical to the eastern Labrador Sea average down to the ca 60000 B.P. level. Prior to 60000 B.P. however HU75-58 sand input rates in the fine-grained facies were significantly lower, especially during the O18 stage 5a/4 transition period of rapid ice growth and within O18 stage 4, the ice volume maximum. Two explanations for these differences that are consistant with our data, other North Atlantic sand input rates, regional paleoceanography and glacial events on Baffin Island are:

1) During the stage 5a/4 interval of ice growth debris-laden bergs carried northward along the southwest coast of Greenland in a "warm" proto-West Greenland Current shed most of their debris before entering the southward surface drift in the western Labrador Sea.

2) During the stage 4 ice volume maximum, very cold surface water in the northwestern Labrador Sea and perhaps even floating ice shelves locally inhibited or displaced the locus of iceberg melting and injections of turbid meltwater containing sand.

Similar conditions are also suggested for the stage 5e/5d transition.

Fillon, R.H.

A MARINE VIEWPOINT ON LATE WISCONSINAN ICE SHEET GROWTH AND DISINTEGRATION IN EASTERN NORTH AMERICA; American Quaternary Association, Sixth Biennial Meeting, Abstracts and Program, p. 76-77, 1980.

Fillon, R.H.

A THREE-PHASE (VAPOR-LIQUID-SOLID) MODEL OF ICE GROWTH AND THE INITIATION OF NORTHERN HEMIPSHERE WISCONSINAN GLACIATION; Sixth Biennial Meeting, American Quaternary Association, Abstracts and Program, p. 78, 1980.

Current glacial inception theories have in common the basic premise of two-phase (vapor-solid) accumulation model of ice sheet initiation and growth. Certainly this is the only logical model which can explain the growth and maintenance of large high-elevation ice domes like those in Antarctica and Greenland. However, rapid ice accumulation and a corresponding enrichment of $\delta 180$ in ocean water during the early stages of ice sheet growth can be explained by an alternative and in some respects more attractive three-phase model. In the three-phase model, the critical effect of a high latitude Northern Hemisphere decrease in summer insolation at the end of an interglacial is the formation of perennial sea ice cover over marginal portions of the Arctic Ocean and peripheral seas such as Baffin Bay and Hudson Bay. Because the Arctic Ocean and adjacent seas constitute a polar ocean fed by runoff from warmer, less polar land masses to the south, spring/summer river runoff onto the sea ice cover would be inevitable. Once on the sea ice, in the absence of a summer breakup, the annual influx of river water would be trapped and frozen in the manner of aufeis, the net result being the formation and rapid expansion of thick, floating ice shelves of the Ward Hunt type. Present day fresh water runoff into the Arctic Ocean is on the order of 4.0×10^6 km^3/1000 years. At this rate, a 1000 m thick coalescent ice shelf incorporating approximately 14×10^6 km^3 of isotopically "light" ice could form in as little as 3500 years for example, during the transition from interglacial marine isotopic substage 5e to 5d, thereby effecting a 0.4 per mil global $\delta 180$ shift in seawater (Broecker, 1975).

Similar sequences of events leading to the formation of marine ice shelves may also be postulated somewhat later in the hemispheric refrigeration process – for example during the late Wisconsinan $\delta 180$ maximum – for waters overlying the continental shelf off eastern Canada and perhaps northwestern Europe. On the Labrador Shelf, there is evidence of ice grounded to the shelf and of subsequent substantial flows of turbid fresh water across the ice for distances up to 40 km during the initial stages of deglaciation.

The transition from a relatively brief episode of three-phase accumulation very early in a glacial event to later, more protracted two-phase ice accumulation could well be related to increased northward advection of warmer surface water and an attendant increase in precipitation such as is thought to have occurred during parts of the isotopic stage 5e/5d and 5a/4 transitions (Ruddiman and McIntyre, 1979).

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

MINERALOGICAL AND GEOCHEMICAL TRANSFORMATION OF CLAYS DURING CATAGENESIS AND THEIR RELATION TO OIL GENERATION; FACTS AND PRINCIPLES OF WORLD PETROLEUM OCCURRENCE, A.D. MIALL, ED., in Canadian Society of Petroleum Geology Memoir 6, p. 153-172, 1980.

Catagenesis of the <0.2 µm and 2.0-0.2 µm clay fractions has been investigated in samples from six wells and one formation in the Sverdrup and Beaufort-Mackenzie Basins of the Canadian Northwest Territories.

Upon burial of the sediments, the concentration of expandable 2:1 layer silicates, kaolinite and amorphous inorganic material decreases while illite increases in concentration in the 2.0 µm fraction. The same trend is observed in the <0.2 µm fraction in which the interstratified layer silicates are concentrated. The first dehydration of the interstratified clays is made permanent by isomorphic substitution for Si^{4+} by Al^{3+} and the ensuing absorption of K^+ and occurs prior to the onset of hydrocarbon generation from the sedimentary organic matter. Water is not only released to the pore system by clay dehydration but also by dissolution of amorphous inorganic matter and destruction of layer silicate minerals. Only the last of these mechanisms is operative within the zone of oil generation.

L'étude de la catagenèse des fractions argileuses à taille inférieure à 0.2 et à 2.0-0.2 µm, s'est faite, à partir d'échantillons provenant de six puits, d'une formation des bassins de Sverdrup et Beaufort-Mackenzie dans les N.W.T. du Canada.

Avec l'enfouissement des sédiments, en concentration en feuillets silicates pouvant doubler de volume, en koalinite et en matériel inorganique amorphe, décroît alors que celle d'illite s'accroît, pour ce qui concerne les fractions de la taille 2 µm. La même tendance s'observe en ce qui concerne la fraction inférieure à 0.2 µm où l'on retrouve concentrés les feuillets silicates interstratifiés. La première déshydratation des argiles interstratifiées se réalise en permanence par substitution isomorphique de l'élément Si^{4+} par l'élément Al^{3+} et par l'absorption du K^+ qui s'ensuit; elle se situe avant la phase de genèse des hydrocarbures à partir de la matière organique.

L'eau n'est pas seulement libérée du système poreaux par déshydration des argiles mais aussi par dissolution de la matière organique amorphe et destruction des minéraux silicates en feuillets. Seul, ce dernier mécanisme se réalise au moment de la genèse de l'huile.

Franklin, J.M., McIlwaine, W.H., Poulsen, K.H., and **Wanless, R.K.**

STRATIGRAPHY AND DEPOSITIONAL SETTING OF THE SIBLEY GROUP, THUNDER BAY DISTRICT, ONTARIO, CANADA; Canadian Journal of Earth Sciences, v. 17, p. 633-651, 1980.

The Sibley Group is a Neohelikian (1339 ± 33 Ma, RbSr, $^{87}Rb = 1.42 \times 10^{-11}$ year^{-1}) red bed sequence located in an elongate basin extending northward for 150 km from Nipigon, Ontario. The lowest unit, the Pass Lake Formation (new name), is 50 m thick and consists of quartz arenite, deposited primarily in a shallow, quiet lacustrine environment. It is overlain by the Rossport Formation (new name), a unit of 135 m thickness consisting of a lower arenacious red dolomite member, central chert–carbonate and stomatolite member, and an upper argillacious red dolomite member. The Rossport Formation was deposited in a shallow, highly saline environment, in a basin of fluctuating

size. The Kama Hill Formation (new name) is 50 m thick, and consists of purple shale composed of smectite, authigenic microcline, and quartz. It was deposited in a periodically dry mud flat, and is characterized by desiccation cracks, evaporite casts, and mud-chip microbreccias.

Both the Rossport and Kama Hill Formations have an increased arenite content near the basin margins. Breccias cut the Rossport Formation and consist of stoped blocks of Rossport and Kama Hill rocks; these breccias are cut by sandstone dykes. The Sibley Group is situated in, and was possibly deposited in, a "failed arm" which radiates from a paleo-plume in the Keweenawan rift valley.

Le groupe de Sibley est une séquence de lits rouges du Néo-Hélikien (1339 ± 33 Ma, RbSr, $^{87}Rb=1.42 \times 10^{-11}$ an^{-1}) située dans un bassin allongé s'étendant vers le nord sur 150 km à partir de Nipigon en Ontario. L'unité la plus basse, la formation de Pass Lake (nouvelle appellation), a une épaisseur de 50 m et consiste en une arénite de quartz, déposée surtout dans un milieu lacustre peu profond et tranquille. Cette unité est recouverte par la formation de Rossport (nouvelle appellation), une unité de 135 m d'épaisseur consistant en un membre inférieur de dolomie rouge arénacée, un membre central de chert–carbonate et de stromatolite et un membre supérieur de dolomie rouge argileuse. La formation de Rossport s'est déposée dans un milieu très salin peu profond, dans un bassin dont les dimensions fluctuaient. La formation de Kama Hill (nouvelle appellation) a 50 m d'épaisseur et consiste en un shale pourpre composé de smectite, de microcline authigène et de quartz. Elle s'est déposée dans une slikke asséchée périodiquement et elle possède de façon caractéristique des fentes de dessication, des empreintes d'évaporites et des microbrèches formées de copeaux de boue.

Pour les formations de Rossport et de Kama Hill, la proportion d'arénite augmente en approchant des bordures du bassin. Des brèches coupent la formation de Rossport et consistent en blocs provenant des roches de Rossport et de Kama Hill; ces brèches sont recoupées par des dykes de grès. Le groupe de Sibley est situé et s'est probablement déposé dans un "bras affaibli" qui rayonne à partir d'un ancien panache thermique dans la fosse d'effondrement de Keweenaw.

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

ARCHEAN-PROTEROZOIC HISTORY AND CORRELATION OF LANDS BORDERING NORTHERNMOST BAFFIN BAY; Geological Association of Canada/ Mineralogical Association of Canada, 1980 Annual Meeting, Program with Abstracts, v. 5, p. 48, 1980.

Onshore geological investigations around northernmost Baffin Bay are now advanced enough to allow correlation between Greenland and Canada to be made with confidence. The crystalline shield in NW Greenland and SE Ellesmere Island (between 76° and 79°N) comprises a high-grade gneiss and metasedimentary terrane. It includes a distinctive suite of late Archean granitic to basic igneous rocks, which have locally been transformed by intense Hudsonian deformation into complexly folded orthogneisses. Marble-rich metasedimentary tracts such as those on opposite sides of Smith Sound at Cape Isabella (Canada) and Sunrise Pynt (Greenland) may well represent parts of a single supracrustal belt. The crystalline shield is unconformably overlain by unmetamorphosed Proterozoic rocks (Thule Group) that are best preserved in Greenland, where they attain a minimum thickness of 4.5 km. Less than 1200 m are present in SE Ellesmere but the succession is so similar to the lower Thule Group in Greenland that unit-to-unit correlation of both sedimentary and volcanic rocks has been established. This correlation strongly supports the concept of a single intracratonic basin (Thule Basin) spanning northernmost Baffin Bay. 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 Precambrian geology suggests that any tectonic movement along the Nares Strait lineament has not resulted in major net transcurrent displacement of Ellesmere Island and Greenland.

Frith, R.A. and Hill, J.D.

GEOCHEMISTRY AND PETROLOGY OF THE HACKETT RIVER GROUP – AN ATYPICAL ARCHEAN GREENSTONE BELT IN THE NORTHEASTERN SLAVE PROVINCE; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 54, 1980.

The Hackett River Group of volcanic and sedimentary rocks is comprised dominantly of andesitic and dacitic calc-alkaline flows and pyroclastics of unusual major and trace element chemistry. Caulderic collapse structures and ensialic deposition are important controlling factors.

Sulphides deposited in sedimentary basins along the belt are abnormally high in lead and silver compared with other Archean layered sulphide deposits of the Canadian Shield. The lead isotopes show 'primitive' μ values falling near a Cumming and Richards lead isotopic development curve at 2.65 Ga.

Rare earth element abundances show tight patterns for both the andesitic and dacitic flows and are similar to modern-day calc-alkaline andesites from Indonesia. It is suggested that the overall composition of the Archean crust was similar to the overall composition of the volcanic belt.

Frith, R.A. and **Roscoe, S.M.**

TECTONIC SETTING AND SULPHIDE DEPOSITS OF THE HACKETT RIVER BELT, SLAVE PROVINCE; Canadian Mining and Metallurgical Bulletin, v. 73, p. 143-153, 1980.

Belts of Yellowknife Supergroup volcanic and sedimentary strata in the Slave Structural Province are separated by granitoid complexes. The strata and most intrusive rocks are 2.7 and 2.5 Ga old, but rocks around 3.1 Ga have been recognized in some of the complexes and are believed to represent a once-extensive sialic crust. Volcanics were erupted along rifts in this crust and the rifts became sites of crustal foundering and the development of troughs that filled with turbidites of volcanic and granitoid provenance. Present margins of the granitoid complexes may be close to the orignial margins of deposition of volcanics, with associated mineral deposits, and close to the thickest parts of basins of sedimentation.

The Hackett River volcanic belt extends 100 kilometres between Mara River and Back River and is crudely S-shaped, with a northern sector surrounding a core of granitoid basement rocks, a northeasterly facing central sector and a southerly facing southern sector. Up to 8 kilometres of andesitic volcanics with intercalated felsic volcanic rocks are preserved within the central sector. The felsic rocks include thick lenses of volcaniclastics with large, quartz-eye-bearing clasts, but the known metal deposits are not associated with these. Both of the deposit areas, at the Hackett River area in the northern domal sector and the 'Aitch' Lake area 40 kilometres to the south in the cental sector, are near the tops of relatively thin atypical volcanic sequences above suspected basement rocks. The Yava deposit near 'Aitch' Lake overlies a unit of subaerially deposited, welded,

andesitic ash flows and the Hackett River deposits overlie highly metamorphosed volcaniclastic rocks that include suspected ignimbrites.

The deposits are notably argentiferous and lead-rich. They consist of stratigraphically zoned sheet-like bodies of iron sulphides, sphalerite, galena and chalcopyrite underlain by altered rocks containing chalcopyrite stringers. The Yava deposit was formed where hydrothermal fluids exuded through the fractured floor of a flooded caldera basin. The Hackett River deposits may have been formed in a similar setting and it is not inconceivable that all the known deposits in the belt were formed in a single large caldera basin, although there is no independent evidence for the required major fault separation between the Hackett River dome and the 'Aitch' Lake area.

Hill, J.D. and **Frith, R.A.**

PETROGENESIS OF THE REGAN GRANITOID INTRUSIVE SUITE IN THE NOSE LAKE-BACK RIVER AREA, NORTHWEST TERRITORIES; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 60, 1980.

The Regan Intrusive Suite consists of 57 granitoid plutons of Archean age that intrudes the Yellowknife Supergroup in the Nose Lake-Back River area. The plutonic rocks grade from diorite to granite.

Structures and textures in the plutons indicate they were magmatic in origin. Mineral analyses suggest that hornblende, plagioclase and biotite are primary whereas microcline is secondary, having undergone subsolidus recrystallization and localized mobilization.

Data from 174 whole rock analyses were used to determine an average composition for each pluton and the approximate composition of each parental liquid. These data fall on relatively smooth variation curves that can be divided in two groups – a more mafic group that includes all plutons from diorite to granodiorite and a more felsic group that includes all the granites. A mechanism of plagioclase-hornblende fractionation of a parental magma at least as basic as quartz diorite best explains the variety of lithologies in the more mafic group of plutons. A calculated subtraction model that assumes perfect fractionation gives major element trends that are similar to those observed. The granite plutons may constitute a separate and younger genetic group.

Gadd, N.R.

LATE-GLACIAL REGIONAL ICE-FLOW PATTERNS IN EASTERN ONTARIO; Canadian Journal of Earth Sciences, v. 17, p. 1439-1453, 1980.

Reconnaissance of eastern Ontario regions lying between the late-glacial positions of Lake Iroquois and the Champlain Sea provides new information on ice-flow patterns as represented by striae and other streamline phenomena. This is related to the distribution of ice-marginal deposits and to structurally controlled topography. Two ice lobes, Madawaska Highland lobe and Ottawa – Lake Ontario lobe, are identified, and the Oak Ridges interlobate moraine system is extended. Discussion of apparent sequences of events allows for a new working hypothesis, including the concept of a calving bay in Ottawa Valley, for the development of the Champlain Sea, and for the timing of the drainage of Lake Iroquois. It reconciles radiocarbon dates previously thought to be anomalous.

Le reconnaissance dans l'est de l'Ontario des terrains qui se trouvent entre les positions tardi-glaciaires du lac Iroquois et de la mer Champlain fournissent de nouvelles données sur les grandes directions de l'écoulement de la glace lorsqu'on utilise les stries et autres phénomènes directionnels. Ces phénomènes dépendent jusqu'à un certain point de la distribution des dépôts de contact glaciaire et des formes topographiques qui sont elles-mêmes contrôlées par la structure. On identifié deux lobes glaciaries, le lobe des Hautes-terres de Madawaska et le lobe Ottawa – Lac Ontario, et on montre l'extension du système morainique interlobaire d'Oak Ridges. La discussion de séquences apparentes d'événements débouche sur une nouvelle hypothèse de travail, qui comprend le concept d'une baie de vêlage dans la vallée de la rivière Outaouais, pour le développement de la mer Champlain et pour la chronologie du drainage du lac Iroquois. Elle permet de concilier des âges au radiocarbone qu'on considérait jusqu'à maintenant comme des anomalies.

Gagné, R.M.

PROGRESS REPORT ON SURFACE SEISMIC REFRACTION SURVEYS; Atomic Energy of Canada Ltd., Technical Record TR-45, 1980.

This report describes the activities of the Seismic Section of the Geological Survey of Canada during the 1977 and 1978 field seasons in which shallow refraction methods were used to determine the depth to bedrock and seismic velocity distribution of the bedrock surface. The report concludes that it is possible to define the bedrock surface and overburden thickness over selected lines at the Atomic Energy of Canada Limited sites at Chalk River and Whiteshell although subsurface conditions cannot be projected to cover the complete test site on the basis of limited data. Further surveys are not planned at this time.

Ce rapport décrit les activités de la Section d'Etudes Sismiques de la Commission Géologique du Canada durant les saisons 1977-1978 d'études sur le terrain au cours desquelles les méthodes de réfraction à faible profondeur furent utilisées pour déterminer la profondeur jusqu'à la roche de fond. Le rapport conclut qu'il est possible de définir la surface de la roche de fond et d'épaisseur des terres de couverture sur des lignes de niveau choisies aux établissements de l'Energie Atomique du Canada Limitée à Chalk River et à Whiteshell bien qu'on ne puisse pas prévoir les conditions sous la surface pour tout le lieu des essais du fait des données limitées. On ne prévoit pas d'autres études en ce moment.

Garrett, R.G. and Goss, T.I.

UANOVA: A FORTRAN IV PROGRAM FOR UNBALANCED NESTED ANALYSIS OF VARIANCE; Computers & Geosciences v. 6, p. 35-60, 1980.

A FORTRAN IV program (UANOVA) to carry out unbalanced analyses of variance, associated variance component testing using synthesized error mean squares and degrees of freedom where appropriate, and the generation of summary statistics is presented. Data transforms are available to assist in meeting the requirements of the ANOVA method, and the data structure is defined as part of the input stream. The summary statistics include estimates of the population mean and variance, and confindence limits for the mean and variance components. The latter are approximations for levels higher than the first, however their calculation affords on indication of the imprecision of the point estimates. The program has been verified, where possible, with published data sets, results of these tests are presented.

Garrett, R.G. and Goss, T.I.

THE STATISTICAL APPRAISAL OF SURVEY EFFECTIVENESS IN REGIONAL GEOCHEMICAL SURVEYS FOR CANADA'S URANIUM RECONNAISSANCE PROGRAM; Mathematical Geology, v. 12, no. 5, 1980.

The design of sampling schemes for regional geochemical reconnaissance surveys in aid of mineral exploration and resource appraisal are based on the concepts of geometric probability. By defining the geochemical target size and an associated risk of misclassification, an appropriate sampling density may be derived. However, even though an individual sample may be collected from within the target there is some probability that this fact will not be recognized. Through the use of a structured sampling design, and subsequent analysis of variance to estimate variance components, the variability at the laboratory and various field scales is determined. It is demonstrated that through an empirical model, which uses the variance components, a survey index of target recognition may be derived. This can then be used to obtain a posterior estimate of the expectation of success in detecting targets of various sizes. This information is of assistance in resource appraisal studies where it is necessary to weight and combine information derived from diverse geoscience studies.

Garrett, R.G., Kane, V.E., and Zeigler, R.K.

THE MANAGEMENT AND ANALYSIS OF REGIONAL GEOCHEMICAL DATA; Journal of Geochemical Exploration, v. 13, p. 115-152, 1980.

Experiences in the U.S. National Uranium Resource Evaluation Program and Canadian Uranium Reconnaissance Program related to the use of geochemical exploration methods are drawn upon to review concepts and standards for data management and analysis. The topics discussed include: (a) field data acquisition; (b) quality control; (c) data management; (d) univeriate statistical analysis; (e) initial data presentation; (f) multivariate statistical analysis; and (g) derivative maps.

It is concluded that computer usage is essential if the data are to be compiled to desired levels of quality assurance in a timely and efficient fashion for interpretation and distribution. In general the costs for data management and analysis are some 10% of total costs; of this 10% some three-quarters is expended on compilation, quality control, editing and archiving. The use of the mathematical and statistical methods, with appropriate presentation techniques, can greatly assist the geochemist in interpretation. The objective of geochemical data analysis in the context of this paper is to identify that small proportion of the samples which relate to mineralization. A variety of tools, both simple and complex, are illustrated and discussed from this viewpoint. However, it is stressed that data analysis is only a tool and the results must be critically reviewed in terms of their geochemical implications before acceptance and incorporation into an interpretation.

Goodfellow, W.D.

WALL ROCK ALTERATION ASSOCIATED WITH VOLCANOGENIC STRATABOUND SULPHIDE DEPOSITS IN THE CANADIAN APPALACHIANS – AN OVERVIEW; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 56, 1980.

Wall rock alteration has been recorded around many massive sulphide deposits situated in the Canadian Appalachians although there are very few deposits where alteration resulting from metal-bearing fluids has been well documented. One of the major problems is that the mineralogical assemblages characterizing hydrothermal alteration have been masked and often destroyed by later regional and, in a few cases, thermal metamorphism. The identification of a feeder pipe and accompanying alteration is made difficult by intense polyphase deformation that has distorted and often displaced what was initally a funnel shaped conduit through which mineralizing fluids permeated.

Despite the overprinting effect of regional metamorphism, alteration resulting from hydrothermal presumably mineralizing fluids has been described at some deposits. These mineral assemblages which are characteristically chlorite + sericite + carbonate are associated with feeder-pipe sulphide mineralization. The accompanying element changes are as follows: Na and Ca are depleted due to the breakdown of plagioclase; K may either increase or remain unchanged due to the alteration of K-feldspar to sericite; and Mg and Fe generally increase due to the alteration of plagioclase to Mg-Fe chlorite and the precipitation of Fe-sulphides in solution conduits. The deposition of sulphides in fluid conduits may result from a decrease in temperature or an increase in pH due to the alteration of feldspar to sericite and quartz as shown in the following reaction: $2NaAlSi_3O_8 + KAlSi_3O_8 + 2H^+ \rightarrow KAl_3Si_3O_{10}(OH)_2 + 2Na^+ + 6SiO_2$.

Zoning of alteration minerals is represented by a core of quartz + sericite + chlorite + sulphides surrounded by less altered rocks characterized by chlorite ± sericite ± feldspar.

Gordon, T.M.

GEOLOGY OF THE DALY BAY COMPLEX, DISTRICT OF KEEWATIN; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 56, 1980.

The Daly Bay Complex of high grade gneiss, gabbroic anorthosite, and migmatite outcrops over an area of 2700 km^2 at the south-east margin of the Armit Lake Block of the Churchill Province. A pronounced Bouguer gravity high coincides with the complex.

Sediments of probable Archean age were intruded by gabbro and gabbroic anorthosite. Early Proterozoic granulite facies metamorphism was accompanied by isoclinal folding, strong flattening, and development of mylonite zones. Mineral assemblages include cordierite-garnet-sillimanite-quartz, hypersthene-garnet-potash feldspar and sapphirine rimmed by sillimanite.

Subsequent deformation resulted in further flattening and faulting at the margins of the complex, accompanied by amphibolite facies metamorphism and local development of migmatite. Garnet was replaced by biotite while pyroxenes reacted to form various amphiboles.

Later north-east trending faults are associated with pegmatite veining and greenschist facies assemblages. Northwest trending diabase dykes cut the complex and parallel a major set of faults observed north and east of the area.

Gordon, T.M.

DIGITAL CARTOGRAPHIC SYSTEMS AND GEOLOGICAL MAPPING; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 56, 1980.

Pilot studies have shown that automated techiniques provide some benefits for the production of plates for publication of geological maps. This technology has been extended to provide digital files of map data for scientific purposes.

Two methods of data organization are used for manipulation of graphic data – topologic data structures, in which individual points, lines, and areas retain their identities, – and grid or raster structures, in which attributes are assigned to individual grid squares in a matrix. Programs written in Ottawa, as well as software from the Laboratory for Computer Graphics and Spatial Analysis of Harvard University, have been used to transfer a digital file from a map production format to the above data structures. The data has been manipulated and displayed on a variety of devices.

Benefits of automated processing include ease of performing geometric operations such as projection and scale change, the availability of a wide variety of display types, and the potential for establishing a single graphic data base. Costs, particularly in geologists' time, will remain high unless economies of scale can be realized.

Berggren, W.A. and **Gradstein, F.M.**

AGGLUTINATED FORAMINIFERAL ASSEMBLAGES IN THE PALAEOGENE OF THE CENTRAL NORTH SEA: THEIR BIOSTRATIGRAPHIC AND EPOSITIONAL ENVIRONMENTAL SIGNIFICANCE; in Petroleum Geology of the Continental Shelf of north-west Europe Conference, March 4-6, 1980, London, Paper 37, p. 33.

A tenfold Cenozoic benthonic and planktonic foraminiferal subdivision is established based on studies of a dozen exploration wells in the British and Norwegian sectors of the North Sea. The Palaeogene foraminiferal record is integrated with the zonation based on dinoflagellates and thence directly with the standard Palaeogene chronostratigraphic subdivision in Europe. The foraminiferal zonation is applicable to a deep water facies not known from the classical onshore section. It is comparable to the Labrador Shelf zonation and has elements of mid-latitude standard planktonic zonations which enhance chronostratigraphic calibration of North Sea subsurface beds.

The Palaeogene deposits of the Central and Viking Grabens are very rich in agglutinated taxa – resembling flysch assemblages – and very poor in calcareous ones. A palaeoecologic model has been developed which establishes a broad link between the presence of the agglutinated fauna and the tectonic–sedimentologic history of basins. The agglutinated assemblage invaded the central North Sea trough as it underwent relatively rapid subsidence and became filled with organic-rich, fine-grained, carbonate-poor, terrigenous sediments; circulation was restricted. Minimum water depths for the Palaeogene clastic sequence in the Central and Viking grabens are in the order of 300-500 m.

Gradstein, F.M. and **Agterberg, F.**

THE APPLICATION OF STATISTICAL MODELS IN CONTINENTAL MARGIN BIOSTRATIGRAPHY; in Symposium Quantitative Stratigraphy, American Association of Petroleum Geologists, Annual Meeting, 1980.

Gradstein, F.M. and Berggren, W.A.

FLYSCH-TYPE AGGLUTINATED FORAMINIFERA AND THE MAASTRICHTIAN TO PALEOGENE HISTORY OF THE LABRADOR AND NORTH SEAS; Symposium Paleogene Biostratigraphy and Paleogeography, 26th-International Geological Congress, Paris, 1980.

Virtually identical agglutinated (arenaceous) benthic foraminiferal assemblage (ca. 30 genera, 45-50 taxa), characteristic of the Alpine-Carpathian flysch basins, occur in the Upper Cretaceous-Paleogene fine-grained clastic (?turbidite) sequences of the East Newfoundland Basin, Labrador Sea and North Sea. The assemblages terminate in both areas in the Late Eocene or Oligocene although in the central (deepest) part of the North Sea elements of this flysch-type fauna have been observed extending into lower-middle Miocene level.

Independent geological evidence and deep sea drilling data indicate that these assemblages have an extensive (paleo) bathymetric distributuon (↶200 m to over 4 km). Therefore, depth alone is not considered a significant factor in their occurrence. A number of interrelated physico-chemical factors at or near the sediment-water interface are believed to account for the observed distribution pattern of these assemblages. These factors involve relatively rapid deposition of fine grained, organic rich, carbonate poor, clastics under somewhat restricted bottom water circulation in compartmented basins.

A dozen forms appear to be of stratigraphic utility when calibrated against sparse planktonic foraminiferal data and known ranges in flysch basins elsewhere.

Gradstein, F.M. and **Srivastava, S.P.**

ASPECTS OF CENOZOIC STRATIGRAPHY AND PALEOCEANOGRAPHY OF THE LABRADOR SEA AND BAFFIN BAY; Palaeogeography, Palaeoclimatology, Palaeoecology, v. 30, p. 261-295, 1980.

Paleogeographic reconstruction show significant opening of the southern Labrador Sea in Campanian/ Maestrichtian to Eocene time and of the northern Labrador Sea in Paleocene/Eocene time. Baffin Bay opened in Eocene time, but motion there probably was largely translational. Micropaleontological studies of Labrador Shelf wells show that the latest Cretaceous – Eocene widespread transgression coincides with the opening phase of the Labrador Sea. Deepest (bathyal) conditions occurred in the Eocene. A broad shelf regression occurred in the Oligocene, probably accentuated by eustatic sea-level lowering. Shelf sedimentation rates were generally high, in excess of 10 cm/1000 yr, since Maestrichtian time, except locally in the mid-Tertiary, when little or no sedimentation took place. The Labrador Shelf region and adjacent land has undergone renewed tectonic activity in (late) Neogene time.

It is likely that a sea strait linking the Atlantic and Arctic Oceans became established as early as Campanian – Maestrichtian time, with surface circulation toward the Arctic. Principal incursions of warm-temperature watermass planktonic foraminifers took place in Maestrichtian and Early – Middle Eocene times. The latter correlates with a postulated Early – Middle Eocene North Atlantic Ocean climatic optimum, and with the findings of Early – Middle Eocene warm-temperature invertebrate and vertebrate remains in the Canadian Arctic. Reversal of surface circulation from the Arctic to the Atlantic occurred in the Late Miocene – Middle Pliocene, when the cold Labrador current became established along the Canadian Atlantic margin.

Grant, A.C.

PROBLEMS WITH PLATE TECTONIC MODELS FOR BAFFIN BAY; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 57, 1980.

Plate tectonic models for the geologic development of Baffin Bay require major shear displacement through Nares Strait. However, these models are based mainly upon observations made in other areas, such as the Labrador Sea, the North Atlantic, or the Arctic. A synthesis of available geological and geophysical data from the Labrador Sea indicates problems with plate tectonic models for this region.

These data can be interpreted alternatively in terms of vertical crustal movements. Such a mechansim applied in Baffin Bay, rather than lateral crustal displacements, accommodates the important geological evidence from field studies in the Nares Strait area that there is structural and stratigraphic continuity from Ellesmere Island to Greenland.

Grant, A.C.

PROBLEMS WITH PLATE TECTONICS: THE LABRADOR SEA; Bulletin of Canadian Petroleum Geology, v. 28, no. 2 (also in Oilweek, April 28, 1980, p. 42).

Stratigraphic data from exploratory wells on the Labrador Shelf permit an integrated interpretation to be made of two important subsurface features of the Labrador margin revealed by multichannel reflection seismic surveys. Firstly, a strong reflector buried deep beneath the slope and rise off northern Labrador is interpreted to represent an unconformity correlative with the Early Cretaceous unconformity beneath the continental shelf to the south. Secondly, a tentative Late Miocene age has been determined for a buried erosional surface represented by irregular seismic reflectors on the Labrador Shelf.

These interpretations conflict with existing plate-tectonic models of the Labrador Sea region. The unconformity beneath the slope and rise off northern Labrador indicates that continental crust extends into a region that previously has been defined as oceanic on the basis of magnetic, gravity, and refraction seismic measurements interpreted in a plate-tectonic mode. The Late Miocene erosional surface on the shelf serves as a marker to illustrate the style of subsidence of the Labrador continental margin in Late Cenozoic time; it is apparent that this subsidence has not proceeded as predicted by conventional plate-tectonic models.

These conflicts pose such questions concerning basic precepts of plate-tectonic theory as the source of linear magnetic anomalies on the seafloor, and the validity of refraction seismic criteria as a basis for defining crust as continental or oceanic. As the Labrador Sea is considered a 'typical' ocean, the problems with plate-tectonic models in this region may exist in other oceanic areas. For the Labrador margin, these conflicts with plate-tectonic models have important implications regarding the occurrence and extent of 'basement' rocks with a potential for trapping or generating hydrocarbon.

Grant, D.R.

QUATERNARY SEA-LEVEL CHANGE IN ATLANTIC CANADA AS AN INDICATION OF CRUSTAL DELEVELLING; p. 201-214 in Earth Rheology, Isostasy and Eustasy, ed. N.-A. Morner, John Wiley and Sons, London, 599 p., 1980.

This marginal segment of the continental plate has been sinking at 5-10 cm/1000 y by means of a spasmodic tilting interrupted by wide swings of sea level, recorded by Mesozoic – Cenozoic shelf strata. However, recent glacio-isostatic perturbations dominate. An important datum for comparing the upwarp of stadial shorelines, as well as for assessing modern equilibrium is a 2-6 m emerged intertidal rock platform of presumed last interglacial age. Common at the seaward periphery, it is tilted up slightly to the north, and in one place faulted up more than 20 m. Late Wisconsinan glaciers comprised two ice-cap complexes, joined to the Laurentide Ice Sheet, but separated by Gulf of St. Lawrence inland sea. Hence, postglacial rebound, as expressed by marine limit, forms two ridges rising to 150 m. Older higher shorelines relate to older, more extensive glaciations. Beyond the zero isobase, shorelines are found submerged at 20-120 m. These may mark differentially uplifted stadial eustatic minima, or interstadial eustatic maxima. The emergence thus reflects ice loads and extent, and date and rate of retreat. Total emergence has been reduced as much as 40 m by late Holocene subsidence that is known from dated submerged forest beds, and archeologic sites. It continues unabated at 30 cm/100 y judging by tide gauge and geodetic measurements. Likely causes are hydro-isostatic depression and a collapsing glacier-marginal forebulge. A series of curves showing local change of relative sea level summarizes the interplay of rebound and subsidence. From north to south, the change varies from continuous emergence to submergence, analogous to the situation in northwestern Europe.

Hillaire-Marcel, C., **Grant, D.R.,** and **Vincent, J-S.**

COMMENT ON 'KEEWATIN ICE SHEET – RE-EVALUATION OF THE TRADITIONAL CONCEPT OF THE LAURENTIDE ICE-SHEET' AND 'GLACIAL EROSION AND ICE SHEET DIVIDES, NORTHEASTERN LAURENTIDE ICE SHEET, ON THE BASIS OF THE DISTRIBUTION OF LIMESTONE ERRATICS'; Geology, v. 8, no. 10, p. 466-467, 1980.

To complement and clarify the developing concept that the Laurentide Ice Sheet was multi-domed rather than monolithic and single-centred, this short note and map summarize the evidence to support the interpretation that a separate, long-lived and probably individually nourished "ice domain" existed over New Québec, as did others over Keewatin and the Foxe-Baffin region. Appalachia supported several small satellitic maritime ice caps. The evidence consists mainly of ice-flow indicators, postglacial emergence patterns and the displacement of glacial lake shorelines. Important consequences of the segmented structure include the expansion of glacial lakes along the inter-dome cleavages or convergence zones, and the advance of Cochrane lobes from an active late stage 'Hudsonian glacier'.

Afin de clarifier le concept que la calotte laurentidienne était constituée de plusieurs dômes plutôt que d'un seul dôme contral, cette brève note, accompagnée d'une carte, résume les preuves qui appuient l'interprétation qu'un domaine glaciaire séparé et individuellement alimenté a existé sur le Nouveau-Québec, comme d'autres sur les régions du Keewatin, de Foxe-Baffin ou des Appalaches, au cours d'une longue période. Les preuves sont fournies par les indicateurs de l'écoulement glaciaire, les patrons de l'émersion postglaciaire et la déformation des lignes de rivage des lacs glaciaires. Les conséquences de la structure compartimentée comprennent l'étendue de lacs glaciaires dans des zones de scission ou de convergence entre les dômes et l'avancée des lobes de Cochrane à partir du glacier résiduel et fort actif d'Hudson.

Grant, D.R.

QUATERNARY STRATIGRAPHY OF SOUTHWESTERN NOVA SCOTIA: GLACIAL EVENTS AND SEA-LEVEL CHANGES; Field Trip Guidebook, Trip 9, Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting, 1980.

Bay of Fundy coastal cliffs between Yarmouth and Digby expose 13 stratigraphic units that record four marine phases and four glacial events of differing provenance and dynamic style. The sequence spans the last glacial stage because it rests on a prominent marine marker horizon believed to be of late interglacial age: oyster-bearing "Barton Silt" and an emerged wave cut rock platform ($^{+}$6 m AHT) with weathered littoral "Sanford Gravel". Glaciation was not

by the Laurentide Ice Sheet but by ice from local ice centres (the Appalachian Glacier Complex), so a separate climato-stratigraphy, the "Acadian Glaciation", is proposed. The cycle began with periglacial conditions that produced colluvium. The first glacial pulse, the "Fundy Stade", was the strongest; it started with a westward spread of ice from Nova Scotia uplands that laid down a locally-derived grey drift, the "Little Brook Till". The advance culminated with a southward ice flood that brought erratics from New Brunswick, red Triassic material from Bay of Fundy and interglacial shell material from St. Mary Bay to form a deep drumlinoid blanket of "Red Head Till". The advance probably constructed the Scotian Shelf End Moraine Complex. Subsequent deglaciation during the "Clare Interstade" 40,000 or more years ago is shown by the glacio-isostatic emerged marine "Salmon River Sand", the glaciofluvial "Cape Cove Gravel" which was graded to a lower sea level, and by deep weathering of these and older tills. Several scattered organic deposits more than 50,000 years old prove that glaciers disappeared from all of Nova Scotia. Renewed glacierization, again from upland centres produced the "Saulnierville Till" during the middle part of the stage ("Digby Stade") and culminated at a bulky coastal end moraine. A second interval of ice retreat, the "St. Mary Interstade" exposed only the coastal regions to glacio-isostatic marine incursion and to subaerial weathering. The final glacial event was the "Scotian Stade" when a weak advance of upland ice climaxed about 15,000 y. B.P. and deposited the immature rubbly grey "Beaver River Till" and a belt of small end moraines. Thereafter, postglacial marine incursion produced an offlap sedimentary couplet, the "Port Maitland Gravel" and "Gilbert Cove Clay", that has been differentially tilted 45 m up to the north toward the main Appalachian ice load. After regression to levels as low as -30 m, the sea has again risen relatively because of crustal subsidence during Holocene time to produce an estuarine aggradation of salt marsh mud, the "Amherst Silt", over terrestrial beds.

Gross, G.A.

A CLASSIFICATION OF IRON FORMATIONS BASED ON DEPOSITIONAL ENVIRONMENTS; Canadian Mineralogist, v. 18, p. 215-222, 1980.

Two groups of ferruginous sediments are recognized: (1) chemically precipitated iron-formations composed mainly of thinly banded chert and iron minerals; (2) ironstones commonly consisting of oölitic chamosite-siderite-goethite beds with appreciable clay and detrital constituents. Both groups form under a wide range of depositional environments and have distinctive lithological and mineralogical facies. Two principal types of siliceous iron-formation are recognized, Lake Superior and Algoma, based on the characteristics of their depositional basins and the kinds of associated rock. The Lake Superior type was deposited with quartzite, dolomite and black shale in continental-shelf environments, and the Algoma type with volcanic and greywacke rock assemblages along volcanic arcs, rift zones and deep-seated fault and fracture systems. Factors pertinent to the classification of depositional environments for chemical precipitation of iron and silica in iron formations include neritic, continental-shelf and deep-ocean basin environments; proximity to volcanic centres, rift zones, fault systems; type of associated sedimentary and volcanic rock, mineralogy, sedimentary features and lithological facies of the iron formation.

On distingue deux groupes de sédiments ferrugineux: (1) précipités chimiques, contenant surtout des cherts finement laminés et des minéraux de fer; (2) sédiments enrichis en argile et en éléments détritiques, caractérisés par des lits oolithiques à chamosite, sidérite et goethite. Les deux groupes résultent d'environnements de dépôts très variés et montrent plusieurs faciès lithologiques et minéralogiques. De plus, on distingue deux types principaux parmi les formations de fer siliceuses, selon le caractère du bassin sédimentaire et des roches associées. Les exemples du type "Lac Supérieur", interstratifiés avec quartzite, dolomie et shale noir, proviennent de la plate-forme continentale; ceux du type "Algoma" sont associés aux roches volcaniques et aux grauwackes le long d'arcs volcaniques, zones de rift, et réseaux de failles et de cassures profondes. La classification des milieux de dépôts des précipités chimiques de minéraux de fer et de silice repose sur les critères suivants: environnement du bassin (milieu néritique, plate-forme continentale ou fond océanique); proximité d'un centre volcanique, d'une zone d'extension ou d'un système de failles; association de lithologies sédimentaire et volcanique distinctes; minéralogie, structures sédimentaires et faciès lithologique de la formation de fer.

Gross, G.A. and **McLeod, C.R.**

A PRELIMINARY ASSESSMENT OF THE CHEMICAL COMPOSITION OF IRON FORMATIONS IN CANADA; Canadian Mineralogist, v. 18, p. 223-229, 1980.

Analytical data on 26 common elements, in over 600 specimens, are stored in a computerized file, which facilitates comparison of the composition of iron formations from different depositional environments and lithological facies. Significant differences are noted: (1) between Lake Superior (average of 201 samples) and Algoma types (447 analyses), (2) between iron formations (all facies) of the Lake Superior type from six depositional basins, and (3) between oxide, silicate and carbonate facies of the Lake Superior type (148, 22, and 31 analyses, respectively) and the mean Algoma type. In the latter the mean content of K_2O, Al_2O_3, Na_2O, P_2O_5, S, B, Cu, Ni, Sr, Ti, V and Zn is more than twice the average for Lake Superior type (all facies); CO_2, Mn and Sc are higher in the Lake Superior type. Correlation coefficients between elements in each of the three main facies for both types may be useful in recognizing genetic processes. For the Algoma type, consistently positive coefficients are found for Co, Ni, Cr and Mg in the carbonate facies, Cr and Ni in the sulfide facies, and Cu, Co, Ni and Cr in the oxide facies; positive correlations of Al, K and Ti were found for all facies of the Lake Superior type.

Un fichier de données sur ordinateur, portant sur 26 éléments courants et plus de 600 échantillons, permet une comparaison des formations de fer de différents environnements de dépôts et faciès lithologiques. On note les différences importantes suivantes: (1) entre le type "lac Supérieur" (moyenne de 201 échantillons) et le type Algoma (447 analyses), (2) entre six exemples distincts de formation de fer du type "lac Supérieur", et (3) entre les faciès à oxydes, à silicates et à carbonates du type "lac Supérieur" (148, 22 et 31 analyses, respectivement) et la composition moyenne du type Algoma. Celui-ci contient plus de deux fois la teneur en K_2O, Al_2O_3, Na_2O, P_2O_5, S, B, Cu, Ni, Sr, Ti, V et Zn de la moyenne de tous les faciès du type "lac Supérieur", CO_2, Mn et Sc sont plus élevés dans ce dernier. Les coefficients de corrélation inter-éléments pour chacun des trois faciès principaux des deux types peuvent servir à cerner les processus pétrogénétiques. Pour le type Algoma, les coefficients sont systématiquement positifs pour Co, Ni Cr et Mg dans le faciès à carbonates, Cr et Ni dans le faciès à sulfures et Cu, Co, Ni et Cr dans le faciès à oxydes; ils le sont pour Al, K et Ti dans tous les faciès du type "lac Supérieur".

Hacquebard, P.A.

GEOLOGIC DEVELOPMENT OF THE SYNDEY COAL BASIN, NOVA SCOTIA; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 58, 1980.

The Sydney Basin is almost entirely sumbarine and extends from N.E. Cape Breton Island to nearly the south coast of Newfoundland. It contains Upper Carboniferous coal measures with characteristics that are associated with paralic basins, such as local washouts and seam splitting that adversely affect mining. The latter can be predicted from the general trend of the hinge lines on the stone partings.

The relatively simple, saucer shaped Sydney Basin is structurally divided into the Ingonish and Glace Bay Subbasins by the Boisdale Anticline. The main production from the Sydney coalfield is from the southern fringe of the Glace Bay Subbasin, which has twelve mineable seams onshore and five in the offshore. Four of these offshore seams have been encountered in two exploratory oil wells, drilled about 35 km from land.

In the near-shore area of the Sydney coalfield the centre of coal deposition is located in the eastern part, where in the Donkin area four successive seams reach their greatest developments, with thicknesses of up to 4.3 m (14 ft.), and "demonstrated" resources of "clean" coal, estimated at 827×10^6 metric tons. The paleoenvironment of this area is illustrated with lithofacies and isopach maps of the Harbour seam.

Although all coals are classed as high volatile "A" bituminous there are significant rank changes within the coalfield. The postdeformational coalification has resulted in an increase of rank with depth, as well as regionally from west to east. These changes are economically favourable because they are accompanied by an improvement in the coking properties of the coal, which is demonstrated by means of petrographic evaluations.

Haworth, R.T.

THE COMBINED INTERPRETATION OF GRAVITY AND MAGNETIC ANOMALIES OVER OPHIOLITES USING AN INTERACTIVE COMPUTER GRAPHICS SYSTEM; International Association of Geomagnetism and Aeronomy, Program and Abstracts, XVII IVGG General Assembly, Canberra, Australia, 14th Dec., 1979.

Some geological structures of local to regional scale can be modelled by a series of physical blocks within each of which the proportionality of susceptibility to density is related to the geology. Varying the shape of each block to fit the observed magnetic anomaly also has the consequence of changing the theoretical gravity anomaly, thereby demonstrating their joint constraint on the model solution. An interactive computer graphics modelling system has been developed which permits rapid manipulation of the geometry and physical properties of a model, presenting an immediate visual display of the consequences of any change and thereby educating the interpreter as to the model's validity. Applied to geological untis with correlative gravity and magnetic anomalies, a low ambiguity model can be produced. Such conditions apply in the ophiolite suites of Newfoundland to which the modelling technique has been applied extensively in order to determine their subsurface structure. The inter-related constraints provided by high resolution gravity and magnetic data indicate that the source of the allochthonous ophiolites was a zone now extending over 100 km at the edge of which the ophiolites lie in imbricate thrust sheets less than 1 km thick which can be sampled as a test of the model.

Haworth, R.T.

GEOPHYSICAL ELEMENTS OF THE CANADIAN APPALACHIANS: AN AID TO INTERPOLATION BETWEEN THE STRUCTURE OF THE CALEDONIDES OF THE USA AND EUROPE; Proceedings "The Caledonites in the USA", I.G.C.P. Project 27: Caledonide Orogen, D.R. Wones, ed., Virginia Polytechnic Institute and State University, Department of Geological Sciences, Memoir 2.

The regional partition of Appalachian structures proposed in the Tectonic Lithofacies Map of the Appalachians (Williams, 1978) and now being used as a working hypothesis in investigations throughout the Caledonides was initially devised for Newfoundland, in and adjacent to which there is good geophysical data coverage. Many of the Appalachian tectonic elements have a geophysical expression. There is, for example, a sharp increase in gravity at the eastern edge of the (Grenvillian) Humber zone along the entire length of the Appalachians. High magnetic and gravity anomalies are associated with the ultramafic units that have been thrust against or onto the Humber zone where they also appear to have high seismic velocities (~7 km/s). Similar velocities are found at depth in the Dunnage zone. The Avalon zone is characterized by well lineated, magnetic, volcanic zones which have a higher seismic velocity that the metasedimentary rocks they intrude. A prominent magnetic and gravity anomaly marks the boundary between the Avalon and Meguma zones.

Gravity and magnetic anomalies may therefore be used to interpolate between Appalachian boundaries throughout North America where, in some places, the seismic refraction data coverage is sufficient to provide control over the validity of deep structural models that have been proposed. Extrapolation of Appalachian structures to the continental margin northeast of Newfoundland on the basis of geophysical data is much more plausible than across the wider and more dissected margin of the British Isles where data coverage is less dense. However, there appears to have been a major offset between the Caledonides in Newfoundland and the British Isles prior to opening of the present Atlantic Ocean, although the differences in deep structure of the two regions as revealed by seismic refraction indicate that a direct comparison of the areas offset may not be possible.

Haworth, R.T.

APPALACHIAN STRUCTURAL TRENDS NORTHEAST OF NEWFOUNDLAND AND THEIR TRANS-ATLANTIC CORRELATION; Tectonophysics, v. 64, p. 111-130, 1980.

The tectonostratigraphic zones of Newfoundland have been traced to the continental margin northeast of Newfoundland on the basis of detailed geophysical surveys of the area. The structures of the Avalon zone veer eastward offshore, whereas the western platform and marginal zones trend northerly for approximatley 400 km before showing a tendency to veer eastward. Using reasonable pre-drift reconstruction on North America and Europe, good correlations are found between the Avalonian units of Newfoundland and Iberia, with the European landfall of the Charlie Fracture zone representing the northern limit of Avalon equivalent basement. Despite the good correlation of the eastern units, the geological elements of western and central Newfoundland, northern Ireland and Scotland, between which geological correlations is "classical", were separated laterally by approximately 900 km prior to opening of the present Altantic. This offset of western units but continuity of eastern units is compatible with the existence of an eastward bend in the Appalachian system similar to but larger than the bends of the Appalachian system within the Gulf of St. Lawrence and the eastern United States.

Haworth, R.T. and Wells, I.

INTERACTIVE COMPUTER GRAPHICS METHOD FOR THE COMBINED INTERPRETATION OF GRAVITY AND MAGNETIC DATA; Marine Geophysical Researches, v. 4, p. 277-290, 1980.

A program for computation of the gravity and magnetic anomalies associated with two-dimensional structures has been adapted for use in an interactive mode using a storage-screen CRT linked to a remote computer via standard telephone lines. This new program aids the user in developing a structural model that satisfies both magnetic and gravity observations. Examples are included to demonstrate the increased efficiency of interpretation using this low-cost graphics approach and to illustrate the detail of the model resulting from the compromise necessary to satisfy both potential field data sets.

Henderson, J.R., Jackson, G.D., and **Morgan, W.C.**

THE CUMBERLAND SOUND METAMORPHIC CULMINATION: A MAJOR TECTONIC ELEMENT OF THE HUDSONIAN OROGEN IN NORTHEAST CANADA AND WEST GREENLAND; Geological Association of Canada/Mineralogical Association of Canada; Annual Meeting, 1980, Program with Abstracts, v. 5, p. 59, 1980.

The Cumberland Sound Metamorphic Culmination (CSMC) extends south into Ungava, west into Melville Peninsula and east into Greenland; it is surrounded by Aphebian fold belts of less intense orogenesis. Hudsonian batholiths, Archean basement gneiss and isolated remnants of Aphebian supracrustal gneiss compose the complex of granulite grade rocks in CSMC. Outward from the central region of the culmination the proportion of Aphebian supra-crustal gneiss increases and the proportion of Hudsonian granitic rock decreases. Periclinal structures on many scales characterize CSMC; these steeply inclined domes and basins pass outward into recumbent folds, thrusts and nappes preserved in linear belts bordering the culmination to the north (Foxe Fold Belt), south (Dorset Fold Belt), and east (Nagssugtoqidian Mobile Belt). Hudsonian orogenesis diminishes south and east from CSMC toward deformation fronts against the Superior and North Atlantic cratons. At the metamorphic climax granulites of CSMC were buried about 30 km deeper than rocks in the marginal fold belts; therefore surface maps show vertical as well as lateral variations in Hudsonian tectonic style. We interpret CSMC to be near the deep seated source region of crustal diapirism where the vertical stems are exposed; the marginal fold belts are upper level regions where parts of the laterally spreading and flattening caps are preserved.

Herd, R.K.

GRANULITE FACIES ROCKS WITHIN THE SOUTHERN LONG RANGE, NEWFOUNDLAND; Geological Association of Canada/Mineralogical Association of Canada; Annual Meeting, 1980, Program with Abstracts; v. 5, p. 59, 1980.

Relict granulite facies mineral association occur in paragneiss and amphibolite of the Cormacks Lake gneiss complex. The high grade rocks are preserved in a region of fold interference, close to a regional fold closure, and also show retrograde, post-tectonic, low pressure amphibolite assemblages. Orthopyroxene is replaced by gedrite in cordierite bearing rocks and by cummingtonite and hornblende in amphibolites. Xenoliths within migmatite regionally adjacent to the gneiss complex also contain relict granulite facies associations. The gneiss complex is probably of Grenvillian age, and the multiply folded supracrustal horizons may have had Aphebian protoliths. Similar orthopyroxene-bearing mineral associations in central Massachusetts have been attributed to prograde Acadian metamorphism of Ordovician-Devonian sediments.

Granulites also occur as layered mafic rocks near the base of the (?) Ordovician Annieopsquotch ophiolite. The gneiss complex and the ophiolite are separated by a major fault along the Lloyds River valley. Granulite grade in the ophiolite was probably attained in oceanic crust, whereas the gneisses must represent deep continental material.

Hoffman, P.F.

PAIRED PLUTONIC BELTS OF WOPMAY OROGEN, NWT: A SIGNATURE OF PROTEROZOIC CONTINENTAL COLLISIONS?; Geological Society of America, Program with Abstracts, v. 12, p. 448, 1980.

Paired plutonic belts rather than paired metamorphic belts may characterize continental collisions older than about 1 Ga. In Wopmay Orogen, a probable 1.9 Ga collision zone in the northwest corner of the Canadian Shield, plutonic belts of contrasting character occur on each side of the cryptic suture. The Great Bear-Plutonic Belt is interpreted as being on the overriding plate and consists of hornblende-rich plutons that become larger and more acidic with time. They discordantly intrude cogenetic calc-alkaline volcanic rocks that include arc-type andesite overlain by more acidic ash-flow tuff. Regional metamorphism is low grade and contact aureoles are very narrow. The structural setting was one of subsidence and broad oblique folding related to longitudinal wrench faulting. The belt is interpreted as an Andean arc that became a post-collision plateau of Turkish-Iran type. The Hepburn Plutonic Belt involves rocks of the subducting plate and consists of peraluminous hornblende-poor plutons that become smaller and more basic with time. The large early granites are strongly foliated and form concordant tabular bodies with hot-side-up and hot-side-down high grade metamorphic aureoles in the passive-margin sedimentary rocks the granites intrude. Plutonism was preceded by crustal underthrusting and imbrication, and was accompanied by uplift and compressive kinking of the thrust stack. No volcanic equivalents are known. The plutons are thought to result from crustal thickening and anatexis, aided by the greater radioactive heat production of Proterozoic crust. Preservation of blueschist after collision is precluded by the rapid upward transfer of heat by rising crustal melts.

Hoffman, P.F.

AUTOPSY OF THE EAST ARM FOLDBELT (2.1-1.8 Ga), GREAT SLAVE LAKE, N.W.T.; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 61, 1980.

Alkaline-peralkaline ring and dyke complexes, followed by a regional ENE mafic dyke swarm, suggest crustal doming and rifting at 2.1 Ga. A narrow ENE zone of lake sediments with alkaline and tholeiitic mafic volcanoes overlies the dyke swarm. The rift zone widened and braided rivers flowed axially toward the newly-rifted and subsiding Wopmay continental margin to the west. A marine transgression from the west extended into the rift zone. As the continental margin entered the W-dipping first Wopmay subduction zone, the rift and its shoulders subsided, accompanied by many small tholeiitic mafic and mafic-salic volcanoes, to become a foredeep embayment oblique to the rising Wopmay Orogen and between the Taltson and Slave cratons. The foredeep succession begins with nonmarine cratogenic quartzite and grades upward into marine shale with silty flysch in the axial zone. Stromatolite banks built up on the NW basin-margin coeval with axial deposition of sandy orogenic flysch. Basinal salt was deposited in front of a fluviodeltaic system that prograded cratonward during isostatic unroofing of the

orogen following continent-microcontinent collision. Flood basalts atop the foredeep succession are about coeval with external crustal thrusting in the orogen. Deformation of the foldbelt is tentatively ascribed to gravity sliding of the entire axial foredeep succesion and part of the axial rift facies onto the NW slope of the basin in response to crustal upthrusting of the Taltson Block, perhaps distantly related to closure of the Cree Lake zone of Saskatchewan. Calc-alkaline laccoliths were intruded into the East Arm nappe-stack above the E-dipping second Wopmay subduction zone. The 60-80 km of right-slip on the McDonald-Wilson fault system, which produced the broad en echelon folds that expose the nappes and accompanied Et-then continental sedimentation, is related to the terminal Wopmay collision. See also Hoffman, P.F., 1979, Wopmay Orogen: continent-microcontinent-continent collision of early Proterozoic age; Geol. Assoc. Can., Program with Abstracts, v. 4, p. 58.

Hoffman, P.F.

WOPMAY OROGEN: A WILSON CYCLE OF EARLY PROTEROZOIC AGE IN THE NORTHWEST OF THE CANADIAN SHIELD; in The Continental Crust and Its Mineral Deposits, edited by D.W. Strangway, Geological Association of Canada Special Paper 20 (1980).

The 2.1 to 1.8 Ga Wopmay Orogen is interpreted as a complete Wilson Cycle by means of direct and detailed comparison with Cenozoic tectonic environments. At 2.1 Ga, a continental plate came to rest over hot spots located at present Great Slave Lake and Coronation Gulf. A system of rifts developed after intrusion of alkaline-peralkaline complexes and mafic dyke swarms, the meridional Wopmay rift joining the hot spots and another rift extending into the present East Arm of Great Slave Lake. East-west extension led to continental breakup along the Wopmay rift, where thick bimodal volcanics and arkosic sediments subsided and a west facing continental terrace and rise were deposited. West-dipping subduction of oceanic lithosphere led to collisional accretion of an arc-bearing microcontinent. During the collision the west dipping thrust complex of continental margin rocks stripped from the subducting plate was intruded by the syntectonic Hepburn and Wentzel Batholiths, which are folded tabular bodies with extensive "hot-side-up" and "hot-side-down" metamorphic aureoles. After the collision, an east-dipping subduction zone developed west of the accreted microcontinent. A major arc-parallel transcurrent fault, reflecting a dextral component of oblique subduction, accompanied renewed calc-alkaline magmatism in the microcontinent and truncated the earlier collision zone. A remote terminal collision to the west is inferred from a 1000 km wide swath of conjugate transcurrent faults indicating east-west compression. At this time, the more rigid Slave Province indented and cracked the northwestern Churchill Province, triggering the 1.8 Ga lower Dubawnt alkaline volcanism. It is concluded that plate tectonics was operative in the early Proterozoic but magmatism was more intense than today in certain environments and the release of mafic tholeiites from subducting plates in trenches seems to be a Proterozoic speciality.

Holroyd, M.T.

GEOPHYSICAL CARTOGRAPHIC APPLICATIONS OF THE COLOUR JET PLOTTER; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 62, 1980.

The APPLICON colour jet plotter creates a picture (86 cm by 55 cm max) composed of contiguous 0.2 mm diameter ink dots. Each dot may contain any combination of the three primary colours. Raster scans may be output made up of .8 mm pixels, each containing from zero to sixteen dots of each primary colour giving the user the choice of over 5000 colour shades for any specific pixel.

This device not only permits rapid and relatively inexpensive production of the types of map that were previously hand coloured but also allows creation of types of map not previously practicable, e.g. "Pseudo imagery". Manually prepared coloured contour maps are reasonably common products. The resolution permitted by the manual process is necessarily low. With the digital process individual zones of one colour may be as small as one pixel (.8 mm square) and may possess any one of a range of over 5000 shades of colour. This permits the production, for example, of a 1:1,000,000 scale aeromagnetic composite map from a grid of 300,000 digitized values which has the appearance of satellite imagery rather than colour-contours. The resulting significant increase in information content permits discrimination and tracing of geological units to a much greater degree than is possible with standard or hand coloured aeromagnetic contour maps.

Hood, P. and **Bower, M.**

AEROMAGNETIC RECONNAISSANCE: LOREX PROJECT; EOS, v. 61, no. 17, p. 277, 1980.

Aeromagnetic reconnaissance of the Lomonosov Ridge has been carried out as a contribution to the LOREX project. The Convair 580 aircraft of the National Aeronautical Establishment was utilized to fly a series of lines along approximately 500 km of the Lomonosov Ridge and orthogonally to it at a height of 300 m. The aircraft was equipped with ASQ-501 cesium magnetometers in wingtip pods and a GSC self-orienting cesium magnetometer was mounted high in the tail section of the aircraft.

Although the correlation between the anomalies on the flight lines is not conclusive, a zone of anomalies in excess of 1000 gammas appears to strike parallel to the ridge crest. The calculated magnetizations of the causative bodies producing the anomalies correspond to those normally associated with basic rocks such as oceanic basalt. On the southern flank of the Lomonosov Ridge, a series of U-shaped anomalies are reminiscent of those due to a graben-like feature such as have been observed in the Melville Bay area of NW Greenland and elsewhere. Thus the aeromagnetic results appear to indicate that the Lomonosov Ridge is composed of igneous rather than sedimentary rocks or at least has had a considerable amount of associated igneous activity during its recent geological past. If the Lomonosov Ridge is indeed composed of basaltic rocks, it appears likely because of its parallelism with the Nansen Ridge over a distance of 1600 km that its formation is the result of a sea floor spreading process and it is possibly a dormant spreading ridge.

Hood, P., Dods, D., Holroyd, M.T., Kornik, L.J., Olson, D., and **Sawatzky, P.**

AEROMAGNETIC GRADIOMETER PROGRAM OF THE GEOLOGICAL SURVEY OF CANADA: A PROGESS REPORT; EOS, v. 61, no. 17, p. 416, 1980.

Interest by GSC personnel in aeromagnetic gradiometry dates from the early 1960's when the advent of optical absorption magnetometers with their much higher sensitivity compared to proton precession magnetometers, made gradient measurements feasible. In 1968, the GSC purchased a light twin engine aircraft and equipped it with an inboard optical absorption magnetometer. After the problems of compensating the aircraft had been overcome, and considerable experience was gained in flying high resolution aeromagnetic surveys, it was decided in 1973 to commence the

fabrication of an inboard gradiometer system. This decision was supported by a theoretical study that demonstrated that the vertical gradients produced by igneous rock formations were measurable by short base (2m) aeromagnetic gradiometer with a 0.01 gamma sensitivity. Considerable effort was subsequently spent on the design and fabrication of the gradiometer system and in devising a compilation system to convert the results into map form. In the past 5 years, more than 40,000 line miles of the gradiometer data has been obtained by the GSC as a result of about 20 surveys in a variety of Precambrian terranes to demonstrate the effectiveness of the gradiometer technique. These surveys have resulted in the publications to date of 45 vertical gradient maps and 6 Open Files of the results. Thus there is a sufficient body of experimental evidence to demonstrate the improved capability e.g. superior resolution of the gradiometer technique over single sensor surveys, i.e. that two heads are better than one.

Howie, R.D.

CARBONIFEROUS SALT IN ATLANTIC CANADA; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 62, 1980.

In southeastern Canada there are two ages of evaporite deposits in the Upper Paleozoic rocks. Continental Horton Group sediments of late Tournaisian to possible early Viséan age contain salt and glauberite in playa lake deposits. Although exploratory drilling has encountered Horton Group evaporites in four different locations, the deposits are not considered to be of economic importance.

Near the close of Horton sedimentation, emergent areas south and east of the Gulf of St. Lawrence caused restricted circulation of the Windsor Sea and the deposition of evaporites over a considerable area. These Windsor Group (Viséan) evaporites, now preserved as outliers on land or as part of a northeast trending basin from northern Nova Scotia to western Newfoundland, represent the only marine sequence in the Upper Paleozoic rocks of the area.

Periods of tectonism caused the migration of Windsor Group evaporites to form domes, diapirs, anticlines, ridges, and pillows. Preliminary investigations indicate some of the Windsor Group salt is pure enough for the underground storage of hydrocarbons and industrial waste.

Hughes, J.D.

COAL AND ROCK UNIT GEOMETRY IN THE LOWER HORSESHOE CANYON FORMATION (CAMPANIAN-MAESTRICHTIAN) OF CENTRAL ALBERTA AND ITS RELATIONSHIP TO DEPOSITIONAL SETTING; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5 p. 62, 1980.

The Horseshow Canyon Formation of central and southern Alberta contains a major proportion of Alberta's surface mineable subbituminous coal resources and has in recent years been extensively explored by industry. The lower part of the formation records the transition from marine strata of the underlying Bearpaw Formation to fluvial deltaic sediments, and has been explored by drilling on 400 m centers over a 300 km^2 area known as the Dodds-Roundhill coal field, about 70 km southeast of Edmonton. Natural gamma, resistivity and gamma-gamma density logs from 1276 holes penetrating the lower 100 m of the formation in this area allow detailed correlation of coal seams, rock partings and certain lithologic units. The geometry of the coal seams, rock partings and interseam rock units determined from isopach maps, and the vertical and lateral distribution of lithologies determined from the geophysical logs, allows subdivision of the succession into several fluvial and deltaic subenvironments. Distributary mouth bar, channel, interdistributary bay, point bar, levee, crevasse splay, swamp, marsh and floodplain deposits have been tentatively recognized. The lower part of the succession is interpreted to be the product of lower delta plain – marginal marine processes. Brackish water deposits are indicated above the lowermost major coal seam. The upper part of the succession comprises point bar and floodplain deposits which suggest an upper delta plain or alluvial plain environment. Thicker partings in the coals are characteristically wedge-shaped and are interpreted as overbank deposits thickening in the direction of the source channel. Reduced compaction of channel sands as compared to adjacent overbank deposits appears in places to have resulted in local highs on the paleo-land surface which controlled the distribution and thickness of partings within overlying coal seams.

Hunter, J.A.

MATING THE DIGITAL ENGINEERING SEISMOGRAPH WITH THE SMALL COMPUTER – SOME USEFUL TECHNIQUES: Proceedings of the 50th Society of Exploration Geophysicists Meeting, November 16-20, 1980.

The development of multichannel digital engineering seismographs capable of talking with inexpensive small computers has the potential to substantially increase interpretation and display capabilities for the engineering seismologist. Problems in groundwater and unconsolidated overburden requiring shallow refraction and reflection techniques have in the past suffered from inability to digitally process field records. With digital recording now available, field records can be filtered, gain enhanced and stacked. Interactive use of a computerized CRT record display results in rapid interpretation using standard refraction and reflection methods. Inexpensive hard copy displays of interpretations and seismic sections can greatly improve report preparation.

Examples of refraction and reflection surveying are given using the Nimbus 1210-F seismograph and G-724S digital recorder, and the Apple II computer with periferal devices.

Hunter, J.A., Burns, R.A., and **Good, R.L.**

OPTIMUM FIELD TECHNIQUES FOR BEDROCK REFLECTION MAPPING WITH THE MULTICHANNEL ENGINEERING SEISMOGRAPH; Proceedings of the 50th Society of Exploration Geophysicists Meeting, November 16-20, 1980.

Where large velocity contrasts exist between unconsolidated overburden and bedrock, reflections from this Interface can be some of the most prominent later events on engineering seismograms. With modern multichannel engineering seismographs having filtering capability, seismograms can be tailored to enhance these events. Interfering ground roll events can be minimized through the use of high frequency geophones and decoupling at the seismic source. Optimum geophone-source windows are dependent on ground-roll velocities and reflector depth and can be selected to obtain good reflector move-out for velocity determinations yet minimizing reflector phase changes found at wide angles of incidence. Reflection profiling of the bedrock interface can effectively replace refraction profiling techniques at bedrock depths in excess of 30 m.

Huang, C. and **Hunter, J.A.**

IDENTIFICATION AND CORRELATION OF TUBE WAVE EVENTS SHOWN ON BOREHOLE SEISMOGRAMS; Progress Report 1978, Seismic Downhole Survey; Atomic Energy of Canada Ltd., Technical Record TR-32, 1980.

Tube waves are generated when a compressional wave in the surrounding solid is incident upon a fractured zone which intersects with the borehole. The identification of tube waves on borehole seismograms appears to be a useful method in pin-pointing the water-filled cracks occurring within a crystalline rock body. It seems that the relative amplitudes of the tube waves are related to the widths of the open fractures, hence the degree of permeability. Since tube waves observed in the borehole are relatively low frequency, it is suggested that the events are effectively sampling a rock volume within several metres of the borehole.

Les ondes tubulaires sont produites lorsqu'une onde de compression de la masse environnante tombe sur une zone crevassée qui entrecoupe le trou de sondage. L'indentification des ondes tubulaires par les séismogrammes du trou de sondage semble être une méthode utile pour repérer les fissures remplies d'eau présentes au sein d'une masse rocheuse cristalline. Il semble qu'il y ait une relation entre l'amplitude des ondes tubulaires et la largeur des crevasses ouvertes et, par conséquent, le degré de perméabilité. Les ondes tubulaires observées dans le trou de sondage ayant une fréquence relativement basse, on avance l'hypothèse que, lorsque ces ondes se produisent, elles représentent l'échantillonnage réel du volume rocheux à plusieurs mètres du trou de sondage.

Huang, C. and **Hunter, J.A.**

THE 1978 PROGRESS REPORT ON THE SEISMIC AND DOWNHOLE SURVEYS AT THE CHALK RIVER AND WHITESHELL RESEARCH AREAS; Atomic Energy of Canada Ltd., Technical Record TR-31, 1980.

A downhole seismic compressional wave profiling method for use in the detection of fractures occurring within massive igneous and/or metamorphic rock bodies has been tested in both Chalk River and Pinawa. The technique adopted consists of suspending an array of hydrophones in the borehole by means of a marked cable and recording the travel times required for seismic energy to travel from the horizontally displaced surface shot holes fired near the hole down to the hydrophones. Several different window-widths of least squares fit were attempted on weighted and non-weighted data. An optimum moving window-width of 11-point least squares fit with the extreme error values of each non-weighted data point was selected as the technique which would give adequate velocity anomaly resolution and the best estimate of error associated with velocity determination.

The experiments carried out to date at Chalk River and Pinawa have shown that rather significant variations in velocities and in bulk elastic properties occurring in the borehole are often poorly correlated with borehole geology. However, it is suggested that a volume of rock circumjacent to the hole equal in radius of 8 to 15 m is involved in formation of the seismic frequency (↶200 Hz) employed in this survey. Hence, the method is monitoring macroscopic bulk properties of the rock mass unaffected by the presence of the borehole.

On a fait l'essai à Chalk River et à Pinawa d'une méthode d'enregistrement du profile par ondes de compression séismiques des trous de sondage pour l'employer dans la détection des fissures se produisant dans les masses rocheuses ignées et/ou métamorphiques. La technique adoptée consiste à suspendre un ensemble d'hydrophones dans le trou de sondage au moyen d'un câble marqué et à enregistrer les temps de parcours de l'énergie séismique des trous de tir de surface disposés horizontalement près du trou de sondage vers les hydrophones. On a appliqué plusieurs largeurs de fenêtres de gammes de moindres carrés à des données pondérées et non pondérées. On a choisi une largeur de fenêtre optimale mobile de gammes de moindres carrés à II points comprenant des valeurs extrêmes d'erreurs de chaque point de donnée non pondérée comme technique permettant la résolution satisfaisante des anomalies de vitesse et la meilleure évaluation des erreurs associées à la détermination de la vitesse.

Les essais effectués jusqu' à présent à Chalk River et à Pinawa ont montré que les variations assez importantes de vitesses et de propriétés élastiques générales se produisant dans le trou de sondage n'ont souvent qu'une faible relation avec la géologie des trous de sondage. On laisse supposer cependant q'un certain volume de roche circonjacent au trou de sondage ayant un rayon de 8 à 15 m a entraîné la formation de la fréquence sismique (↶200 Hz) employée dans cette étude. Par conséquent, la méthode permet de vérifier l'ensemble des propriétés macroscopiques de la masse rocheuse non influencées par la présence du trou de sondage.

Jackson, G.D. and Iannelli, T.R.

RIFT-RELATED CYCLIC SEDIMENTATION IN THE LATE PROTEROZOIC BORDEN BASIN, NORTHERN BAFFIN ISLAND; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 63, 1980.

Sedimentation began with deposition of 1000 m of braided stream to shallow subtidal quartzarenites and basal plateau basalts on a peneplaned gneiss complex locally capped by a regolith. These were succeeded by 1100 m of strata, which, adjacent to the Central Borden Fault Zone, include large sandstone-shale delta fan complexes that grade laterally northward into subtidal shales.

The above strata are overlain by 1700 m of supratidal to shallow subtidal stromatolitic shelf carbonates that contain karst-related lead-zinc mineralization, a subtidal shale zone south of the White Bay Fault Zone, and many gypsiferous coastal sabkha cycles in the east.

The upper sequence contains 2200 m of interbedded sandstones, shales, carbonates, and boulder conglomerates. In the lower part of the sequence, along the White Bay Fault Zone, alluvial fan complexes grade laterally southward into alluvial plain and intertidal sediments. These grade into intertidal to subtidal stromatolitic limestones and shale-sandstones turbidites which are absent north of the fault zone. The upper part of the sequence was deposited in mixed subtidal to alluvial plain, fluvial and possibly aeolian environments.

Paleocurrent trends and facies distributions indicate infilling of topographic lows, with subsequent rejuvenation of source areas caused by periodic faulting. Sedimentation in the Borden Basin occurred on a coastal platform with a major eastern land source. Late Proterozoic rifting may have been related to an ocean-opening event to the northwest, and early events in the Innuitian Mobile Belt.

Jackson, H.R, and **Blasco, S.M.**

GEOPHYSICAL AND GEOLOGICAL STUDIES IN THE CENTRAL AND EASTERN ARCTIC OCEAN; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 63, 1980.

Two ice stations LOREX and FRAM 1 were established in the spring of 1979 to investigate two distinct features of the Arctic Ocean basin, the Lomonosov Ridge, and the region adjacent to the Nansen (or Gakkel) Ridge. Survey techniques for LOREX included bathymetric and shallow seismic reflection profiling, sediment sampling, and sea bed photography; while at FRAM 1 deep seismic reflection and crustal refraction were carried out. The Lomonosov Ridge has a relief of 2800 metres and a width of 88 km along the drift path. Asymmetrical in shape, the American and Eurasian flanks have maximum apparent slopes of 12° and 7° respectively. Ridge morphology suggests the feature consists of an echelon fault blocks. A thin veneer of unconsolidated sediments on the ridge crest was probably deposited prior to the assumed separation from the Barents shelf. The presence of neritic dinoflagellate **Luxadinium propalulum** in these sediments suggests separation occurred no earlier than mid-Cretaceous. At FRAM 1 the seismic reflection data indicate the existence of 1.5 seconds of sediments infilling depressions between outcropping basement highs within 80 km of the Nansen ridge axis. Nine crustal refraction lines, 40 to 120 km in length reveal an oceanic crustal structure which is only 4 km thick. The arrivals from the M discontinuity are well defined and break over early limiting the crustal thickness. A strong shear wave arrival with the same phase velocity as the first arrival but with a greater intercept time is apparent in sediment covered areas.

Jackson, L.E., Jr.

GLACIAL HISTORY AND STRATIGRAPHY OF THE ALBERTA PORTION OF THE KANANASKIS LAKES MAP AREA; Canadian Journal of Earth Sciences, v. 17, p. 459-477, 1980.

Deposits of till, glaciofluvial, and glaciolacustrine sediments representing four glaciations are recognized in the Albera portions of the Kananaskis Lakes 1:250 000 map sheet (82J). The oldest episode is represented by scattered erratics and patches of till above 1400 m in the Porcupine Hills. This episode involved nonsynchronous advances of Laurentide and Rocky Mountain ice sheets. The next glacial episode involved coalescence of Rocky Mountain and Laurentide ice in the eastern Foothills, north of the Porcupine Hills. The Rocky Mountain Maycroft Till, the Laurentide Maunsell Till, and the glaciolacustrine Chain Lakes Clays and Silts were deposited during this episode. The next glaciation involved the last coalescence of Rocky Mountain and Laurentide ice sheets in the vicinity of the study area. The Rocky Mountain Bow Valley Till and the mixed Rocky Mountain – Laurentide provenance Erratics Train Till were deposited during this episode along with the Foothills Erratics Train. The latest glaciation involved an advance of the Laurentide ice sheet to the eastern margin of the study area and Rocky Mountain valley glaciers to the mountain front. One readvance of Rocky Mountain valley glaciers during retreat is recognized. The glaciolacustrine Midnapore Silts and Clays were deposited due to Laurentide ice damming of Bow River valley while the Canmore and Eisenhower Junction Tills were deposited by valley glaciers. On the basis of land mammal chronology, the two oldest glaciations are believed to be Illinoian in age. Radiocarbon evidence indicates the Erratics Train Glaciation to be at least Early Wisconsinan in age and the post-Erratics Train to be of Late Wisconsinan age.

On reconnait des dépôts de till et de sédiments fluvio-glaciaires et glacio-lacustres représentant quatre glaciations dans les parties albertaines de la carte 1:250 000 de Kananaskis Lakes (82-J). L'épisode le plus ancien est représenté par des blocs erratiques clairsemés et des lambeaux de till au-dessus de l'altitude 1400 m dans les collines de Porcupine. Cet épisode impliquait des avances non synchronisées des inlandsis des Laurentides et des Rocheuses. L'épisode glaciaire suivant est marqué par la coalescence des deux inlandsis dans la partie est des Foothills, au nord des collines de Porcupine. Le till de Maycroft du glacier des Rocheuses, le till de Maunsell du glacier des laurentides et les argiles et silts glacio-lacustres de Chain Lakes se sont déposés durant cet épisode. La glaciation suivante a vu la dernière coalescence de l'inlandsis des Rocheuses avec celui des Laurentides au voisinage de la région étudiée. Le till de Bow Valley (glacier des Rocheuses) et le till mixte Rocheuses-Laurentides composé d'une trainée de blocs erratiques se sont déposés durant cet épisode en même temps que la traînée d'erratiques des Foothills. La dernière glaciation a vu l'avancée de la glace des Laurentides jusqu' à la bordure est de la région étudiée et la progression des glaciers de vallée dans les Rocheuses jusqu' au front des montagnes. On peut reconnaître une réavancée des glaciers de vallée dans les Rocheuses au cours de leur retraite. Les argiles et silts glacio-lacustres de Midnapore se sont déposés à la suite du barrage de la vallée de la rivière Bow par la glace des Laurentides alors que les tills de Canmore et d'Eisenhower Junction ont été déposés par des glaciers de vallée. En se basant sur la chronologie des mammifères terrestres, les deux plus anciennes glaciations dateraient de l'Illinoien. Les données au radiocarbone indiquent que la glaciation des trainées d'erratiques daterait au moins du début du Wisconsinien et que les sédiments subséquents dateraient de la fin du Wisconsinien.

Jansa, L.F.

SEDIMENTARY PROCESSES IN THE NORTH ATLANTIC AND THEIR SIGNIFICANCE IN PLATE TECTONIC RECONSTRUCTIONS; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 64, 1980.

Tectonic, climatic and paleo-oceanographic events are reflected in the composition of the sedimentary strata in the North Atlantic basin. The oldest sediments encountered in the basin to date are Oxfordian-Hauterivian pelagic limestones which were deposited in an oxidizing, bathyal environment above CCD, after the onset of seafloor spreading. Toward the end of the Neocomian, anoxic conditions in the basin resulted in the deposition of dark, marly chalk beds. This process culminated in the Barremian with the deposition of organic rich clays. The Late Cretaceous transgression is reflected in the deep sea basin by starved conditions and zeolitic variegated clays. During Late Paleocene through Middle Eocene time biogenic silica deposition predominated in the deep basin. Accumulation of mixed calcareous-siliceous sediments on the shelf at the same time may reflect enhanced circulation and upwelling in response to cooler climate. A major unconformity beneath the continental rise reflects erosion by contour-currents between the Late Eocene and the earliest Miocene; scouring affected sediments as old as Lower Cretaceous. Rapid hemipelagic deposition with turbidites and debris-flows has dominated deposition in the basin since the Early Miocene.

The deep sea sediments reflect the major sedimentological changes on the shelves, where the Late Jurassic to Early Cretaceous was dominated by carbonate bank development, the Early Cretaceous to Cenomanian by terrigenous clastics and extensive deltas, and the Late Cretaceous by deposition of littoral shales.

The presence of syntopogenic rock units of different composition on opposite margins of the North Atlantic demonstrates the difficulty of application of rock comparative methods in plate tectonic reconstructions.

Jansa, L.F., Enos, P., Tucholke, B.E., **Gradstein, F.M.,** and Sheridan, R.E.

MESOZOIC-CENOZOIC SEDIMENTARY FORMATIONS OF THE NORTH AMERICAN BASIN; WESTERN NORTH ATLANTIC; in Maurice Ewing Series 3, Deep Drilling Results in the Atlantic Ocean Continental Margins and Paleoenvironment, M. Talwani, W. Hay, and W.B.F. Ryan, American Geophysical Union, Maurice Ewing Series 3, 1979.

Deep Sea Drilling Project sites in the North American Basin penetrated Mesozoic and Cenozoic sedimentary sequences of similar lithology, age, faunal assemblages and petrographic composition, permitting the definition of six formations. These are in ascending order: the Cat Gap Formation (Oxfordian-Tithonian grey-green limestone, reddish-brown argillaceous limestone, and calcareous claystone); the Blake-Bahama Formation (Tithonian-Barremian light grey limestone and chalk); the Hatteras Formation (Barremian-Cenomanian black and green-grey shale and claystone); the Plantagenet Formation (Late Cenomanian to ?Early Eocene varicolored zeolitic clay); the Bermuda Rise Formation (Paleocene to Middle Eocene chert and siliceous ooze); and the Blake Ridge Formation (Eocene to Holocene hemipelagic grey-green mud with local mass-flow deposits). In addition, the Crescent Peaks Member (Maastrichtian nannofossil marl) of the Plantagenet Formation and the Great Abaco Member (Miocene mass-flow deposits) of the Blake Ridge Formation are defined. The Cat Gap, Blake-Bahama, and Bermuda Rise Formations and the Crescent Peaks and Great Abaco Members are seismically mappable, with the formation boundaries approximately corresponding to major seismic reflectors (C, β, A^C, A*, M, respectively) in the western North Atlantic.

The oldest sedimentary rocks recovered by DSDP in the North American Basin are red or grey-green argillaceous limestones at Sites 99, 100 and 105, which are not older than Oxfordian. These sediments were deposited in a deep bathyal environment, near but above the calcite compensation depth (CCD). Pelagic carbonate deposition above the CCD continued into the Barremian, producing light-grey limestones. The CCD shallowed abruptly in the Barremian, and this was accompanied by stagnation of bottom and intermediate water that developed euxinic conditions which extended through the Cenomanian. Bottom circulation was re-established in the Late Cretaceous, but shallow CCD and lack of terrigenous input to the deep basin resulted in deposition of pelagic multicolored clays. Maastrichtian limestone beds within otherwise carbonate-poor variegated clays indicate temporary deepening of the CCD in the North American Basin in the Late Cretaceous.

Pelagic and hemipelagic clays were deposited in much of the deep basin during the Paleocene, followed by accumulation of dominantly biogenic siliceous deposits in the deep basin in latest Paleocene through Middle Eocene time. Mixed siliceous and calcareous sediments accumulated on the shallower mid-oceanic ridge. Silica diagenesis formed porcelanitic cherts in the upper Lower to lower Middle Eocene sediments, and these correlate with the widespread seismic reflector Horizon A^C. The Upper Eocene and Oligocene are represented by clays with varying amounts of biogenic silica and carbonate, together with locally important mass-flow deposits. Towards the continental margin, sediments of this age are missing because a major pre-Miocene unconformity overlies Lower Cretaceous to Eocene sediments beneath the continental rise. Except for calcareous ridge-flank sediments, deposition of hemipelagic grey-green mud was predominant in the North American Basin throughout the Neogene and continues to the present. The thickest deposits are Miocene and form the continental rise. Mass-flows from the continental shelf and slope deposited a massive blanket of Miocene carbonate breccia (the Great Abaco Member) in the Blake-Bahama Basin, and form flat-lying wedges of dominantly Pleistocene terrigeneous sand silt and clay in the present abyssal plains.

Jansa, L.F., Remane, J., and **Ascoli, P.**

CALPIONELLID AND FORAMINIFERAL-OSTRACOD BIOSTRATIGRAPHY AT THE JURASSIC-CRETACEOUS BOUNDARY, OFFSHORE EASTERN CANADA; Rivista Italiana de Paleontologia, v. 86, no. 1, p. 67-126, 1980.

Calpionellid assemblages found in five offshore oil exploratory wells drilled on the Canadian Atlantic Shelf, can be correlated with the European Late Tithonian-earliest Berriasian calpionellid zones A and B, indicating that the Grand Banks and the Iberian Peninsula were already separated by a deep sea in the Tithonian. The established calpionellid zonation permits calibration of the stratigraphic ranges of Foraminifera and Ostracoda at and near the Jurassic-Cretaceous boundary in offshore eastern Canada. The top of the Tithonian has been placed at the highest stratigraphic occurrence of **Anchispirocyclina lusitanica** (Egger), which in Bonnition H-32 corresponds to the lower part of calpionellid zone B.

The co-occurrence of Tethyan and Boreal foraminiferal species near the Jurassic-Cretaceous boundary on the Scotian Shelf and Grand Banks is interpreted to reflect paleocirculation pattern with the Tethyan species favouring warmer waters and thus occurring in shallower environments and the Boreal species flourishing in colder, deeper waters. Colder waters from North Europe and Greenland, providing favourable living conditions for Boreal foraminiferal species, probably flowed southward along the North American margin, while warmer waters rich in Tethyan species were outflowing from the Mediterranean into the North Atlantic. The warm water influence on the central North Atlantic is confirmed by the presence of calpionellids in five Deep Sea Drilling Project sites from eastern and western North Atlantic. Calpionellids at these sites are assigned to Late Tithonian zones A and B.

Les associations de Calpionelles trouvées dans cinq sondages offshore forés dans la plateforme atlantique Canadienne, peuvent être correlées avec les zones A et B de Calpionelles du Tithonien supérieur-Berriasien basal. Elles indiquent qu'au Tithonien les Grand Banks de Terre-Neuve et la Péninsule Ibérique étaient déjà séparés par une mer profonde. La zonation établie aves les Calpionelles permet de calibrer les répartitions stratigraphiques des foraminifères et des ostracodes dans la plateforme atlantique canadienne à ou près de la limite jurassique-crétacé. Le sommet du Tithonien a été placé à la plus haute occurrence stratigraphique de **Anchispirocyclina lusitanica** (Egger), qui, dans Bonnition H-32, correspond à la partie inférieure de la zone B à Calpionelles. On interprète que la coexistence des espèces de foraminifères téthyennes et boréales près de la limite jurassique-crétacé sur le Scotian Shelf et les Grand Banks a été causée par des différences de paléocirculation et de température de l'eau. Les espèces téthyennes préféraient les eaux plus chaudes et apparaissaient ainsi dans les environments moins profonds et les espèces boréales florissaient dans les eaux plus froides et plus profondes. Les eaux froides du Nord de l'Europe et du Groenland, fournissant des conditions de vie favorables aux espèces boréales de foraminifères, coulèrent probablement vers le Sud, le long de

la côte nord américaine, tandis que les eaux plus chaudes, riches en espèces téthyennes, coulèrent de la Méditerranée dans l'Atlantique Nord. L'influence de l'eau chaude sur le centre de l'Atlantique Nord est confirmée par la présence de Calpionelles dans cinq sites de Deep Sea Drilling Project de l'Est à l'Ouest de l'Atlantique Nord. Les Calpionelles, dans ces sites, sont attribuées aux zones A et B du Tithonien supérieur.

Jansa, L.F., Ascoli, P., and Remane, J.

CALPIONELLID AND FORAMINIFERAL-OSTRACOD BIOSTRATIGRAPHY AT THE JURASSIC-CRETACEOUS BOUNDARY, OFFSHORE EASTERN CANADA; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 64, 1980.

Calpionellid assemblages found in five offshore oil exploratory wells drilled on the Canadian Atlantic Shelf are identical with European Late Tithonian-earliest Berriasian calpionellid zones "A" and "B". The stratigraphic ranges of Foraminifera and Ostracoda at and near the Jurassic-Cretaceous boundary in offshore eastern Canada are calibrated with the established calpionellid zonation. The top of the Tithonian has been placed at the highest stratigraphic occurrence of **Anchispirocyclina lusitanica** (Egger), which in the Mobil-Gulf Bonnition H-32 well corresponds with the lower part of the calpionellid zone "B". Fifteen other foraminiferal and 14 ostracod marker species allow refinement of the dating and correlating of the Kimmeridgian to Valanginian sediments of the Scotian Shelf and Grand Banks, whether in shallow water or in deep water facies. Concurrence of Tethyan and Boreal foraminiferal species near the Jurassic-Cretaceous boundary on the Scotian Shelf and Grand Banks in interpreted to reflect differences in paleocirculation and water temperature. Available evidence suggests that colder waters from North Europe and Greenland provided favourable living conditions for Boreal foraminiferal species, and probably flowed southward along the North American margin, while warmer waters rich in Tethyan species flowed out from the Mediterranean into the North Atlantic.

Jansa, L.F., Bujak, J.P. and **Williams, G.L.**

UPPER TRIASSIC SALT DEPOSITS OF THE WESTERN NORTH ATLANTIC; Canadian Journal of Earth Sciences, v. 17, p. 547-559, 1980.

The Amoco-Imp-Skelly Osprey H-84 well, located in the Carson subbasin on the eastern Grand Banks of Newfoundland, penetrated 2054 m of evaporites consisting almost exclusively of halite. These are dated palynologically as Carnian-Norian to Hettangian-Sinemurian and establish the occurrence of Upper Triassic evaporites on the western side of the North Atlantic. A lateral-fractionation model is proposed to explain the progressive decrease in less soluble evaporitic minerals west of the western periphery of Tethys. According to this model, slow and intermittent encroachment of the sea into the developing intracontinental graben system occurred after initial rifting. This encroachment took place in a hot and arid climatic zone and led to the brines becoming progressively depleted in less soluble salts towards the distal margins of the basin system. The similarity in composition of the Upper Triassic evaporitic sequences on the Grand Banks and in the Lusitanian Basin indicates that the two areas were close at this time. This would preclude major rotation of the Iberian Peninsula and the presence of a cratonic arch between the Iberian Peninsula and Grand Banks.

Le puits Amoco-Imp-Skelly Osprey H-84, situé dans le sous-bassin de Carson dans la partie est des Grands Bancs de Terre-Neuve, a percé à travers 2054 m d'évaporites constituées presqu'exclusivement de halite. Sur une base palynologique, ces évaporites dateraient du Carnien-Norien au Hettangien-Sinémurien, ce qui confirme la présence d'évaporites du Trias supérieur dans la partie ouest de l'Atlantique Nord. On propose un modèle de fractionnement latéral pour expliquer la diminution progressive des minéraux d'évaporites moins solubles à l'ouest de la bordure ouest de Téthys. D'après ce modèle, l'envahissement lent et intermittent par la mer du système de graben intracontinental qui se développait s'est produit dans une zone climatique chaude et aride et a fait que les saumures se sont progressivement appauvries en sels moins solubles vers les marges distales du système de bassin. La ressemblance dans la composition des séquences d'évaporites du Trias supérieur sur les Grands Bancs et dans le bassin lusitanien indiquent que les deux régions étaient rapprochées à cette époque. Ceci rend impossible une rotation majeure de la péninsule ibérique et la présence d'une arche cratonique entre la péninsule ibérique et les Grands Bancs.

Keen, C.E. and Royden, L.

THERMAL AND TECTONIC RECONSTRUCTION OF THE EASTERN CANADIAN CONTINENTAL MARGIN DETERMINED FROM SUBSIDENCE HISTORY; Northeastern Section of the Geological Society of America, 15th Annual Meeting, Abstracts with Programs, March 13-15, 1980.

Quantitative analysis of the subsidence history from subsided basins at rifted continental margins yields information about the nature, timing and thermal consequences of tectonic processes associated with basin formation. The subsidence history of the Nova Scotian and Labrador shelves, determined from deep exploratory well data, indicates that these regions underwent extension during rifting in the Early Jurassic and Late Tertiary, respectively, and have since subsided passively due to conductive cooling of the lithosphere. The timing of the extension process is consistent with the ages of the oldest sea floor adjacent to these margins. The magnitudes of extension determined solely from the subsidence history are in good agreement with observed crustal thicknesses obtained from seismic refraction data, and yield a present thermal gradient almost identical with that measured in the offshore wells. The paleotemperatures within the sediments suggest that thermal conditions have been favorable for hydrocarbon generation in some of the older strata.

Keen, C.E.

EARLY EVOLUTION OF RIFTED CONTINENTAL MARGINS; EOS, Transactions, American Geophysical Union; v. 61, no. 17, p. 206-207, 1980.

Comprehensive studies of the deep crustal structure on the rifted margins of Eastern Canada show that the continental crust thins by amounts up to 17 km towards the ocean continent boundary. The thinning occurs over horizontal distances of several tens to hundreds of kilometers and is perhaps the most striking and ubiquitous feature of crustal profiles across rifted margins. Such crustal thinning probably occurred as a result of extensional forces during the early development of these margins, perhaps by brittle faulting in the upper crust and flow in the lower crust. This extension process appears to have dominated others, such as volcanism or deep crustal metamorphism, which may also have modified the continental crust during rifting. A simple model of extension in which the amount of extension is estimated from the deep crustal structure, allows the

subsidence and sedimentation history, as well as the thermal evolution of the margins to be predicted. The predicted subsidence is in excellent agreement with that obtained from analysis of data in many deep exploratory wells off Eastern Canada. The predicted thermal evolution can be used to determine probable rheological models of the lithosphere which vary both with time and with position across the margins. The paleotemperatures are also useful in estimating whether the sediments, which are potential sources of hydrocarbons, will have undergone a thermal history favourable to the generation of sufficiently mature organic material.

Royden, L. and **Keen, C.E.**

RIFTING PROCESS AND THERMAL EVOLUTION OF THE CONTINENTAL MARGIN OF EASTERN CANADA DETERMINED FROM SUBSIDENCE CURVES; Earth and Planetary Science Letters, v. 51, p. 343-361, 1980.

The subsidence history of the Nova Scotia and Labrador shelves, determined from deep exploratory well data, indicates that these regions underwent extension during rifting in the Early Jurassic and Late Cretaceous, respectively, and have since subsided passively due to conductive cooling of the lithosphere. The timing of the extension process is consistent with the ages of oldest sea floor adjacent to these margins. Extension parameters determined from the subsidence history of the Nova Scotian margin indicate both crustal and subcrustal material extended by approximately the same amount. For Labrador, the extension parameters indicate that the mantle lithosphere was extended considerably more than the crust. The magnitudes of extension on both margins are in good agreement with observed crustal thicknesses determined from seismic refraction data. Profiles depicting the sedimentary stratigraphies and depth to basement were constructed across each margin. The temperature distribution within the sediments was calculated from the extension parameters using a two-dimensional model with sediment units of varying thickness, radioactive heat production, and conductivity. The calculated temperature distribution across the margins is in good agreement with bottom hole temperatures measured in deep exploratory wells, and with surface heat flow measurements where they are available. Similar plots of temperature paleotemperature within the sediments suggest that thermal conditions have been favorable for hydrocarbon generation in some of the older strata.

Keen, C.E. and Beaumont, C.

PALEOTEMPERATURE DISTRIBUTION AND MECHANICAL PROPERTIES OF THE LITHOSPHERE BENEATH RIFTED MARGINS – IMPLICATIONS FOR ISOSTASY AND SEDIMENTARY BASIN FORMATION; 26^{e} Congrès Géologique International, Abstracts, Paris, 7-17 July, 1980, Volume III, Sections 13 à 20.

Recent models for the evolution of rifted continental margins have enjoyed singular success in predicting the broad features of their observed subsidence history and in describing the paleotemperatures and the consequent maturity of hydrocarbons which may be present within marginal sedimentary basins. However, the potential of these models for predicting changes in the mechanical properties of the lithosphere, both in time and space, has not been exploited. Such properties control the means by which the margins are maintained in isostatic equilibrium. They therefore affect the response of the lithosphere to sediment loading which in turn partly controls the shape of the sedimentary basins, their subsidence as functions of both time and space, and the shape of the gravity "edge-effect" anomaly. In this paper the thermal history within the lithosphere is used to predict these mechanical properties and it is shown how their variation has affected the evolution of marginal sedimentary basins, in terms of subsidence and depositional histories. Examples are given for several rifted margins of different ages off Eastern North America, where deep exploratory well data, stratigraphic cross-sections and gravity data are available with which to compare the model predictions.

Keen, C.E. and **Cordsen, A.**

OBS REFRACTION RESULTS FROM THE CONTINENTAL MARGIN OFF NOVA SCOTIA: Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 65, 1980.

Two seismic refraction lines were shot subparallel to the edge of the shelf off Nova Scotia using Ocean Bottom Seismometers as receivers; one line lies across Banquereau Bank while the other is located approximately 70 km seaward of Sable Island over the foot of the continental slope. Models of crustal structures presented here are developed on the basis of results from travel time analysis, using layered model techniques, the tau-p extremal inversion technique, and ray tracing. Sonic logs from three nearby exploratory wells are utilized as additional constraints in deriving a satisfactory model of the geological section beneath Banquereau Bank.

The model shows that the Upper Triassic and Lower Jurassic salt deposits beneath Banquereau Bank are at least 2.3 km thick; sedimentary rocks below may reach a thickness of 7 km unless part of this layer is comprised of Meguma basement. Only one seismic velocity, which could represent either unit, is found for this layer.

The major crustal layer has a seismic velocity of 6.3 km s^{-1} beneath Banquereau Bank; the depth to its top surface appears to be 9.5 km in the west and 16 km in the east of this survey area.

The profile over the continental slope, although unreversed, reveals crustal velocities of 5.9 km s^{-1} identified with a 1.7 km thick oceanic layer 2 and a velocity of 7.8 km s^{-1} representing mantle at a depth of 9.5 km.

Kerr, J.Wm. and Dawes, P.R.

THE CASE FOR MINOR LEFT LATERAL NET DISPLACEMENT ALONG NARES STRAIT; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 65, 1980.

Nares Strait, between Greenland and Ellesmere Island, is the site of an important fault zone that was active during late Phanerozoic continental break-up. Broadly speaking two different interpretations have been made of the strait, one from geological evidence, and the other from geophysical evidence.

Geological data from lands bordering Nares Strait indicate that net left lateral displacement along it is minor, certainly less than 50 km, and probably less than 25 km. Geophysical data collected elsewhere, in Baffin Bay and Labrador Sea, as well as globally, has generally been used to suggest much greater left lateral displacement. Some workers suggest 100 km, but most suggest between 220 and 400 km.

Nares Strait cuts obliquely across the northern margin of the North Atlantic Craton and through one of its Proterozoic intracratonic basins. It also cuts through an extensive lower Paleozoic platform and a thicker trough (Franklinian Geosyncline), the latter now represented by a regional belt of folding and metamorphism. The geological evidence that displacement was minor is the close alignment

of Proterozoic and lower Paleozoic sedimentary facies belts and isopach trends across the strait, supported by structural and metamorphic evidence from the fold belt.

The foremost argument in support of great displacement along Nares Strait has been that, without such displacement, the structure and oceanic crust of Baffin Bay and Labrador Sea cannot be easily explained by the generally accepted plate tectonic model based on substantial sea floor spreading. However there is at least one other reasonable plate tectonic model for the formation of Baffin Bay and Labrador Sea, that involves lesser sea floor spreading, and only minor displacement along Nares Strait.

Kerr, J.Wm.

HISTORICAL BACKGROUND TO THE NARES STRAIT DILEMMA: Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 65, 1980.

It was first suggested by Taylor in 1910 that Greenland drifted hundreds of kilometres northward along Nares Strait. Wegener put forth the same view in the 1920's as part of his Continental Drift Theory, but was widely opposed. A concensus soon developed that drift had not occurred, and for several decades it apparently was taken for granted that there had been no lateral displacement along Nares Strait.

In 1958 Carey rejuvenated the Continental Drift Theory and once again invoked great displacement along Nares Strait. This was not generally accepted until 1963, when J.T. Wilson supported the idea. Since then, during the ascendency of plate tectonic theory, the probability of great displacement along Nares Strait has become widely accepted.

There now are three schools of thought regarding Nares Strait, all apparently agreeing that it is fault-controlled. Supporters of conventional Plate Tectonic theories invoke great lateral displacement (220 km or more), but have made various reconstructions, including some with oblique movement. Fixists have not discussed Nares Strait specifically, but imply lack of displacement as part of their overall model for the Arctic. The author's intermediate view suggests minor rotational opening from the south, minor lateral displacement (approximately 25 km or less), and major foundering of continental crust. These latter two views are supported by few scientists.

The origin of Nares Strait has important consequences to tectonics. If displacement was great as conventional plate tectonic theory suggests, then that theory has withstood a major challenge. If displacement was minor, or non-existent, then plate tectonics is faced with a major problem concerning the origin of rifted ocean basins.

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

"REAL TIME" DECONVOLUTION OF GAMMA-RAY LOGS WITH A NEW GENERATION PORTABLE LOGGING SYSTEM; The Log Analyst, v. 21, no. 2, p. 23, 1980.

An ideal borehole log would present the desired information immediately instead of after the delays and expense of computer processing. This ideal has been approached closely in the case of gamma-ray logging for uranium ore grade determinations by using suitable inverse filters to deconvolve the gamma-ray log as it is being recorded. The technique was initially implemented in the minicomputer-based R & D logging truck of the Geological Survey of Canada. Successful testing and evaluation in model holes and field boreholes has led to the development of a microprocessor-based portable digital logging system which performs the deconvolution of gamma-ray logs in essentially real time (delayed only by half the filter length). This new generation logging system was built under contract to the G.S.C., and a commercial version is now being offered by the manufacturer.

Gamma-ray spectral logging with the system is described. In addition to deconvolution, this system provides on-line correction for borehole parameters, complete spectral stripping and simultaneous digital recording of ten software selectable gamma ray energy windows. Full spectral recording (512 channels) can also be accomplished, if desired. The system is stabilized against energy drift due to borehole temperature variations. The system was designed for logging in remote areas, and therefore weight has been minimized to the extent possible without restricting the systems advanced capabilities.

In addition to on-line processing, the raw data are recorded digitally on a cartridge tape recorder, and a flexible playback program allows the original data to be reprocessed using different parameters, with simultaneous output of up to eight channels of information via digital to analog converters. Field data obtained with the new system are presented and discussed.

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

THE APPLICATION OF INVERSE FILTERING TO BOREHOLE GAMMA-RAY SPECTRAL LOGGING; EOS, v. 61, no. 17, p. 415, 1980.

In uranium exploration an iterative technique is commonly used to convert count rates recorded in a gamma-ray log to a measure of uranium ore grades and thickness of mineralized zones. An alternative approach now available is to use a digital inverse filter to deconvolve the gamma-ray log in one pass to produce a profile of uranium concentrations as a function of depth. Inverse filtering of the data can improve the spatial resolution of the gamma-ray log, increase the accuracy of grade-thickness determinations, and reduce the computing time and core storage requirements (relative to iteration).

The inverse filter technique which enables 'real time' data processing in the field has been implemented in the truck mounted DIGI-PROBE R&D logging system of the Geological Survey of Canada, and in a microprocessor based portable logging system. Tests based on logging a model hole with a known complex distribution of uranium grades and thicknesses demonstrate the effectiveness of the technique.

When potassium and/or thorium contribute significant gamma radiation, deconvolution can be extended to gamma-ray spectral logs by using information from the spectral windows to modulate the total count gamma-ray log to determine the uranium grade and thickness of mineralized zones.

Parrott, D.R., Dodds, D.J., **King, L.H.,** and Simpkin, P.G.

MEASUREMENT AND EVALUATION OF THE ACOUSTIC REFLECTIVITY OF THE SEA FLOOR; Canadian Journal of Earth Sciences, v. 17, p. 722-737, 1980.

The effect of seabed character on the distribution of acoustic energy reflected from the seabed was studied using digitized data from a high resolution, broad band, seismic source (Huntec Deep Towed Seismic System). Reflected energy was measured in two time windows representing the top metre of the seabed, and normalized to correct for operational variables and spreading losses due to propagation in the water column. These energy values were used to calculate acoustic reflectivity as a percentage of the energy content of the original outgoing pulse, and were displayed as continuous profiles alongside the seismic section. Most of the surficial geology formations on the Scotian Shelf,

established from previous investigations, are seen to have a characteristic range in reflectivity. Thus, the acoustic reflectivity profiles enhance the seismic section by providing quantitative information on the nature and distribution of the lithology of the seabed in addition to the stratigraphic information which is normally obtained.

On a étudié l'influence des caractéristiques du fond marin sur la distribution de l'énergie acoustique réfléchie par le fond marin en utilisant des données digitalisées provenant d'une source sismique (Huntec DTS) à haute résolution et à large bande. On a mesuré l'énergie réfléchie dans deux fenêtres de temps représentant le mètre supérieure du fond marin et on a normalisé pour corriger les variables opérationnelles et les pertes par diffusion causées par la propagation dans la colonne d'eau. On a utilisé ces valeurs d'énergie pour calculer la réflectivité acoustique comme un pourcentage du contenu en énergie de l'impulsion originale émise et on les représente par des profils continus le long de la coupe sismique. La plupart des formations géologiques superficielles sur la plate-forme de Scotian, identifiées dans des études antérieures, semblent avoir un domaine caractéristique de réflectivité. Ainsi, les profils de réflectivité acoustique mettent en relief la coupe sismique en fournissant de l'information quantitative sur la nature et la distribution des lithologies sur le fond marin en plus de l'information stratigraphique qu'on obtient normalement.

King, L.H.

ASPECTS OF REGIONAL SURFICIAL GEOLOGY RELATED TO SITE INVESTIGATION REQUIREMENTS – EASTERN CANADIAN SHELF; in Offshore Site Investigation, Proceedings of a conference sponsored by The Society of Underwater Technology, The Geological Society of London, and the Institution of Civil Engineers, ed. D.A. Ardus, Published by Graham & Trotman Limited.

Results of regional surficial geological mapping on the eastern Canadian Shelf provide a basis for demonstrating the potential use of such regional studies in the planning, execution, and interpretation stages of site investigation surveys.

Engineers are primarily interested in the stability of the seabed and substrate, and there are many geological elements and attributes of the seabed that appear to be significant to such interests. These aspects are varied and include the textural character of sediments and their distribution, bed forms and their environmental significance, the occurrence of gas in sediment, the occurrence of pockmarks, a knowledge of whether or not the seabed is in equilibrium with its present environment, and many others.

Regional studies provide an inventory of these geological aspects, an appreciation for their spatial variability, interrelationships and continuity, and information on their mode of origin and geological history. This background knowledge is essential if one is to confidently and thoroughly interpret geological data on a local scale.

Kirkham, R.V.

COPPER OCCURRENCES IN CARBONIFEROUS SEDIMENTARY SEQUENCES OF THE ATLANTIC PROVINCES; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 66, 1980.

Although no significant production has been obtained from them, copper occurrences are widespread in Carboniferous sedimentary sequences of the Atlantic Provinces. Occurrences are found primarily in two geologic settings: paralic marine and fluviatile rocks; both types have close associations with red beds.

Occurrences in paralic marine rocks are restricted to the Viséan Windsor and the correlative Codroy Group. Minor, conformable concentrations of copper, lead, and/or zinc sulphides are widely distributed along the basal contact of Lower Windsor limestone where it overlies continental red beds of the Horton or stratigraphically equivalent Groups. Somewhat similar, conformable base metal sulphides also occur disseminated in Upper Windsor oölitic, stromatolitic, and/or micritic limestones underlain and overlain by red beds.

Although a few, very minor copper occurrences have been found in braided stream and lacustrine deposits, most of the "continental" ones are found in typical Upper Windsor and Pennsylvanian fining-upward meandering stream deposits. In contrast with a number of lead (zinc) occurrences of the Salmon River (Yava)-type, which occur in grey fluviatile rocks of the basal parts of coal bearing sequences, copper sulphides are found only where a significant portion of the section is red. These occurrences show reduction and permeability controls, with most of the copper having been concentrated in lower, coarse-grained channel lag and point bar deposits that contain significant amounts of wood trash and early diagenetic pyrite. The Dorchester copper deposit in New Brunswick, the best known example of this type, occurs in the base of the Pennsylvanian Boss Point Formation.

Copper occurrences in Carboniferous sedimentary sequences were formed during early diagenesis. The copper probably was derived from the red beds, transported in NaCl brines, and deposited in any reduced sediment with which the brines came in contact.

Kornik, L.J. and **Teskey, D.J.**

INTERPRETATION OF AEROMAGNETIC GRADIOMETER SURVEYS IN THE WOLLASTON LAKE AREA, SASKATCHEWAN; EOS, v. 61, no. 17, p. 416, 1980.

An area 27 by 43 km located west of Wollaston Lake in Saskatchewan was surveyed in 1979 with the G.S.C. airborne vertical gradiometer system.

The increased sensitivity of the high-resolution total field and vertical gradient maps of this area which includes Rabbit Lake and Midwest Lake presents a much more detailed picture of the regional lithology and structure than the older standard resolution maps.

Quantitative methods are employed to provide estimates of the parameters (depth, susceptibilities and dimensions) of magnetic sources, thus giving some indication of the depth to the Archean/Aphebian basement and the topography of this basement surface.

Lachance, G.R. and Claisse, F.

A COMPREHENSIVE ALPHA COEFFICIENT ALGORITHUM; From: Advances in X-Ray Analysis, v. 23, Edited by John R. Rhodes, Plenum Publishing Corporation, 1980.

An algorithm is proposed as a model that describes the intensity-concentration relation over a wide concentration range in binary and more complex systems involving absorption and enhancement. All the influence coefficients can be determined from fundamental parameter equations. Terms containing product of two weight fractions are always negligible in pure absorption cases, are often negligible in absorption/weak enhancement cases and are necessary but small in strong absorption/strong enhancement situations.

Once the magnitude of the coefficeints is known, the range of application of the one- or two-coefficient models can be established with certitude.

Lachance, G.R.

A PRACTICAL RELATION BETWEEN ATOMIC NUMBERS AND ALPHA COEFFICIENTS; Presented at the 28th Annual Conference on Applications of X-Ray Analysis, Denver, Colorado (1979).

A first approximation indicates that fundamental alpha coefficients for a given analyte vary as a function of the ratio of their respective atomic number raised to a power. This simple rule applies mainly at the limits (i.e., when the weight fraction of analyte i, W_i is of the order of 0.0 or 1.0) in cases of absorption and weak enhancement. The relation thus provides a means of generating coefficients for the system i-k from experimental data obtained on system i-j and a means of verifying experimental alphas, since arrays of coefficients must show a high degree of concordance.

LeCheminant, A.N. and **Eade, K.E.**

THE BAKER LAKE BASIN: AN EARLY PROTEROZOIC RIFT; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 68, 1980.

The Baker Lake Basin and smaller subparallel basins in the District of Keewatin contain continental sedimentary and igneous rocks that record a period of extensional tectonics at about 1.8 Ga. The basins are generally parallel to earlier structual trends in the Archean and Aphebian basement. Sedimentary rocks, mainly alluvial fan and fluvial deposits, reflect major changes in provenence but little change in depositional environments during development of the basins. The basins may have formed in response to tectonic events marginal to the western Churchill craton such as collisions within the Wopmay Orogen.

The Baker Lake Basin, a northeasterly trending complex graben, is more than 300 km long and averages 50 km wide. Development began with basement uplift followed by deposition of red bed sequences in subsiding troughs. Red beds were buried by products of subaerial alkaline volcanic cycles that mark the initial stage in the igneous history of the basin. Wedges of volcaniclastic alluvial fan sediments overlie the alkaline lavas. Renewed igneous activity resulted in a bimodal association of acid and basic volcanic and plutonic rocks. Rhyolite flows are probably comagmatic with granite plutons that intrude central and southwest parts of the basin. The acid rocks are closely associated with small gabbroic intrusions and a few basalt flows. The Pamiutuq Granite, emplaced near the southwest end of the basin, shows evidence for injection of basic magma into acid magma. Evolution of the basin ended with cessation of igneous activity except for minor faulting and local infilling of the northwest side of the basin by sandstones of the Thelon Formation.

Lewis, C.F.M., MacLean, B. and **Falconer R.K.H.**

ICEBERG SCOUR ABUNDANCE IN LABRADOR SEA AND BAFFIN BAY; A RECONNAISSANCE OF REGIONAL VARIABILITY; in Proceedings on the First Canadian Conference on Marine Geotechnical Engineering, published by The Canadian Geotechnical Society, p. 79, 1980.

Lichti-Federovich, S.

DIATOM FLORA OF RED SNOW FROM ISBJØRNEØ, CAREY ØER, GREENLAND; Nova Hedwigia, Band XXXIII, Braunschweig, J. Cramer, p. 395-432, 1980.

Diatom analytical investigation of a 'red snow' melt water sample disclosed a flora comprising three distinct components, represented by 104 taxa within 28 genera: an oligohalobous element dominated by **Pinnularia krookii** Grun., a mesohalobous constituent and a small, euhalobous component. Consideration of the compositional pattern of the diatom association suggests the importance of 'adapability to changes in osmotic pressure' as controlling physiological parameter characterizing the species of this nival biotope. Taxonomic enumeration with notes on species distribution and autecologic information are presented.

Lichti-Federovich, S.

NAVICULA SUBFOSSILIS SP.NOV., THE DOMINANT TAXONOMIC ENTITY OF A PLEISTOCENE ASSEMBLAGE FROM ELLESMERE ISLAND, N.W.T.; Canadian Journal of Botany, v. 58, p. 1334-1340, 1980.

The numerically dominant diatom of a Pleistocene marine littoral assemblage has been ascribed to the **Naviculae microstigmaticae** section and assigned a "new species" status. Scanning electron and light photo micrographs have been presented to demonstrate the structural features used in the morphological delineation of the taxon **Navicula subfossilis** sp.nov. The phenotypic characteristics of allied forms have been evaluated and their structural relationships have been assessed.

La diatomée dominante numériquement dans un assemblage littoral marin d'âge pléistocène appartient à la section **Naviculae microstigmaticae** et le statut de "nouvelle espèce" lui est attribué. Des micrographies en microscopie photonique et électronique à balayage présentent les caractères structuraux utilisés pour la délinéation morphologique du taxon **Navicula subfossilis** sp.no. Les caractéristiques phénotypiques des formes apparentées et leurs relations structurales sont évaluées.

Livingstone, D.B. and **Falconer, R.K.H.**

SKYWAVE LORAN-C NAVIGATION AT SEA IN THE EASTERN ARCTIC; Proceedings of the 19th Annual Canadian Hydrographic Conference, Lighthouse, Journal of the Canadian Hydrographers' Association, Special Edition: March 1980.

Observations of skywave Loran-C in the eastern Arctic show that when used in conjunction with satellite navigation, skywave range-range Loran-C can be used for navigation throughout Baffin Bay and the northern Labrador Sea. The amount of diurnal propagation patn change can be predicted and thus corrected for. The times of sunrise and sunset transitions are related to solar zenith angle and thus are predictable. The realtime 1σ accuracy of the combined Loran-C/Satnav system was 420 m during daytime and 660 m at night. Postprocessing would improve the accuracy. The continuous navigation provided by skywave Loran-C has proven superior to the combined Satnav and log and gyro dead-reckoning used previously.

Goldflam, P., Weigel, W., and **Loncarevic, B.D.**

SEISMIC STRUCTURE ALONG RRISP – PROFILE I ON THE SOUTHEAST FLANK OF THE REYKJANES RIDGE; Journal of Geophysics, v. 47, p. 250-260, 1980.

During the first leg of the 'METEOR-Expedition 45', July 1977, crustal seismic refraction measurements were obtained in the vicinity of the Reykjanes Ridge, south of

Iceland. Profile I was located approximately along magnetic lineation anomaly 5 (8.34 9.74 Ma) and was a part of an 800-km-long land-sea seismic experiment. The purpose of the overall experiment was to study the changes in crustal structure of the Ridge near Iceland and to resolve the seismic structure at greater depth than was previously possible by extending the seismic line south of Iceland. At the Mohorovičić discontinuity the velocity increases to 7.7 km/s, a 'typical' low mantle velocity observed frequently in oceanic refraction profiles near ridge crests. A normal upper mantle velocity of 8.2 km/s is observed at a depth greater than 16 km. Reflection profiles show a rough basement topography in the south, becoming smooth towards the north. The results indicate: (i) that a normal oceanic crust is in place within 100 km of an active ridge crest; (ii) that the presence of Iceland has only a second-order effect on the oceanic crust to the south, (iii) that a normal upper-mantle velocity is present underneath a low (7.7 km/s) velocity at the Mohorovičić transition zone; and (iv) that velocity gradients in the lower crust and the upper mantle are consistent with the results of the inversion of time-distance data, but should be confirmed by synthetic seismogram modelling.

Sobczak, L.W. and **Long, D.G.F.**

PRELIMINARY ANALYSIS OF A GRAVITY PROFILE ACROSS THE BONNET PLUME BASIN, YUKON TERRITORY, CANADA: AN AID TO COAL BASIN EVALUATION; Canadian Journal of Earth Sciences, v. 17, p. 43-51, 1980.

Preliminary analysis of gravity anomalies across the Bonnet Plume Basin indicates that the gravity method can be used as a relatively inexpensive method of establishing basin structure and approximating formation thickness in coal basins with little to no subsurface control, providing that density contrast between the coal-bearing strata and underlying rocks is sufficiently high. In the Bonnel Plume Basin gravity measurements recorded along an east-west profile give Bouguer anomalies which vary from -42 to -82 mGal and place constraints on geological models which can be applied to the clastic fill of the Cretaceous-Tertiary basin. Within these constraints the Bonnet Plume Formation can be modelled as an eastward, gently dipping (1-9°) sequence of coal-bearing rocks which attains a maximum thickness of between 760 m and 4.7 km in a region 7 km west of Knorr Fault. The unconformity between the Bonnet Plume Formation and underlying Proterozoic rocks, east of this zone of maximum thickness, dips to the west at between 10 and 44°. Accurate estimates of both the thickness and dip of the sequence cannot be made due to inadequate knowledge of the subsurface distribution of the upper (low density) and lower (high density) members of the formation. Application of a two-layer model of the Bonnet Plume Formation would indicate that the upper, lignite-bearing member of the formation may be more restricted than previously suspected and that the greater proportion of the basin to the south of the line of profile is underlain only by the lower member, containing subbituminous coals.

L'analyse préliminaire des anomalies de gravité dans le bassin de Bonnet Plume indique que la méthode par gravité peut être utilisée comme une technique relativement peu dispendieuse pour établir la structure d'un bassin et pour évaluer l'épaisseur des formations dans les bassins houillers avec peu ou pas de contrôle de sous-surface, en autant que le contraste de densité entre les strates riches en charbon et les roches sous-jacentes soit suffisamment élevé. Dans le bassin de Bonnet Plume, les mesures de gravité enregistrées le long d'une coupe est-ouest donnent des anomalies de Bouguer qui varient de -42 à -82 mGal et qui apportent des contraintes sur le choix des modèles géologiques applicables au remplissage clastique du bassin du Crétacé-Tertiaire. A l'intérieur de ces contraintes, on peut représenter la formation de Bonnet Plume sur modèle comme une séquence de faible pendage (1-9°) à l'est composée de roches riches en charbon et qui atteint une épaisseur maximum entre 760 m et 4.7 km dans la région située 7 km à l'ouest de la faille de Knorr. La discordance entre la formation de Bonnet Plum et les roches du Protérozoique en dessous, à l'est de cette zone d'épaisseur maximum, a un pendage vers l'ouest entre 10 et 44°. On ne peut faire d'évaluations précise de l'épaisseur et du pendage de la séquence à cause des connaissances inadéquates de la distribution sous la surface des membres supérieurs (de faible densité) et inférieurs (de densité élevée) de la formation. L'application d'un modèle à deux couches pour la formation de Bonnet Plume indiquerait que le membre supérieur de la formations qui contient de la lignite pourrait être plus limité qu'on ne le croyait auparavant et que la plus grande partie du bassin au sud de la ligne du profile repose seulement sur le membre inférieur qui contient des charbons subbitumineux.

McLean, B. and **Williams, G.**

UPPER CRETACEOUS ROCKS IN BAFFIN BAY; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 69, 1980.

In 1978 the Bedford Institute drill was used to obtain three short cores in Buchan Trough, offshore northeast Baffin Island, in approximately 550 m of water. The sediments sampled are primarily calcareous siltstones with abundant glauconite and some siderite, suggesting that the environment of deposition was neritic. All samples contain rich dinoflagellate assemblages which have been dated as Campanian and closely resemble described assemblages from other arctic areas, including Bylot Island, Graham Island and west Greenland. This supports the existence of a seaway connecting the Buchan Trough area with other parts of the eastern arctic in the Campanian. The west Greenland dinoflagellate assemblages also show affinities with coeval assemblages from the Labrador Shelf, Grand Banks and Scotian Shelf. This can be explained by postulating a direct marine connection in the Campanian through Davis Strait with the Labrador Sea and North Atlantic.

Martin, G.M.

A SYSTEM DESIGN FOR MARINE GEOPHYSICAL DATA MANAGEMENT; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5 p. 69, 1980.

The requirements of the Atlantic Geoscience Centre of the Geological Survey of Canada for the storage, retrieval and update of gravity, magnetic, bathymetric and navigation data have been established. Analysis and design of a data management system to meet these requirements is complete and development is currently underway.

The data content and data dependencies have been identified and basic computational operations defined. Two levels of data item are identified: an index level containing reference and calibration data and a lower level containing all the logged items. A time is associated with the value of every item and serves as a universal link. The data is structured hierarchically with a cruise as the basic entry. System 2000 is used to manage the index level data and the bulk of the processing uses FORTRAN PLI. The lower level items are stored in index sequential files and access is also through FORTRAN programs.

The users major requirements are reduced to four basic operations – retrieval, update of calibration or reference data, update of logged data and retrieval with user substituted values – using a cruise or part-cruise as selection criteria. The network access path required for an area-based retrieval is simulated using the index level data in a preliminary step.

The design has undergone feasibility testing using the CYBER 171 System at the Bedford Institute of Oceanography.

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

STRUCTURAL EVIDENCE ON EASTERN ELLESMERE ISLAND FOR STRIKE-SLIP SLIP DISPLACEMENT ALONG NARES STRAIT; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 69, 1980.

Three phases of structural deformation can be distinguished in the area extending from Copes Bay in the south to Cape Baird in the north. They are: 1) thrusting, 2) strike-slip movement and 3) normal faulting.

The thrusts are simple, low angle features and are present in the south, adjacent to Kane Basin. Strike-slip movement is inferred from the presence of braided, synthetic strike-slip faults in the Scoresby Bay area and conjugate shears on Judge Daly Promontory. 19 km of displacement is estimated for the Judge Daly Fault Zone. This is the minimum value for total displacement along Nares Strait. Normal faulting caused the graben adjacent to the Judge Daly Fault Zone.

The structural phases are of post-Paleocene age. Thrusting and strike-slip movement observed onshore appear to correspond to compressional and strike-slip phases deduced form geophysical evidence offshore in Baffin Bay and south of Greenland.

McGlynn, J.C. and Irving, E.

PALEOMAGNETISM OF THE NORTHWEST CANADIAN SHIELD AND THE SLAVE-SUPERIOR COMPARISON; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 70, 1980.

Paleopoles from rocks in the approximate age range 2300 to 1900 m.y. from the Slave Structural Province form a linear array stretching from northwestern Canada to the South Atlantic. Results from rocks of comparable age from the Superior Structural Province form a roughly meridional array stretching from northwestern Canada to Peru. In both data sets the magnetization are complex, and it is not yet clear it the somewhat different positions of the two arrays of paleopoles are the consequence of a history of widespread subsequent remagnetization or are real tectonic effects indicative of relative motion between the Slave and Superior Provinces prior to the Hudsonian Orogeny (about 1800 m.y.). Our most recent data from the Slave Province tend to support the latter possibility, but the problem is not yet resolved. Paleopoles from the sedimentary and volcanic sequences of the Coronation Geosyncline about (1900 to 1700 m.y.) form a loop – the Cornonation Loop. All paleopoles from other parts of the Canadian Shield conform to this loop and evidently most of the tectonic elements of the Shield (other than the younger Grenville Province) were assembled in their present spacial relationships by this time.

Monger, J.W.H. and Irving, E.

NORTHWARD DISPLACEMENT OF NORTH-CENTRAL BRITISH COLUMBIA; Nature, v. 285, no. 5763, p. 289-294, 1980.

An extensive terrain in north-central British Columbia, apparently moved ~1,300 km northwards along the western fringe of North America during the late Cretaceous or early Tertiary, perhaps in much the same fashion as Baja California is doing today. Large anticlockwise rotations occurred within this terrain.

Irving, E., Morel, P., and **Monger, J.W.M.**

THE ROLE OF TRANSCURRENT MOTIONS IN THE CORDILLERA AND APPALACHIANS; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 63, 1980.

In the Cordillera paleomagnetically determined paleolátitudes and geological constraints on paleolongitude show that the Stikine block of central B.C. moved northwards by 1300 km of night-lateral shear in the Late Cretaceous and Early Tertiary. In the Appalachians Morris has invoked 2000 km of left-lateral shear between Britain and North America in the Devonian, and Kent Opdyke have invoked 1500 km of left-lateral shear between the Newfoundland-Maritimes -New England block and North America in the Carboniferous to explain the observed paleolatitudes. Global analyses of the Paleozoic and Mesozoic paleomagnetic data indicate several episodes of gross lateral shear between Gondwana and the northern continents located presumably along or close to Appalachian foldbelt; notably a 3500 km night-lateral shear between the Appalachians and the foldbelts of NW South America and Africa in the Late Permian and/or Triassic. Geological and paleomagnetic evidence for gross lateral shear have gone hand-in-hand in the Cordillera, but in the Appalachians the geological support for such contentions has been meagre. Indeed many Appalachian paleomagnetists have been tardy in their support because the reference APW path (against which motions are measured) for the early and middle Paleozoic for North America is poorly known. Certainly intra-Appalachian motions are yet poorly constrained in time and space. Nevertheless indications of gross lateral shear in the Appalachian region have arisen from independent regional and global paleomagnetic analyses and cannot now be lightly set aside.

Irving, E., **Monger, J.W.H.,** Yole, R.W.

NEW PALEOMAGNETIC EVIDENCE FOR DISPLACED TERRANES IN BRITISH COLUMBIA; in The Continental Crust and Its Mineral Deposits, edited by D.W. Strangway, Geological Association of Canada, Special Paper 20, p. 441-456, 1980.

Geological evidence and new paleomagnetic results suggest that the evolution of the western Canadian Cordillera has been dominated by two major tectonic blocks of exotic origin. The outer, western block (sometimes called Wrangellia) consists of Vancouver Island, the Queen Charlotte Islands and parts of southern Alaska. The inner Stikine terrane comprises much of central and northwestern British Columbia. These terranes are separated from one another, and from the rest of North America, by narrow remnants of former oceanic crust. The western oceanic remnants between Wrangellia and the Stikine terrane have a minimum age of Middle Jurassic. The eastern remnants between the Stikine terrane and cratonic North America have a minimum age of Late Triassic. In the Late Triassic, the Stikine terrane was situated about 13° south of its present position, and at least part of Wrangellia was situated over 20° south of its

present position relative to cratonic North America. Wrangellia moved northwards during the Jurassic, and geological evidence indicates that it became attached to the Stikine terrane in the Late Jurassic or Early Cretaceous. The amalgamated terranes of Wrangellia and the Stikine terrane apparently remained at about 13° south of their present position until the Late Cretaceous or early Tertiary, and were in this position when the emplacement of the plutons of the Coast Ranges of British Columbia commenced. During the latest Cretaceous or early Tertiary the amalgamated terranes, now containing the Coast Plutonic complexes, moved northwards to arrive at their present position relative to cratonic North America in pre-Oligocene time. This motion occurred along major transcurrent faults, such as the Pinchi Fault and the Denali-Shakwak system. We suggest that Wrangellia and the Stikine terrane were formerly attached to oceanic plates, and that the northward motions that we have observed paleomagnetically reflect the general northward motion of the floor of the Pacific Ocean relative to North America since the Triassic. The fault systems bounding the Stikine terrane to the east might therefore be the Late Cretaceous and early Tertiary analogues of the present-day San Andreas transform fault system.

L'évidence géologique et les résultats des nouvelles études paléomagnétiques suggèrent que l'évolution de la partie ouest de la Cordillère canadienne a été dominée par deux grands blocs tectoniques d'origine exotique. Le bloc occidental extérieur (désigné quelquefois sous le terme de Wrangellia) comprend l'île de Vancouver, les îles Reine-Charlotte et certaines parties du sud de l'Alaska. La région intérieure de Stikine comprend la plus grande partie du centre et du nord-ouest de la Colombie-Britannique. Ces régions sont séparées l'une de l'autre et du reste de l'Amérique du Nord par des vestiges étroits d'une ancienne croûte océanique. Les vestiges océaniques occidentaux entre les terrains de Wrangellia et de Stikine ont un âge minimum du Jurassique moyen. Les vestiges orientaux entre les terrains de Stikine et le craton nord-américain ont un âge minimum de la fin du Trias. A la fin du Trias, les terrains de Stikine étaient situés environ 13° au sud de leur position actuelle et au moins une partie de Wrangellia était située située plus de 25° au sud de sa position actuelle par rapport au craton nord-américain. La région de Wrangellia s'est déplacée vers le nord au cours du Jurassique et l'évidence géologique indique qu'elle s'est rattachée aux terrains de Stikine à la fin du Jurassique ou au début du Crétacé. Les terrains amalgamés de Wrangellia et de Stikine sont apparemment demeurés à environ 13° au sud de leur position actuelle jusqu'à la fin du Crétacé ou au début du Tertiaire et ils étaient dans cette position lorsqu'a débuté la mise en place des plutons de la chaîne Côtière de Colombie-Britannique. A la toute fin du Crétacé ou au début du Tertiaire, les terrains amalgamés comprenant maintenant les complexes plutoniques Côtiers, se sont déplacés vers le nord pour arriver à leur position actuelle par rapport au craton de l'Amérique du Nord avant l'Oligocène. Ce mouvement s'est produit le long de failles transversales majeures comme la faille de Pinchi et le système Denali-Shakwak. On suggère que les terrains de Wrangellia et de Stikine étaient auparavant rattachés à des plaques océaniques et que les mouvements vers le nord que révèle le paléomagnétisme reflètent le mouvement général vers le nord du fond de l'océan Pacifique par rapport à l'Amérique du Nord depuis le Trias. Les systèmes de failles qui limitent les terrains de Stikine à l'est peuvent ainsi être les analogues de la fin du Crétacé et du début du Tertiaire du système actuel de failles transformantes de San Andreas.

Coney, P.J., Jones, D.L., and **Monger, J.W.H.**

CORDILLERAN SUSPECT TERRANES; Nature, v. 288, p. 329-333, 1980.

Over 70% of the North American Cordillera is made up of 'suspect terranes'. Many of these geological provinces are certainly allochthonous to the North American continent and seem to have been swept from far reaches of the Pacific Ocean before collision and accretion into the Cordilleran margin mostly in Mesozoic to early Cenozoic time.

Knight, I. and **Morgan, W.C.**

THE APHEBIAN RAMAH GROUP, NORTHERN LABRADOR; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 66, 1980.

The Ramah Group is a 1700 m thick outlier of Aphebian sedimentary strata resting unconformably on peneplained Nain Province Archean basement at the Nain-Churchill boundary. Two contrasting sequences reflect a change from shallow siliciclastic shelf to basinal deposition. Shelf sedimentation succeeded basement transgression and well washed to muddy clastics were deposited in sand dominated shallow shoreline environments interrupted by muddy deposition and subaerial volcanism. Shelf sands were covered by a northward advancing deltaic complex, capped by secondary dolomite reflecting a depositional hiatus. Deep basinal conditions followed rapidly and pyritic muds, sulphide iron formation, chert, volcanogenic mud and turbidites were deposited in an initially fetid, quiet basin. A submarine fan of thinly stratified argillaceous carbonate muds, megga breccias and sands prograded into the basin from a shelf located outside the area. Renewed black shale deposition gradually succeeded the carbonates and culminated with sandy turbidites rich in volcanic detritus. Diabase sills intruded the strata prior to the Hudsonian Orogeny, which deformed the group into a syncline in which deformation and greenschist to amphibolite facies metamorphism increases west and south. Granulite facies Archean basement west of the group was reworked by the Hudsonian and thrust over Nain Archean craton. A cataclastic zone west of the craton is a continuation of the Nagssugtoqidian boundary. Regional correlation of Aphebian supracrustal sequences in Labrador and Greenland is possible.

Muller, J.E.

CHEMISTRY AND ORIGIN OF THE EOCENE METCHOSIN VOLCANICS, VANCOUVER ISLAND, BRITISH COLUMBIA; Canadian Journal of Earth Sciences, v. 17, p. 199-209, 1980.

The Metchosin Volcanics of southern Vancouver Island consist of submarine pillow lavas, tuffs, and breccias, overlain by subaerial flows of mainly tholeiitic composition. They overlie basaltic dyke complexes and gabbro and are interpreted as Eocene (and older?) oceanic floor and oceanic island tholeiites. They are separated by the fundamental Leech River Fault from the Paleozoic and Mesozoic rocks underlying Vancouver Island. Major and trace element chemical analyses of the volcanics and a few related intrusive rocks are compared with those of recent to late Tertiary tholeiites from known oceanic settings and with the coeval Crescent Volcanics of the Olympic Peninsula. Possible settings are: (1) oceanic ridge (e.g., mid-Atlantic, Juan de Fuca); (2) oceanic ridge-island (e.g., Iceland); (3) oceanic intra-plate island (e.g., Hawaii); and (4) oceanic island arc (e.g., Tonga-Kermadec). Alkali-silica and AFM diagrams clearly define the subalkaline and tholeiitic character but do not allow distinction of these four oceanic settings. Major element factor analysis yields doubtful

results but could perhaps be improved by increased data base. Several orthogonal plots of abundances of Ti, Fe, Mg, Zr, and Cr seem to permit distinction of the four types of tholeiites.

On geological and chemical bases Metchosin and Crescent formations correspond most closely to the Icelandic ridge-island setting; the Hawaiian intra-plate island setting is less probable in view of several chemical distinctions. The ocean floor setting, though chemically similar in several plots, is precluded at least for the upper, nonmarine parts of the formations. Lastly, an island arc setting is not indicated by either general lithology or chemistry.

Les roches volcaniques de Metchosin dans le sud de l'île de Vancouver se composent de laves sous-marines en coussins, de tufs et de brèches recouverts par des coulées subaériennes de composition surtout tholéiitique. Ces roches recouvrent des complexes de dykes basaltiques et du gabbro et on les interprète comme des tholéiites de fond océanique ou d'île océanique datant de l'Éocène (ou plus ancien?). Elles sont séparées par la faille majeure de Leech River des roches du Paléozoique et du Mésozoïque qui forme le socle de l'île de Vancouver. On campare les analyses chimiques des éléments majeurs et des traces dans les roches volcaniques et dans quelques roches intrusives parentes avec des tholéiites de la fin du Tertiaire jusqu'au Récent de contexte océanique connu et avec les roches volcaniques contemporaines de Crescent dans la péninsule Olympic. Les milieux possibles de mise en place sont: (1) crête océanique (exemples, Médio-atlantique, Juan de Fuca); (2) crête océanique-île (par exemple, l'Islande); (3) île océanique intra-plaque (comme à hawaii); (4) arc insulaire océanique (par exemple, Tonga-Kermadec). Les diagrammes alcalis-silice et AFM définissent clairement le caractère sub-alcalin et tholéiitique mais ne permettent pas de distinguer entre ces quatre contextes océaniques. L'analyse factorielle sur les éléments majeurs donne des résultats discutables mais on pourrait peut-être l'améliorer en augmentant le nombre des données de base. Plusieurs diagrammes orthogonaux des teneurs en Ti, Fe, Mg, Zr et Cr semblent permettre de distinguer les quatre types de tholeiites.

Sur une base géologique et chimique, les formations de Metchosin et de Crescent correspondent le plus au contexte islandais de crête-île; le modèle havaiien d'île intra-plaque est moins probable à cause de plusieurs distinctions chimiques. Le modèle de fond océanique quoique semblable chimiquement dans plusieurs diagrammes est exclu à l'avance, du moins pour les parties supérieures non marines des formations. Finalement, il n'y a pas de preuve en faveur d'un arc insulaire que ce soit en considérant la lithologie générale ou la chimie.

Overton, A.

INTERMEDIATE REFLECTION PROFILES; EOS, Transactions, American Geophysical Union, v. 61, no. 17, p. 276, 1980.

Seismic reflection profiling of the sedimentary column and basement structures was conducted along the drift path of ice station Lorex during April and May, 1979. This work was part of a multidisciplinary program to gain knowledge of the nature and origin of the little studied Lomonosov Ridge, the major submarine ridge which divides the Arctic Ocean basin. The drift path extended from the Makarov basin, across the Lomonosov Ridge, and into the Fram basin in the vicinity of the North Geographic Pole. More than 200 high quality seismic reflection records and digitally recorded magnetic tapes were taken at regular time intervals along the drift path. A cross shaped array was used with explosive sources at the centre so that reflections can be analyzed in terms of dip angle, depth, and position. Estimates of seismic velocities may also be obtained for selected reflections which originate from both sedimentary layers and basement features. No reflections are observed from witinin the ridge. Digital processing of the magnetic tapes may extract depths to the Mohorovicic Discontinuity in detail along the drift path.

Pedder, A.E.H.

DEVONIAN CORALS OF LATE EIFELIAN AGE FROM THE OGILVIE FORMATION OF YUKON TERRITORY; Canadian Journal of Earth Sciences, v. 17, p. 594-616, 1980.

Coral faunas from 254.9-345.4 m above the base of the type section of the Ogilvie Formation on Mount Burgess, and from parts of other Ogilvie sections, are shown to be equivalent to late Eifelian coral faunas of the Hume Formation of western District of Mackenzie, and its correlatives in southwestern District of Mackenzie and northeastern British Columbia. Although older faunas from lower beds and younger faunas from higher beds of the Ogilvie Formation have been described previously, this is the first description of Hume faunas from the formation.

The Redstoneainae, a new subfamily of the Spongophyllidae, is proposed. Two new genera, **Tawuphyllum** and **Gaynaphyllum,** and a new species, **Radiastraea norrisi,** are also established.

Photographic illustrations of interiors of **Iteophyllum virgatum** Crickmay, **Endophyllum barbatum** Crickmay, the lectotype of **Smithia verrilli** Meek, and neotype of **Spongophyllum sedgwicki** Edwards and Haime are published for the first time.

On montre que la faune des coraux de 254.9-345.4 m au-dessus de la base de la coupe type de la formation d'Ogilvie sur le mont Gurgess, et de certaines parties d'autres coupes de cette formation, est équivalente aux faunes de coraux de la fin de l'Eifélien de la formation de Hume dans l'ouest du district de Mackenzie et de ses corrélatifs dans le sud-ouest du district de Mackenzie et dans le nord-est de la Columbie-Britannique. Bien que des faunes plus anciennes dans les lits inférieurs et que des faunes plus récentes dans les lits supérieurs de la formation d'Ogilvie aient été décrites précédemment, c'est la première description des faunes de Hume de la formation.

On propose une nouvelle sous-famille de Spongophyllidae, les Redstonainae. On établit aussi deux nouveaux genres, **Tawuphyllum** et **Gaynaphyllum,** et une nouvelle espèce, **Radiastraea norrise.**

On publie pour la première fois des illustrations photographiques des parties intérieures d'**iteophyllum virgatum** Crickmay, d'**Endophyllum barbatum** Crickmay, le lectotype de **Smithia verrilli** Meek et le néotype de **Spongophyllum sedgwicki** Edwards and Haime.

Poulton, T.P. and Simony,P.S.

STRATIGRAPHY, SEDIMENTOLOGY, AND REGIONAL CORRELATION OF THE HORSETHIEF CREEK GROUP (HADRYNIAN, LATE PRECAMBRIAN) IN THE NORTHERN PURCELL AND SELKIRK MOUNTAINS, BRITISH COLUMBIA; Canadian Journal of Earth Sciences, v. 17, p. 1708-1729, 1980.

The Hadrynian Horsethief Creek Group in the northernmost Purcell Mountains and adjacent Selkirk Mountains is subdivisible regionally into grit, slate, carbonate, and upper clastic divisions in upward succession. The grit division represents a submarine fan assemblage and the slate division

hemipelagic muds probably deposited in intermediate depths. The carbonate division comprises an interval of discontinuous lenses representing "bahamian" carbonate bank and off-bank assemblages, and the upper clastic division is a heterogeneous clastic wedge, which shows some evidence of northerly and westerly increasing depositional depths. Feldspathic quartz pebble conglomerate beds intercalated with the carbonates in both bank and off-bank facies indicate tectonic activation of granitic source areas like those from which similar rocks in the upper part of the Miette Group of the Rocky Mountains were derived.

The upper part of the slate division, which can be differentiated in western localities as a distinct semipelite-amphibolite unit, and the upper clastic division each expand in thickness northwestward to dominate the Horsethief Creek outcrops in the Selkirk Mountains. These thickness variations, the increase of amphibolite northward in the semipelite-amphibolite unit, and the loss of grit beds northward in the slate division suggest deposition in a depocentre that received coarse sediment from southerly and easterly directions, and that became the site of mafic igneous activity.

Le groupe hadrynien de Horsethief Creek dans la partie extrême nord des monts Purcell et dans les monts Selkirk adjacent peut se subdiviser régionalement en divisions de grès, d'ardoises, de carbonates et une division supérieure de clastiques dans une succession vers le haut. La division des grès représente un assemblage de cône sousmarin et la division des ardoises des boues hémipélagiques probablement déposées à des profondeurs intermédiaires. La division des carbonates comprend un intervalle de lentilles discontinues représentant des bancs de carbonates de type "Bahamas" et des assemblages au large des bancs, alors que la division supérieure des clastiques comprend un coin clastique hétérogène qui donne certaines indications d'un approfondissement des milieux de dépôt vers le nord et l'ouest. Les lits de conglomérats à cailloux de quartz feldspathique intercalés avec les carbonates dans les faciès de bancs et au large des bancs indiquent une activation tectonique des régions sources granitiques comme c'était le cas pour les régions sources qui ont alimenté les roches semblables de la partie supérieure du groupe de Miette dans les Rocheuses.

La partie supérieure de la division des ardoises, qu'on peut différencier dans les localités situées à l'ouest comme une unité distincte de semipélite-amphibolite, et la division supérieure des clastiques augmentent toutes deux en épaisseur vers le nord-ouest pour coiffer les affleurements de Horsethief Creek dans les monts Selkirk. Ces variations d'épaisseur, l'augmentation de l'amphibolite vers le nord dans l'unité de semipélite-amphibolite et la disparition des lits gréseux au nord dans la division des ardoises suggèrent une sédimentation dans une zone centrale qui recevait des sédiments grossiers des directions sud et est et qui devint le site de l'activité ignée mafique.

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

GEOCHEMISTRY OF CRUDE OILS AND CONDENSATES FROM THE SCOTIAN BASIN, OFFSHORE EASTERN CANADA; Bulletin of Canadian Petroleum Geology, v. 27, no. 4, p. 453-466, 1979.

Geochemical analyses have been conducted on thirty-six crude oil and condensate samples from the Scotian Shelf. These families of crude oils and condensates have been defined on the basis of n-alkane distributions, pristane-to-phytane ratios, carbon isotope distributions in the saturate and aromatic fractions, distributions of twenty-six gasoline-range hydrocarbons and ring distributions in the aromatic fraction. Biodegraded samples occur in the upper part of the Logan Canyon Formation and the Wyandot Formation. The three families of crude oils are largely confined to discrete stratigraphic units within which they are thought to have been generated. These units are: 1) Wyandot Formation, 2) Logan Canyon Formation, 3) Mic Mac, Mississauga and Verrill Canyon Formations. The occurrence of separate families of oils at relatively shallow depths provides additional evidence for the local maturation and generation of hydrocarbons in sediments at local thermal anomalies which may or may not be associated with salt diapirism. Except in the Wyandot samples, the pristane-to-phytane ratios indicate that the oils and condensates were derived at least in part form terrestrial organic matter.

Pringle, G.J. and **Thorpe, R.I.**

BOHDANOWICZITE, JUNOITE AND LAITAKARITE FROM THE KIDD CREEK MINE, TIMMINS, ONTARIO; Canadian Mineralogist, v. 18, p. 353-360, 1980.

Bohdanowiczite (ideally $AgBiSe_2$) is a common but minor constituent of the selenide-bearing bornite-rich ore that forms a small zone in the Kidd Creek volcanogenic massive sulfide deposit, in the area of Timmins, Ontario. The lead-bismuth selenides junoite and laitakarite were identified in a single specimen from a drill hole that passes beneath the bornite zone. Some grains of junoite are partly rimmed by laitakarite, which contains inclusions and intergrowths of an unidentified phase that has higher lead and sulfur contents. A few minute blebs of an antimony-rich phase are also present in these intergrowths. Improved electron-microprobe analyses of bohdanowiczite ($Ag_{1.01}Bi_{1.00}Se_{1.99}S_{0.01}$) and junoite ($Bi_{7.99}Pb_{2.89}Ag_{0.12}S_{10.06}Se_{5.94}$) have been achieved by the use of synthetic standards and a modified empirical matrix correction that is more suitable for lead-bismuth sulfosalts than the customary theoretical correction. The Kidd Creek junoite contains about 14.7 wt.% selenium, whereas 12 wt.% was the highest content reported for junoite from the Juno mine, Australia. Laitakarite (Bi_4Se_2S) was semi-quantitatively analyzed by energy-dispersive techniques. X-ray powder data are presented for bohdanowiczite and junoite. The refined hexagonal cell for bohdanowiczite (Cu Kα radiation, λ = 1.5418 Å is a 8.412(6), c 19.63(3) Å; for junoite (Co Kα radiation λ = 1.7900 Å), the cell is a 26.71(1), b 4.060(2), c 17.172(7), Å β = 127.65(3)° [or a = 21.17 Å, $b' = b$, $c' = c$, β' = 92.32° in the conventional setting]. The Kidd Creek mine is the first Canadian locality for bohdanowiczite, junoite and laitakarite.

La bohdanowiczite (idéalement $AgBiSe_2$) constitue un minéral accessoire répandu dans le minerai sélénifère riche en bornite d'une petite zone du gisement de sulfures massifs volcanogéniques de Kidd Creek (Timmins, Ontario). Les séléniures de Pb et Bi junoite et laitakarite ont été identifiés dans une seule carotte, d'un trou de sondage foré sous la zone à bornite. Certains grains de junoite sont partiellement enrobés de laitakarite, qui renferme des inclusions et des intercroissances d'une espèce non-identifiée, enrichie en Pb et S. On trouve aussi dans les intercroissances quelques particules d'une phase riche en antimoine. Des analyses à la microsonde électronique, améliorées par l'emploi, d'étalons synthétiques et d'une correction de matrice empirique modifiée plus appropriée que la correction théorique à l'étude de sulfosels Pb-Bi, ont donné $Ag_{1.01}Bi_{1.00}Se_{1.99}S_{0.01}$ pour la bohdanowiczite et $Bi_{7.99}Pb_{2.89}Cu_{1.96}Ag_{0.12}S_{10.06}Se_{5.94}$ pour la junoite. Cette dernière contient environ 14.7% en poids de Se, surpassant ainsi le maximum (12%) trouvé à la mine Juno, en australie. La laitakarite a pu ête analysée semi-quantitativement par les techniques à dispersion d'énergie. Les dimensions de maille, affinées par diffraction X (méthode des poudres), sont: pour la maille

hexagonale de la bohdanowiczite, *a* 8.412(6), *c* 19.63(3) Å (radiation Cu K*a*, λ = 1.5418 Å) pour la junoite, *a* 26.71(1), *b* 4.060(2), *c* 17.172(7) Å, β 127.65(3)° (radiation Co K*a*, λ = 1.7900 Å; *a'* = 21.17 Å, *b'* = *b*, *c'* = *c*, β' = 92.32° pour la maille conventionnelle). Pour chacune des trois espèces, la mine Kidd Creek constitue la première localité canadienne.

Rencz, A.N. and **Shilts, W.W.**

NICKEL IN SOILS AND VEGETATION OF GLACIATED TERRAINS; in Nickel in the Environment, J.O. Nriagu, ed., p. 151-188; John Wiley and Sons, Inc. 1980.

Shows how pattern of nickel distribution in soils of glaciated areas is influenced by glacial dispersal processes and how complex mineralogy of soils created by glacial abrasion influences availability and trace element associations of nickel, particularly as it is utilized by plants. High nickel concentrations in glacial till suppress chlorophyll production and strongly affect vigor and areal distribution of plant species.

Rimsaite, J.

SELECTED MINERAL SUITES AND EVOLUTION OF RADIOACTIVE PEGMATITES IN THE GRENVILLE STRUCTURAL PROVINCE, CANADA; Abstracts, 26th International Geological Congress, p. 999, 1980.

Mineral parageneses were studied in samples from uranium mines and radioactive occurrences in metamorphic-migmatitic terranes in the Bancroft area, Ontario, and Mont-Laurier and Johan Beetz areas, Quebec. Mineral chemistry and age were determined using electron microprobe, scanning electron microscope and U-Pb and Rb-Sr isotope analyses.

In the Bancroft area, a close proximity of diverse sediments, basic rocks and granite pegmatites yielded the following unusual mineral associations during metamorphism and partial anatexis: (1) clinopyroxene, clinoamphibole, anhydrite, titanite, calcite, albite, microcline, quartz, garnet, biotite, tourmaline, apatite, allanite, uraninite, uranothorite, amorphous radioactive REE-,Y-, and Nb-bearing minerals and cyrtolite; 2) albite, microcline, quartz, accessory clinopyroxene and amphibole in graphic intergrowths with quartz, REE minerals, uraninite, uranothorite, cyrtolite, fluorite, calcite and phlogopite; (3) coarse grained albite, betafite overgrown by muscovite, apatite, xenotime, uraninite, radiogenic galena and unidentified U-Nb compounds. Paragenetic relationships between pure uraninite and U, Th, REE-bearing mineral phases will be described. Mineral associations in Quebec deposits are less complex. They comprise albite, microcline, quartz, biotite, muscovite, uraninite, xenotime, monazite, apatite, allanite, and Ti minerals. Evolution of pegmatites, mineral parageneses and replacements of uraninite by U-Th-REE-Pb-Ti mineral phases and secondary minerals will be discussed. The presence of B, CO_2, F, H_2O, S and P delay crystallization of U and REE minerals. Isotopic ages of U-minerals range from 80 to 1050 Ma.

Rimsaite, J.

ISOTOPE, SCANNING ELECTRON MICROSCOPE AND ENERGY DISPERSIVE SPECTROMETRIC STUDIES OF HETEROGENEOUS ZIRCONS IN RADIOACTIVE GRANITES IN THE GRENVILLE STRUCTURAL PROVINCE, CANADA; Association Internationale De Mineralogie 12e Assemblee Generale; Abstracts, p. 112, 1980.

Heterogeneous zircons from radioactive granites in the Grenville structural province, Canada, yielded discordant Pb/U and $^{207}Pb/^{206}Pb$ ages. All points fell below the concordia curve and the extension of the discordia line intersected the concordia curve at **ca.** 100 Ma and 1000 Ma implying losses and remobilization of parent and daughter elements.

To investigate evidences for the mobilization of u and radiogenic Pb, zircon grains were studied using a scanning electron microscope coupled with an energy dispersive spectrometer. High magnification backscattered (BEI) and secondary (SEI) electron images at high magnifications (x2000-x4000) revealed the presence of an intricate network of narrow (<1 μm) fractures, of zoning and of diverse mineral inclusions in host zircon (crytolite). Three groups of mineral inclusions were observed: (1) those pre-dating zoned zircons and apparently serving as a nucleus: quartz and groups of small zircons; (2) inclusions of uraninite, feldspar and apatite associated with the growth and zoning of the host; and (3) fracture-fillings that post-date crystallization of the host zircon: rare-earths-bearing grains, arsenides, U-rich material and specks of galena. The uraniferous material and galena are the evidence of migration and redeposition of U and radiogenic Pb released from the zircon, or are the indications of introduced U and Pb from outside. Both would affect isotopic ages.

Although most of the zircon crystals are shattered and consist of isotropic and weakly anisotropic zones apparently as a result of radiation damage, no uranium was detected within the zircon crystals, with a few exceptions observed in oxidized material. Such oxidized samples contained radioactive Fe-rich secondary grains (0.5mm in size) with enclosed disintegrating zircons (50-100 μm in size) having zoned uranium and thorium concentrations detectable by an energy dispersive spectrometer. Uraninite grains in samples containing disintegrating zircons are veined by zirconium-bearing compounds.

This paper presents electron scanning images of heterogeneous and disintegrating zircons and spectra of complex secondary uranium-thorium-zirconium compounds thus providing evidences on migration of Pb and U along the fractures in zircon; on disintegration of zircon, uraninite and uranothorite; and on complex reactions between the liberated zirconium, uranium, thorium and other elements. The scanning electron microscope images were secured by the Central Laboratories, Geological Survey of Canada.

Roberts, A.C., Ansell, H.G., and **Bonardi, M.**

PARAREALGAR, A NEW POLYMORPH OF AsS, FROM BRITISH COLUMBIA; Canadian Mineralogist, v. 18, p. 525-527, 1980.

Pararealgar is a new polymorph of realgar, described from two localities in British Columbia; Mount Washington, Vancouver Island, and the Gray Rock property, Lillooet district. The mineral has also been found at other localities in North America and Europe. Pararealgar occurs as powdery to granular fine grained aggregates that replace realgar. At the Gray Rock property, pararealgar is associated with stibnite and is intimately mixed with α-AsS. Associated minerals at Mount Washington are stibnite, tetrahedrite, arsenopyrite, duranusite, arsenic, arsenolite, α-AsS, sulfur, lepidocrocite and pyrite. Pararealgar is yellow to orange-yellow with a vitreous to resinous lustre, a bright yellow streak, Mohs hardness 1-1½, uneven fracture and no apparent cleavage. The measured density is 3.52(5) g/cm^3 and the calculated density is 3.499 g/cm^3. Indices of refraction are greater than 2.02. The mineral is anisotropic with a high birefringence, and internal reflections are gold to orange-red. Results of electron-microprobe analyses average As 69.81, S 29.97, total 99.78, corresponding to $As_{0.997}S$, calculated on S = 1. Pararealgar is monoclinic, *a* 9.929(4), *b* 9.691(6), *c* 8.503(3) Å, β 97.06(2)°, *Z* = 16, space group *Pc* or *P2/c*.

Le pararéalgar, nouvelle forme polymorphe du réalgar, a été découvert en deux endroits de la Colombie britannique (au mont Washington sur l'île de Vancouver et à la propriété Gray Rock dans le district de Lillooet) ainsi qu'ailleurs en Amérique du nord et en Europe. Il forme des agrégats finement grenus ou pulvérulents qui remplacent le réalgar. A Gray Rock, il est associé à la stibnite dans un mélange avec α-AsS; au mont Washington, stibnite, tétraédrite, arsénopyrite, duranusite, arsenic, arsénolite, α-AsS, soufre, lépidocrocite et pyrite lui sont associés. C'est un minéral de densité élevée (D_{mes} 3.52(5), D_{calc} 3.499), à l'éclat vitreaux ou résineux, jaune à jaune-orange, jaune brillant dans la rayure, de dureté (Mohs) 1-1½, à cassure inégale et sans clivage, dont les indices de réfraction dépassent 2.02. Anisotrope, fortement biréfringent, il montre des réflexions internes or à rouge-orange. La microsonde électronique donne: As 69.81, S 29.97, total 99.78, d'où $As_{0.997}S$ (S=1). Le pararéalgar est monoclinique *a* 9.929(4), *b* 9.691(6), *c* 8.503(3) Å, β 97,06(2)°, *Z* = 16, groupe spatial *Pc* ou *P2/c*.

Ruzicka, V.

WORLD URANIUM RESOURCES IN PROSPECT; in Markets for Canadian Uranium; Proceedings of a Symposium held October 25, 1979, ISBN 0-920522-08-4.

The reasonably assured and estimated additional uranium resources in the western world increased over the past two decades. This increase was a result of exploration efforts exerted worldwide.

New types of uranium deposits were discovered in new areas and in areas containing known deposits of conventional kinds.

Recently thirty-five countries of the western world reported uranium resources that were classified by the Organization for Economic Cooperation and Development – Nuclear Energy Agency and International Atomic Energy Agency (OECD, NEA and IAEA) into six categories: (1) quartz-pebble conglomerate deposits; (2) Proterozoic unconformity-related deposits; (3) disseminated magmatic, pegmatitic and contact deposits in igneous and metamorphic rocks; (4) vein deposits; (5) sandstone deposits; and (6) other types of deposits.

Results of the work conducted under the International Uranium Resource Evaluation Project (IUREP), jointly organized by OECD NEA and IAEA with Canadian participation, show that the potential for significant additional uranium discoveries in the world still exists.

Among the most promising categories of deposits are the Proterozoic unconformity-related deposits, but the other types may also substantially augment world uranium resources.

Sangster, D.F.

QUANTITATIVE CHARACTERISTICS OF VOLCANOGENIC MASSIVE SULPHIDE DEPOSITS; Metal Content and Size Distribution of Massive Sulphide Deposits in Volcanic Centres; Canadian Mining and Metallurgy Bulletin, v. 73, p. 74-81, 1980.

Eight volcanogenic massive sulphide districts in Canada and Japan, ranging in age from Archean to Miocene, were selected for analysis. The study revealed that: (1) each district has an average diameter of 32 km; (2) the districts contain 4 to 20 deposits each, with an average of 12 deposits; (3) the average total base metal content per district is 4.6 million tonnes, with a coefficient of variation of 32%; (4) ranked in order of size, the largest deposit in each district contains, on average 67% of the total metal and the second largest about 13%. The remaining deposits range downward in decreasing proportions.

Empirical observations such as these may be used for evaluating the undiscovered potential of new districts as well as contributing to a better understanding of the distribution and genesis of this important class of base metal deposits.

Sangster, D.F.

A REVIEW OF APPALACHIAN STRATABOUND SULPHIDE DEPOSITS IN CANADA; Geological Survey of Ireland, Special Paper, no. 5, p. 7-18, 1980.

In Canada the Applachian (Caledonian) Orogen encompasses an area of 1 million km^2 of which only one third is above sea level. This area is further reduced by a cover of approximatley 80,000 km^2 of Permo-Carboniferous strata in New Brunswick, Nova Scotia and western Newfoundland. During the Cambro-Ordovician, the Orogen was dominated by four facies belts: miogeosynclinal sediments in the northwest; a thick eugeosynclinal sequence in the centre; a thin sequence of sediments (shales and limestone) to the southeast; and a great thickness of 'greywacke slate' farther southeast.

Within the Canadian Appalachian Orogen, approximately 100 stratabound sulphide deposits with recorded production and/or reserves are known to occur and a representative selection of these will form the basis of the discussion to follow. A listing of the more significant deposits is given.

The stratabound sulphide deposits are reviewed in terms of two main categories: 1. those occuring in **volcanic** or **volcanogenic rocks** and 2. those occurring **sedimentary rocks.** Deposits in the former are mainly massive pyrite – and/or pyrrhotite-rich conformable deposits in Hadrynian (Late Precambrian), Cambrian, and Ordovician volcanics. Sediment-hosted deposits are: (i) stratiform copper variety in fine grained clastics and (ii) epigenetic, stratabound lead-zinc and copper deposits in shallow-water carbonates.

Sangster, D.F.

CORRELATION OF STRATABOUND SULPHIDE DEPOSITS IN THE NORTH AMERICAN APPALACHIANS: A DISCUSSION; Norges geologiske Undersoekelse, v. 360, p. 289-293, 1980.

Two major types of stratabound sulphide deposits are present within the Appalachian orogenic belt in North America: a) syngenetic, pyritic, polymetallic, massive sulphide deposits of exhalative origin within, or closely associated with volcanic rocks; b) epigenetic, disseminated Zn-Pb or An-bearing carbonate-hosted deposits.

The problems of **correlation** of these two major types of ores are discussed in the light of an accepted definition of the term, emphasis being placed on the chronological aspects of correlation. It is shown that, while the chronological correlation of the carbonate rocks hosting the Pb-Zn and Zn ores is relatively simple, correlation of the ages of deposition of the ores themselves has yet to be accomplished. On the other hand, due to lack of fossils, severe metamorphism and deformation and other causes, correlation of many of the syngenetic polymetallic sulphide deposits and their host rocks is rather doubtful.

A review is then given of some methods which could be applied to correlating these, and other, stratabound sulphides, including determination of the absolute age of mineralization, the position of the ores in the Wilson cycle and lead and sulphur isotopic studies.

Sangster, D.F.

DISTRIBUTION AND ORIGIN OF PRECAMBRIAN MASSIVE SULPHIDE DEPOSITS OF NORTH AMERICA; in The Continental Crust and Its Mineral Deposits, edited by D.W. Strangway, Geological Association of Canada Special Paper 20, p. 723-739, 1980.

Conformable Precambrian massive sulphide deposits are widely distributed within the Canadian Shield as well as in isolated "windows" of Precambrian rocks in the remainder of North America. Within the Shield, massive sulphide deposits have been recorded in all structural provinces except Nutak and Bear.

The approximately 150 deposits can be grouped into four main periods coinciding with the formation of thick supracrustal accumulations: 1) 2750 to 2650 Ma, 2) 1900 to 1700 Ma, 3) 1400 to 1100 Ma, and 4) 800 to 600 Ma. Although the number of deposits are about evenly distributed between Archean and Proterozoic, a decisive majority of those in the Proterozoic were formed during the 1900 to 1700 Ma ore-forming period.

Alternatively, the deposits may be grouped in terms of the dominant lithology of locally associated host rocks; 1) a tholeiitic to calc-alkaline volcanic suite including a felsic component, 2) basalt-shale intercalations with little or no felsic volcanic rocks present, 3) clastic sediments of greywacke affinity with little or no direct volcanic component, and 4) shallow-water sediments such as lithic arenites, impure carbonates, and evaporites with minor associated volcanics. No ophiolite-associated deposits are known in the Precambrian of North America.

As a group, the deposits exhibit a range of Cu-Pb-Zn ratios, with the Cu-Zn association predominating. Many, but not necessarily most, of them display prominent alteration zones in the stratigraphic footwall. In the undeformed deposits these zones are markedly discordant to enclosing strata.

The deposits are considered to have originated as syn-volcanic or syn-sedimentary precipitates from hydrothermal solutions discharging directly into the submarine environment. Lead isotope evidence permits derivation of metals either directly from a magma or by leaching from the underlying rocks. Sulphur isotopes in the volcanic-associated deposits are close to meteoritic values, suggesting that the sulphur has been derived, perhaps indirectly, from an uncontaminated magmatic source, sulphur in the sediment-associated deposits may have been indirectly derived from seawater sulphate.

Schafer, C.T., Smith, J.N., and Loring, D.H.

RECENT SEDIMENTATION EVENTS AT THE HEAD OF SAGUENAY FJORD, CANADA; Environmental Geology, v. 3, p. 139-150, 1980.

Saguenay Fjord, near Saint Fulgence, eastern Canada. Preservation of allochthonous benthonic foraminifera, recognition of occasional rapid sedimentation events associated with the spring runoff of the Saguenay River, and the unmixed character of the sediment can be used in conjunction with several dating techniques to obtain a temporal resolution of paleoriverine events on a time scale of months to years.

The geologic and geochemical record of the upper 150 cm of sediment reflects (1) the anoxic character of the benthic environment, resulting from the high flux of terrigenous material to the bottom; (2) the transport and deposition of landslide-derived sediment into the head of the fjord over several years; (3) an indication of the nature and timing of dissolution processes that have altered or totally eliminated the allochthonous calcareous microfossil assemblage from the recycled sediment; and (4) a cyclic depositional pattern that may be useful in reconstructing paleoclimatologic trends that have influenced annual river discharge of this drainage system over the past millennium.

Schafer, C.T. and Mudie, P.J.

SPATIAL VARIABILITY OF FORAMINIFERA AND POLLEN IN TWO NEARSHORE SEDIMENT SITES, ST. GEORGES BAY, NOVA SCOTIA; Canadian Journal of Earth Sciences, v. 17, p. 313-324, 1980.

Spatial variability of sediment texture, foraminiferal, and pollen assemblages were studied at two core sites in St. Georges Bay, using data from replicate cores spaced about 1 m apart. Despite the similarity of water depth (22 m) and location (3.6 km offshore) of the two sites, correlatable sediment textural units could not be clearly distinguished except for the ubiquitous presence of a surface layer of fine grained sediment. Textural parameters strongly indicate distinctive Holocene depositional histories at each site, which appear to be related to local submarine morphological features.

Despite the between-site textural heterogeneity, the depositional histories of all the cores can be correlated spatially and temporally by means of selected paleontologic parameters. In all cores the top 20-30 cm of sediment was found to coincide with the historical weed pollen assemblage zone; hence, the uppermost fine sediment layer most probably reflects an increased influx of fine grained sediment associated with deforestation and other local land use practices. At both sites, the ratio of common modern calcareous to arenaceous foraminifera species can be used to reveal comparable relative sea level records in each of the cores. However, critical evaluation of combined lithological and faunal data is necessary to distinguish an apparent decrease in water depth that can arise from an increased influx of nearshore sediment and species rather than a real change in relative sea level.

Detailed statistical analysis of the variation in foraminiferal abundance parameters shows that absolute abundance data cannot be used for determining relative sedimentation rates in nearshore environments and suggests that biofacies correlations in these environments should be based on assemblages of comparatively abundant species. Within-site similarity in both foraminiferal and palynological assemblages is generally lower for the texturally more heterogeneous site at Linwood than at the more uniformly muddy site near Pomquet. Howéver, relatively high within- and between-site correlations of pollen taxa are evident throughout all sediment intervals that comprise more than 50% mud, regardless of differences in sediment sorting parameters and changes in paleodepths at the depositional sites.

It appears that studies of the depositional histories of nearshore Holocene sediments in the Atlantic coastal region are most likely to yield results when analysis of combined textural, microfaunal, and palynological parameters is carried out on cores obtained from relatively low-energy depositional sites. It is predicted that for upper Holocene marine sediments, the coarser the texture of a core the less representative it will be of the overall paleoecological history of a region.

On a étudié la variabilité spatiale de la texture des sédiments, des assemblages de foraminifères et de pollen dans deux carottes prélevées dans la baie de St-Georges en utilisant des données de carottes répliques prélevées à 1 m de distance. Bien que la profondeur de l'eau (22 m) et la

localisation (3.6 km au large) soient semblables pour les deux sites, on n'a pu distinguer clairement des unités correspondantes de testure sédimentaire à l'exception d'une couche superficielle de sédiments fins présente partout. Les paramètres texturaux indiquent des histoires de sédimentation clairement distinctes à chacun des sites au cours de l'Holocène, ce qui semble s'expliquer par les caractères morphologiques sous-marins locaux.

En dépit de l'hétérogénéité texturale entre les sites, les histoires de sédimentation de toutes les carotes peuvent être mises en corrélation dans l'espace et dans le temps en utilisant certains paramètres paléontologiques choisis. Dans toutes les carottes, les 20-30 cm supérieurs de sédiments coincident avec la zone d'assemblage historique de pollen d'herbages; par conséquent, la couche supérieure de sédiments fins reflète très probablement un accroissement de l'apport de sédiments fins associés à la déforestation et à d'autres pratiques locales d'utilisation des terres. Aux deux sites, on peut utiliser le rapport des espèces modernes calcareuses aux espèces arénacées communes de foraminifères pour mettre en relief des registres de niveau marin relatif comparable dans chacune des carottes. Toutefois, l'évaluation critique des données combinées de la lithologie et de la faune est nécessaire pour distinguer une diminution apparente de la profondeur de l'eau qui peut se produire à la suite d'une augmentation de l'apport de sédiments et d'espèces provenant de la zone côtière plutôt qu'un changement réel de niveau marin.

L'analyse statistique détaillée de la variation dans les paramètres d'abondance des foraminifères montre qu'on ne peut utiliser les données d'abondance absolue pour déterminer les taux relatifs de sédimentation dans les milieux près du rivage et l'analyse suggère que les corrélations de biofaciès dans ces milieux devraient être basées sur des assemblages d'espèces comparativement abondantes. La similitude pour un même site dans les assemblages de foraminifères et de pollen est généralement plus faible pour le site à texture plus hétérogène de Linwood que pour le site plus uniformément boueux près de Ponquet. Toutefois, les corrélations relativement élevées des taxa de pollen à l'intérieur d'un site et entre les sites sont évidentes dans tous les intervalles sédimentaires qui renferment plus de 50% de boue, sans égard aux différences dans les paramètres de tri et aux changements de paléoprofondeur aux sites de dépôt.

Il semble que les études sur les histoires de sédimentation dans les sédiments holocènes près du rivage dans la région côtière de l'Atlantique sont plus susceptibles de fournir des résultats quand on pratique des analyses de paramètres texturaux, microfauniques et palynologiques combinés sur des carottes prélevées dans des milieux sédimentaires à énergie relativement faible. Pour la partie supérieure des sédiments marins de l'Holocène, on propose que plus la texture d'une carotte est grossière, moins cette carotte sera représentative de l'histoire paléoécologique globale de cette région.

Scott, D.B., **Schafer, C.T.,** and Medioli, F.S.

EASTERN CANADIAN ESTUARINE FORAMINIFERA: A FRAMEWORK FOR COMPARISON; Journal of Foraminiferal Research, v. 10, no. 3, p. 205-234, 1980.

Estuarine benthonic foraminifera commonly have been used as salinity indicators and consequently as classification tools for estuaries in the traditional sense – i.e., spatial distribution of salinity. However, we have demonstrated in eastern Canada that estuarine foraminifera can be employed to detect estuarine characteristics such as modal circulation patterns, depth-stability and open-ocean influences. Studies have been concentrated on benthonic foraminifera in three estuaries studied by the authors and selected as type estuaries: Miramichi River, New Brunswick; Restigouche Estuary, New Brunswick; and Chezzetcook Inlet, Nova Scotia. With data from these areas a framework of estuarine classification based on benthonic foraminiferal distributions was developed, allowing comparison with other published works. The framework was based on estuarine characteristics other than salinity, defined by assemblages of foraminifera. For example, transitional or non-transitional estuaries was a supplementary estuarine classification proposed by us when we investigated Miramichi River in 1977. Certain agglutinated foraminiferal species indicate relatively stable, inner estuarine regions (e.g., **Ammotium cassis** [Parker] in this study). Additionally, some species, particularly **A. cassis,** have distribution patterns linked to high concentrations of suspended particulate matter, enabling the mapping of this characteristic with the distribution of **A. cassis.** In short, the estuarine foraminiferal assemblages can be used to detect and delimit many oceanographic characteristics in estuaries, often more economically than conventional oceanographic techniques.

Schafer, C.T. and Smith, J.N.

PALEOCEANOGRAPHIC SIGNIFICANCE OF HOLOCENE SEDIMENT BIOTURBATION ON THE CONTINENTAL SLOPE OFF NEWFOUNDLAND; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 79, 1980.

Sediments of the middle continental slope (800-2,000 m) are relatively fine (+80% mud) compared to those on the lower slope to upper rise (2,000-3,000 m; <45% mud). Middle slope sediments have been reworked by bioturbators in Holocene time, while the lower slope to upper rise sediments show almost no bioturbation during this period. Reduced bioturbation on the lower slope and upper rise is apparently related to the presence of the Western Boundary Undercurrent (WBU), which inhibits the deposition of fine grained, organic-rich material that serves as a food source for some bioturbating benthos.

The re-initiation of sediment reworking by the WBU is evidenced at a depth of about 6 to 10 cm in core 13A by a rapid decrease of silt plus clay from about 73% to 40%. This zone of rapid textural change parallels a switch in diatom species dominance from **Rhizosolenia styliformis** to **Coscinodiscus divisus,** which may be related to the eastward displacement of North Atlantic Drift Water by Labrador Sea Water after 9,000 years BP. Comparison of the **Planulina wuellerstorfi** and **Pullenia bulloides** time stratigraphy of Schnitker (1979) to Core 13A, paleontologic data indicates that the onset of sediment reworking by the WBU started at least 3,000 years BP or about 1,000 years after the estimated period of maximum rate of supply of Norwegian Sea Overflow Water to the Northwest Atlantic Basin.

Schau, M.

GEOLOGICAL HISTORY OF ANORTHOSITES AND GRANULITES AT THE EDGE OF THE ARMIT LAKE BLOCK, NORTHERN CHURCHILL STRUCTURAL PROVINCE CANADA; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 79, 1980.

The Armit Lake block is bounded to the south by the Chesterfield Fault Zone. The north dipping fault zone is locally well exposed east of Baker Lake along and north of Chesterfield Inlet where it contains lenticular fault bounded granulite anorthosite complexes which show positive gravity anomalies. The Zone has been cut by gabbro stocks and granite plutons emplaced along it. One of the high grade complexes is found at the east end of Baker Lake where

Archean medium pressure granulites and an extensively flattened anorthosite complex has been folded into a shallowly west plunging structure.

Although the protolith of these granulites is uncertain metamorphic assemblages such as pyrope-sapphirine-phlogopite-kyanite-garnet-perthite-quartz-graphite, and orthopyroxene-clinopyroxene-garnet-plagioclase-quartz indicate that medium pressure granulite grade was attained.

Elemental ratios in various mineral pairs indicate that different minerals were quenched at different stages of the uplift of this complex.

The uplift of this "sherd" was presumably concurrent with movement on the Chesterfield Fault Zone and both ceased prior to the emplacement of an east-west striking mafic dyke swarm and the later deposition of the Dubawnt Group unconformably over the zone during mid Proterozoic time. Late northwest faulting cuts across zone and was locally accompanied by mafic dykes.

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

RESET MAGNETIZATION IN DYKE CONTACTS IMPLICATIONS FOR VERTICAL MOTION IN THE SOUTHERN AND SUPERIOR PROVINCES; EOS, v. 61, no. 17, p. 217, 1980.

Oriented samples were taken along two profiles perpendicular to a 1250 Ma dyke contact near Sudbury and also along two profiles perpendicular to a 2150 Ma dyke near Matheson (Ontario). In each profile the zone of hybrid magnetization was identified, and the maximum temperature attained in these zones was determined from the maximum blocking temperature of the reset component. Heat conduction theory yielded the contribution to this maximum temperature due to intrusion and, thus, the ambient temperature of the country rock at the time of intrusion temperatures of 280°C ± 20°C at 1250 Ma and 250°C ± 25°C at 2150 Ma were obtained. These results tend to suggest that the depth of burial of the present level of erosion was about 1 1 m greater at 1250 Ma than at 2150 Ma if the Superior and Southern provinces can be regarded as one block during the last 2150 Ma.

Schwartz, E.J.,

PALEOMAGNETISM OF PROTEROZOIC ROCKS ON AND ALONG THE WESTERN PART OF THE SUPERIOR PROVINCE (NEW QUEBEC); Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 80, 1980.

Igneous rocks and reddish sediments were collected at 50 sites along the coast of Hudson Bay between Inoucdjouac and Great Whale River, near Richmond Gulf and near La Grande 4. The results of the 270 cores (2 specimens per core) are varied as to within-core consistency, stability of remanent magnetization, direction of remanent magnetization, and carriers of remanent magnetization. The stratigraphically highest rocks sampled are the Nastapoka sediments (no consistent results) and basaltic rocks (good results, with approximate mean direction: declination (D)=130, inclination (I)=38). The underlying Richmond Gulf reddish sediments yield a similar direction in some cores but usually shows little consistency without good end points and directions towards the West and down (positively inclination). Pachi Group red sediments and andesite cores also generally show the SE to S up direction like the Nastapoka basalts where the high declination values are confined to the relatively thick accumulation in the Northern part of Richmond Gulf. The sites collected from reddish sediments near La Grande 4 (Dam site) give consistent results with upward magnetization but a declination which is lower (45 to 100°) than the Pachi Group data from the Southern part of Richmond Gulf.

Buchan, K.L., **Schwarz, E.J.,** Symons, D.T.A., and Stupavsky, M.

REMANENT MAGNETIZATION IN THE CONTACT ZONE BETWEEN COLUMBIA PLATEAU FLOWS AND FEEDER DIKES: EVIDENCE FOR GROUNDWATER LAYER AT TIME OF INTRUSION; Journal of Geophysical Research, v. 85, no. B4, p. 1888-1898, 1980.

The remanent magnetization of basaltic flows in the contact zones of two feeder dikes of the Columbia Plateau series was investigated in detail by af and thermal methods with the aim of estimating the depth of the sampling levels at the time of dike intrusion. In these cases these depths are known from geological and geochemical correlation of the dikes and certain flows stratigraphically higher in the series. In both cases the host rock direction differs strongly from the younger dike direction. In the Fields Spring contact zone, one sample in the profile across the contact displays a hybrid direction between that of the flow and that of the dike. Both remanence components show district blocking temperature spectra with an interface at 540°C. This implies that the maximum temperature to which this sample (taken at 60 cm from the contact with the 17.7-m-thick dike) was heated was 540°C. Applying heat conduction theory, the maximum temperature increase due to the cooling dike at 60 cm from the contact is calculated to be 614°C, which would imply a significant negative ambient temperature in the host rock prior to the intrusion. Although complicated by the absence of a hybrid sample in the profile across the Almota contact and the occurrence of spontaneous oxidation during heating of the samples, a comparable negative ambient temperature is derived. No evidence for multipe intrusions is observed, and the Almota dike is only 1.8 m thick. Furthermore, substantial heat leakage to the surface can be ruled out because of the relatively large depths of the sampling levels (250 m for Almota and 850 m for Fields Spring) with respect to the short distances to the contacts. For this reason a model is set up based on heat conduction theory allowing for 5% porosity in the flows. Assuming stagnant water in the flows, a reduction of about 9°C of the temperature increase is calculated. Consequently, if the discrepancy is to be explained by evaporation of water, high permeability would be required to allow perhaps 10 times the volume of the stagnant water to be evaporated. High permeability is indicated by the high-density jointing in the lavas and the present dry condition of the surface. In this case the conclusion is that the groundwater layer extended from a minimum depth of 250 m (Almota sampling level) to at least 850 m (Fields Spring sampling level) at the time of dike intrusion about 15 m.y. ago. A semiquantitative model for convecting groundwater is also presented and, using published data for basaltic flows, is shown to represent a useful model to account for the derived temperatures in the hybrid zone.

Schwarz, E.J., Muller, J.E., and **Clark, K.R.**

PALEOMAGNETISM OF THE KARMUTSEN BASALTS FROM SOUTHEAST VANCOUVER ISLAND; Canadian Journal of Earth Sciences, v. 17, p. 389-399, 1980.

One hundred and twenty oriented drill cores were collected from 20 sites in the Karmutsen basalts of Karnian age in the eastern part of Vancouver Island. Alternating field and thermal demagnetization studies reveal stable endpoint directions in 13 sites which fall into the following groups: (1) northwest-up (four sites); (2) north-up (four sites); (3) north-northeast-down (four sites); and (4) easterly-up (one site). The northwest-up direction is observed in the

least altered samples with only pure magnetite of high coercive force and blocking temperatures as a carrier. The north-up direction, which shows streaking in a east-west sense, is also observed in (other) least altered specimens, and shows a complex magnetic mineralogy with lower coercivity. The north-northeast-down direction occurs in definitely more altered specimens, and some specimens show a northerly flat magnetization at the end of the blocking temperature range. The easterly-up direction is poorly defined but may correspond to the direction reported for the Nicolai Greenstones in Alaska. The relation between these groups of directions is not clear, and only in a few specimens an indication for the separation of remanence components has been observed. The available evidence indicates that a northerly component is probably the oldest and that the northwest-up magnetization may represent this component. The pole position calculated for this magnetization is 90°E, 21°N which is about 40°S of the Triassic pole position for cratonic North America. The discrepancy would be larger still if the northwest-up direction is a single component secondary direction. The discrepancy can, of course, be explained by a northward shift of the Karmutsen from a source area near 10°N with or without a sinistral rotation.

On a recueilli cent vingt carottes de forage orientées provenant de 20 sites dans les basaltes de Karmutsen datant du Karnien dans la partie est de l'île de Vancouver. Des études de désaimantation thermique et par champ alternatif mettent en évidence des directions finales stables pour 13 des sites et on les regroupe comme suit: (1) nord-ouest et vers le haut (quatre sites), (2) nord et vers le haut (quatre sites), (3) nord-nord-est, vers le bas (quatre sites), et (4) est, vers le haut (un site). On observe la direction nord-ouest vers le haut dans les échantillons les moins altérés avec seulement de la magnétite pure de force coercitive et de températures de blocage élevées comme porteur. On observe aussi la direction nord vers le haut avec des directions secondaires dans le sens est-ouest dans (d'autres) spécimens très peu altérés et possédant une minéralogie magnétique complexe avec des coercitivités plus faibles. La direction nord-nord-est vers le bas se retrouve dans des spécimens nettement plus altérés et quelques échantillons montrent une aimantation plane vers le nord à l'extrémité du domaine des températures de blocage. La direction est vers le haut est mal définie mais pourrait correspondre à la direction déjà rapportée pour les roches vertes de Nicolai en Alaska. La relation entre ces groupes de directions n'est pas claire et seulement dans quelques spécimens existe-t-il des indications permettant la séparation des composantes de rémanence. Les preuves disponibles indiquent que la composante vers le nord est probablement la plus ancienne et que l'aimantation nord-ouest vers le haut pourrait représenter cette composante. La position du pôle calculée pour cette aimantation est de 90°E, 21°N, ce qui est environ 40° au sud de la position du pôle pour le craton de l'Amérique du Nord au Trias. L'écart serait encore plus grand si la direction nord-ouest vers le haut était une direction secondaire à composante unique. On peut, bien sûr, expliquer la différence par un déplacement vers le nord de la région de Karmutsen à partir d'une région source située près de 10°N avec ou sans rotation sénestre.

Andrews, J.T., Miller, G.H., and **Shilts, W.W.**

HISTORY OF HUDSON BAY DURING THE WISCONSIN GLACIATION; BASED ON AMINO ACID GEOCHRONOLOGY; in 4th Symposium in the Quaternary of Quebec, Abstracts and Program; 1980.

Shilts, W.W.

GEOCHEMICAL PROFILE OF TILL FROM LONGLAC, ONTARIO TO SOMERSET ISLAND; Canadian Mining and Metallurgical Bulletin; v. 73, p. 85-94, 1980.

In carrying out a geotechnical survey of a proposed gas pipeline route from the Arctic Islands south to Longlac, Ontario, the Polar Gas Consortium contracted the drilling of several hundred 2- to 20-m-deep boreholes in drift and bedrock. Samples from these holes were made available to the Geological Survey of Canada, where they were subjected to stratigraphic and trace-element geochemical analyses. The geochemical characteristics of the clay and sand-sized heavy mineral fractions of till samples from these boreholes have been summarized in a series of geochemical profiles.

From the proposed pipeline terminus at Longlac northward to the vicinity of God's River in Manitoba, tills contain significant amounts of Paleozoic carbonate rocks and Proterozoic sedimentary rocks derived from the Hudson Bay basin and lowlands. Within this section, two sites were enriched in base metals, indicating the possibility of local mineralization of possible economic interest.

From God's River northward to Seal River, Manitoba, no evidence of local mineralization was noted. The heavy mineral fractions of the tills are universally enriched in Mn-rich siderite thought to originate on or in the Paleozoic section of the Hudson Bay lowlands.

From Seal River northward to Thelon River, near Baker Lake, tills contain only components originating west of the Hudson Bay sedimentary basin. Near the Keewatin-Manitoba border, all till is enriched in uranium, which probably originates in the "young" porphyritic granites underlying much of the region, and produces a distinctive airborne radiometric anomaly.

At the Thelon River, multiple till sections are variously enriched in Cr, Ni, U, Cu and Mo in the vicinity of a distinctive aeromagnetic anomaly.

From Thelon River northward, several coincident zones of chromium and uranium enrichment are found where the line of boreholes crosses east-west-striking belts of volcanic, ultramafic and sedimentary rocks of the Prince Albert Group.

The results of this study indicate that till tends to have characteristic element associations or concentrations over each of several broad regions along the pipeline route. These are related both to large-scale bedrock associations and to large-scale effects of glacial dispersal. In addition, the samples, collected more or less at random with respect to local bedrock geology, have intersected several small-scale geochemical anomalies that appear to be related to zones of mineralization of possible economic interest.

Shilts, W.W.

FLOW PATTERNS IN THE CENTRAL NORTH AMERICAN ICE SHEET; Nature, v. 286, no. 5770, p. 213-218, 1980.

Patterns of glacial dispersal of lithologically distinctive erratics around Hudson Bay show the central portion of the North American Laurentide ice sheet to have been made up of at least two land-based centres, one that grew and dissipated in Keewatin, and one that grew and dissipated in Nouveau Quebec-Labrador.

Sinha, A.K.

A STUDY OF TOPOGRAPHIC AND MISORIENTATION EFFECTS IN MULTIFREQUENCY ELECTROMAGNETIC SOUNDINGS; Geoexploration, v. 18, p. 111-133, 1980.

A theoretical analysis has been made on the effects of rugged topography and misorientation of loops on the observed results in the case of a new ground multifrequency electromagnetic sounding system which uses a horizontal loop as the transmitter. The system measures the ratios of the amplitudes of the vertical and the horizontal magnetic fields at a receiver for several frequencies. Three possible sources of error have been considered, namely, the effects of a sloping ground, the effects of an altitude difference between the transmitter and the receiver loops and the effects of a tilt of the axis of the transmitter loop away from the vertical. The results have been presented in terms of the percentage variations of the ratio parameters with the variation of a normalized frequency parameter. It has been shown that the errors are maximum in the low frequency range where the observed ratio values may be too low. It is also clear that in the case of an altitude difference, it is important to know which loop is at a higher altitude. When the axis of the transmitter loop is not vertical, the values of the measured ratios are dependent on the direction of the tilt, i.e., whether the tilt is towards or away from the receiver. The study indicates that it may be possible to apply a first order correction to the field data if information about the topography and the geology of the area is known.

Snowdon, L.R.

PETROLEUM SOURCE POTENTIAL OF THE BOUNDARY CREEK FORMATION, BEAUFORT-MACKENZIE BASIN; Bulletin of Canadian Petroleum Geology, v. 28, no. 1, p. 46-58, 1980.

Organic geochemical analyses have been carried out on samples of the Boundary Creek Formation shale in order to determine its petroleum source potential. Solvent extraction, gas chromatographic analysis, total organic carbon analysis and elemental analysis of the kerogen indicate that this formation is an excellent potential hydrocarbon source rock in regions where it has been subjected to moderate thermal alteration and has, in fact, been the source for oils recovered from three different boreholes in the basin. Hydrocarbon yields in excess of 100 mg/g occur in the marginally mature zones whereas values of about 20 mg/g characterize the Boundary Creek over most of the study area because of the low levels of maturity.

Srivastava, S.P.

VARIATION IN BASEMENT TOPOGRAPHY AND FORMATION OF MAGNETIC QUIET ZONE IN THE CENTRAL REGION OF THE LABRADOR SEA; EOS, v. 61, no. 17, p. 358, 1980.

Recent compilation of magnetic data in the Labrador Sea show prominent bands of positive anomalies flanking a central region which has been described as a magnetic quiet zone. The anomalies in this zone are small in amplitude (between 100 and 200 nT) and difficult to correlate between tracks. Examination of a large number of single channel and a limited number of multi-channel seismic reflection profiles across the Labrador Sea show a marked contrast in basement roughness across the boundaries of this quiet zone, with the quiet zone having rougher basement than adjacent non-quiet areas. This rougher basement is interpreted to have formed following a 45° change in the direction of spreading and to be indicative of close FZ spacing, caused by the direction change.

Within the quiet zone the basement roughness increases with the increase in the obliqueness of spreading. In the northernmost part of the Labrador Sea, the seismic basement characteristics, together with magnetic and gravity data have been used to decipher the evolution of spreading patterns following the spreading direction change.

Sweet, A.R.

APPLICATION OF PALYNOLOGY TO COAL EXPLORATION IN WESTERN AND NORTHERN CANADA; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 84, 1980.

Problems associated with the use of palynology in the identification and correlation of coal zones are related to age, degree of coalification and the depositional environment.

Palynological assemblages from coals of Late Jurassic to Early Albian age are composed mainly of gymnosperm pollen and bryophyte and pteridophyte spores. A lack of unique, short ranging species in many of these assemblages limits the application of palynology to the use of relative abundance diagrams in attempting to identify individual coal horizons or to the development of broad biostratigraphic zonations. The high degree of coalification in many pre-Late Albian coals is also a limiting factor.

Capacity for palynology to provide relatively narrow biostratigraphic zonations to aid in intrabasinal correlations increases with the addition of angiosperm pollen to the palynological assemblage in the Middle Albian and the subsequent rapid diversification in the number of species in the Late Cretaceous and again in the Late Paleocene. However, unless coal seam development fortuitously coincides with a conspicuous break in the character of the flora, such as that at the Maastrichtian-Paleocene boundary, the identification and correlation of individual coal seams may be complicated by changes in the pollen assemblage which reflect only localized shifts in the depositional environment.

Taylor, F.C.

TWO SAPPHIRINE LOCALITIES IN NEW QUEBEC; Canadian Mineralogist, v. 18, p. 373-374, 1980.

Two sapphirine localities are reported in New Quebec, one near Cape Hopes Advance (1) and the other at Lake Sirmiq (2). These are associated with granulite and amphibolite (retrograded granulite) facies rocks. Microprobe analyses lead to the following structural formulae: (1) $(Mg_{2.8}Fe^{2+}_{0.7})$ $(Al_{4.3}Fe^{3+}_{0.2}Cr_{0.04})$ $(Al_{4.4}Si_{1.6})O_{20}$; (2) $(Mg_{3.2}Fe^{2+}_{0.5})$ $(Al_{4.2}Fe^{3+}_{0.2}Cr_{0.01})$ $(Al_{4.4}Si_{1.6})O_{30}$.

Se trouvent deux endroits du nouveau Québec (cap Hopes Advance, lac Sirmiq) où on signale la sapphirine dans des roches de faciès granulite ou amphibolite (granulite rétrograde). Les deux échantillons, analysés à la microsonde, ont donné: (1) $(Mg_{2.8}Fe^{2+}_{0.7})$ $(Al_{4.3}Fe^{3+}_{0.2}Cr_{0.04})$ $(Al_{4.4}Si_{1.6})O_{20}$; (2) $(Mg_{3.2}Fe^{2+}_{0.5})$ $(Al_{4.2}Fe^{3+}_{0.2}Cr_{0.01})$ $(Al_{4.4}Si_{1.6})O_{30}$.

Tempelman-Kluit, D.J.

EVOLUTION OF PHYSIOGRAPHY AND DRAINAGE IN SOUTHERN YUKON; Canadian Journal of Earth Sciences, v. 17, p. 1189-1203, 1980.

The physiography of southern Yukon is dominated by upland plateaux and plateau remnants that probably evolved in the Tertiary, culminating in a mature erosion surface

about Miocene time. Variations in the elevation of this surface are thought to result from uneven uplift and faulting in the Late Miocene or Pliocene. The Tintina and Shakwak Trenches are young grabens superposed on the upland and the mountain ranges are youthful dissections of raised parts of the plateau.

In the Miocene, water from central Yukon probably drained to the coast across the region occupied by the St. Elias and Coast Mountains. About the late Miocene, general uplift occurred and the St. Elias and Coast Mountains rose unevenly above interior parts of the Yukon. As a consequence, the drainage became entrenched. During deglaciation, ice in the St. Elias outlasted that in the interior and this forced derangements of the entrenched stream system. It was abandoned in favour of the less direct northwest drainage of today. The northwest drainage perists, but is unstable and in danger of capture by more vigorous streams that flow directly to the coast.

La physiographie du sud du Yukon est dominée par les hauts plateaux et des vestiges de plateaux qui se sont probablement développés au Tertiaire pour arriver à une surface d'érosion de maturité au Miocène. Les variations dans l'élévation de cette surface sont probablement le résultat du soulèvement inégal et du faillage à la fin du Miocène ou au Pliocène. Les fosses de Tintina et de Shakwak sont de jeunes grabens superposés aux plateaux et les chaînes de montagnes sont des dissections plus jeunes dans les parties soulevées du plateau.

Au Miocène, l'eau provenant du centre du Yukon se drainait probablement vers la côte à travers la région occupée par les monts Côtiers et St-Elie. Vers la fin du Miocène, un soulèvement général s'est produit et les monts St-Elie et Côtiers se sont élevés inégalement au-dessus des parties intérieures du Yukon. Comme conséquence, le drainage s'est retranché. Durant la déglaciation, la glace de St-Elie a persisté après la fonte de celle de l'intérieur et cela a provoqué des dérangements dans le système de cours d'eau retranchés. Ce système a été abondonné en faveur du drainage moins direct vers le nord-ouest qu'on observe aujourd'hui. Le drainage au nord-ouest persiste mais il est instable et en danger de capture par des cours d'eau plus vigoureux qui coulent directement vers la côte.

Tempelman-Kluit, D.J. and **Wanless, R.K.**

ZIRCON AGES FOR THE PELLY GNEISS AND KLOTASSIN GRANODIORITE IN WESTERN YUKON; Canadian Journal of Earth Sciences, v. 17, p. 297-306, 1980.

Two samples of Pelly Gneiss with different field relations and post-crystallization histories give different U/Pb ages that are Devonian and Permian (375 and 276 Ma). A sample of Klotassin granodiorite gave an age of 192 ma confirming its Early Jurassic age. These Devonian, Permian, and Jurassic plutonic rocks in Yukon Crystalline Terrane lack equivalents in the adjacent Omineca Belt where sedimentary strata accumulated at these times. This suggests that the Yukon Crystalline Terrane is allochthonous with respect to the Omineca Belt.

Deux échantillons du gneiss de Pelly avec des relations de terrain et des histoires postérieures à la cristallisation différentes donnent des âges U/Pb différents qui correspondent au Dévonien et au Permien (375 et 267 Ma). Un échantillon de granodiorite de Klotassin a donné un âge de 192 Ma, ce qui confirme son âge du début du Jurassique. Ces roches plutoniques du Dévonien, du Permien et du Jurassique dans la région cristalline du Yukon n'ont pas d'équivalents dans la zone adjacente d'Omineca où les strates sédimentaires se sont accumulées durant ces périodes. Ceci suggère que la région cristalline du Yukon est allochthone par rapport à la zone d'Omineca.

Moore, J.M. and **Thompson, P.H.,**

THE FLINTON GROUP: A LATE PRECAMBRIAN METASEDIMENTARY SUCCESSION IN THE GRENVILLE PROVINCE OF EASTERN ONTARIO; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 72, 1980.

Clastic and carbonate sediments, preserved in narrow synclines have been correlated over more than 100 km strike length. These strata, the Flinton Group, lie unconformably on metamorphosed volcanic, clastic, and carbonate rocks and on large granitoid intrusions. The group comprises seven formations and one tentatively correlated informal unit. The group has undergone at least two major folding episodes and one main regional metamorphism of varying grade. Post-Flinton intrusive rocks are absent, except pegmatites at high metamorphic grade and one tectonically implaced ultramafic slice.

Depositional environment ranged from fluvial to moderate-depth marine. Rapid facies changes and close relationships between facies and underlying pre-Flinton lithology point to local sources and local tectonic control of deposition basins. A deeply weathered source terrane is postulated. Mature basal redbeds were succeeded by less mature clastics, as block faulting caused increase of relief between sources and basins; these facies passed offshore into finer, more reduced sediments. Flinton Group deposition took place between 1060 and 1090 ± 25 Ma, after arc-volcanism, plutonism, uplift and erosion, and before regional deformation and metamorphism. All these events are grouped within the Grenvillian Orogenic Cycle, spanning the interval 1300-1000 Ma.

Purcell, L.P., **Umpleby, D.C.,** and **Wade, J.A.**

REGIONAL GEOLOGY AND HYDROCARBON OCCURRENCES OFF THE EAST COAST OF CANADA; in Canadian Society of Petroleum Geologists Memoir 6, Facts and Principals of World Oil Occurrences, P. 551-566, 1980.

Petroleum exploration has been carried out in four major Mesozoic-Cenozoic tectonic provinces off the east coast of Canada. Numerous structural and stratigraphic traps occur in the Scotian Basin continental margin clastic and carbonate wedge, which overlies a thick, mobile evaporite sequence. Maximum thickness of sedimentary rocks exceeds 11 km. The subsurface of the Grand Banks is characterized by a series of fault-bounded sub-basins with most of the trap types related to salt and basement tectonics. Sedimentary thicknesses are generally less than 7 km. The East Newfoundland Basin contains a clastic wedge superimposed on fault-bounded sub-basin with a total sedimentary thickness exceeding 12 km. Similarly, on the Labrador Shelf the thick Cretaceous-Tertiary clastic wedge covers faulted basement structures, with basal beds draped over these features.

The hydrocarbon occurrences on the Scotian Shelf are predominantly gas, whith some condensate and oil. Generally poor source rocks have been encountered, due partly to a preponderance of terrestrial-type organic matter and partly to thermal immaturity. There is an indication of good marine Jurassic source rocks at greater depths, which enhances the oil potential for deeper, undrilled prospects. Three good gas shows have been encountered on the Labrador Shelf. The coincidental improvement in source rocks, reservoir and seal makes the hydrocarbon potential of this area more attractive.

On a entrepris l'exploration pétrolière dans quatre provinces tectoniques majeures d'âge Nésozoïque-Cénozoïque au large de la côte est du Canada. Sur la bordure continentale du bassin Scotian, de nombreux pièges structuraux et stratigraphiques se situent dans les masses de roches clastiques et carbonates reposant sur une séquence évaporitique épaisse et mobile. L'épaisseur maximum des roches sédimentaires excède 11 km. Le sous-sol des Grands Bancs de Terre Neuve est caractérisé par une série de sous bassins limités par des failles dont l'origine de la plupart des pièges est liée aux tectoniques du sel et du sousbassement. La série sédimentaire a généralement moins de 7 km d'épaisseur. Dans le bassin de Terre Neuve Est une masse clastique recouvre des sous-bassins, limités par des failles, d'une épaisseur sédimentaire totale dépassant 12 km. De même, sur le plateau du Labrador, l'épaisse masse clastique d'âge Crétacé-Tertiaire recouvre les structures faillées du sousbassement, des couches basales enrobant ces structures.

Les occurrences d'hydrocarbures sur le plateau Scotian sont principalement de gaz avec un peu de condensat et d'huile. Des roches-mères généralement pauvres ont été rencontrées; cela est due en partie à la prépondérance de matière organique terrestre et en partie à l'immaturité thermique. Il y a une indication de roches-mères Jurassiques marines plus favorables à l'accumulation d'hydrocarbures à de plus grandes profondeurs, ce qui augmente le potentiel de trouver de l'huile dans des sondages plus profonds qui n'ont pas encore été percés. Trois bonnes indications de gaz ont été rencontrées sur le plateau du Labrador. L'amélioration simultanée des roches-mères, des reservoirs et du scellement des réservoirs rend le potentiel d'hydrocarbures de cette région plus attrayant.

Vilks, G.

LATE GLACIAL AND POST GLACIAL BOUNDARY IN SEDIMENTS OF EASTERN CANADA, DENMARK AND NORWAY; Geological Association of Canada/-Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 86, 1980.

Shallow marine sediments deposited during the time of the last glacial retreat on both sides of the Atlantic contain similar foraminiferal assemblages. This Late Glacial ecozone is typified by the dominance of **Elphidium excavatum** forma **clavata** associated with **Cassidulina crassa.**

The Late Glacial **E. excavatum** forma **clavata** faunas reflect the marine conditions proximal to continental and sea ice. The melting of the ice kept waters cold in addition to reducing the salinity. The coastal waters that were formed during this time replaced the North Atlantic Drift waters on the Danish and Norwegian continental shelves and also minimized the effect of the offshore Labrador Sea water on Labrador and Scotian Shelves, thus explaining the similarity of Late Glacial faunas on the both sides of the Atlantic. The coastal waters were sufficiently extensive along the Labrador coast to maintain inner shelf conditions well offshore and to depths in the vicinity of 300 metres.

The Late Glacial-Post Glacial boundary, as determined by the reduction of **E. excavatum** forma **clavata,** has not been dated in Denmark, but in Norway it is well established at 10,300 years BP. In cores from the Canadian continental shelf, this boundary is reasonably well defined only in Cartwright Saddle where it is at 15,000 years BP. In the Emerald Basin of the Scotian Shelf, a 15,000 years BP date was obtained at the bottom of one core and well within the **E. excavatum** forma **clavata** zone. By extrapolation the top of the **E. excavatum** forma **clavata** zone in this core was suggested to be the age of 8,000 years BP. The 5 dates obtained from 4 cores in a small basin off Cape Sable are within the **E. excavatum** f. **clavata** zone and are older than 17,000 years BP.

Hillaire-Marcel, C. et **Vincent, J-S.**

STRATIGRAPHIE DE L'HOLOCENE ET EVOLUTION DES LIGNES DE RIVAGE AU SUD EST DE LA BAIE D'HUDSON, CANADA/HOLOCENE STRATIGRAPHY AND SEA LEVEL CHANGES IN SOUTHEASTERN HUDSON BAY, CANADA; Paléo-Québec, no 11, 165 p., 1980.

Ce volume, en français et en anglais, est une réédition, avec des améliorations, d'un livret-guide publié la première fois, en 1979, à l'occasion de la rencontre géologique à l'est de la baie d'Hudson (Programme international de corrélation géologique – Projet 61, Variations du niveau de la mer; INQUA – Commissions des Lignes de rivage, de l'Holocène et de Néotectonique).

La première partie du travail traite d'aspects généraux tels que la suite d'événements glaciaires au cours de l'Holocène, l'évolution des lignes de rivage et le relèvement isostatique. La seconde partie concerne les divers aspects de la géologie régionale et comprend un itinéraire détaillé pour les trois régions visitées.

Wagner, F.J.E.

A FAUNAL INTERPRETATION OF TIDAL EVOLUTION IN MINAS BASIN, NOVA SCOTIA; Géographie physique et Quaternaire, v. 34, no. 2, p. 253-257, 1980.

Interpretation of the evolution of the tidal cycle in Minas Basin and upper Bay of Fundy (Scots Bay) based on molluscan assemblages agrees well with that derived by AMOS (1978) from sedimentological evidence. Prior to about 6300 years B.P. quiet water conditions, i.e. with minimal or no tidal activity, prevailed. From that time, tidal range and intensity have increased to their present levels. The molluscs show this change by a change from intact specimens of deposit feeders at, or near, the base of two of the vibrocores, through a mixture of incomplete specimens and suspension feeders, to accumulations of minute, unidentifiable shell fragments.

Une interprétation faunique de l'évolution de l'amplitude des marées dans le bassin des Mines, Nouvelle-Écosse. Une interprétation de l'évolution du cycle des marées dans le bassin des Mines et le fond de la baie de Fundy (baie Scots), fondée sur les assemblages de mollusques, correspond bien à celle qu'AMOS (1978) a donnée en se basant sur des preuves sédimentologiques. Avant environ 6300 BP, les eaux étaient calmes, c'est-à-dire qu'il y avait peu ou pas de marées. Par la suite, l'amplitude et l'intensité des marées se sont accrues pour atteindre les niveaux actuels. L'examen des mollusques de deux des carottes, obtenues par vibration, confirme cette interprétation puisque l'on passe de spécimens intacts de mangeurs de sédiments, à la partie inférieure des forages, à un mélange de spécimens incomplets de mangeurs de sédiments et de mangeurs de matières en suspension, puis à des accumulations de fragments d'écailles minuscules et non identifiables, vers le sommet.

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

EARLY CRETACEOUS PALEOGEOGRAPHY IN THE ALBERTA FOOTHILLS AND ADJACENT PLAINS; in L.S. Beck, J.E. Christopher and D.M. Kent (eds.) Lloydminster and Beyond: Geology of Mannville Hydrocarbon Reservoirs, Saskatchewan Geological Society, Special Publication 5, 1980.

The Early Cretaceous paleogeography of the Alberta Foothills region developed in two principal stages. The first was a period of predominantly erosion, with an extensive drainage system carved into the underlying Mesozoic and

Paleozoic sediments. Local topographic relief exceeded 100 m in some areas. Rivers flowed generally in northerly direction towards a boreal sea.

The second stage was predominantly depositional and accompanied the gradual southward transgression of the Moosebar-Clearwater sea. River valleys were flooded, forming extensive estuaries and, with stream gradients lowered, aggradation took place in alluvial valleys, eventually filling them.

The Cadomin Formation represents deposition during the erosional and earliest depositional phases. The overlying Gladstone Formation represents deposition during the marine transgression when the drainage system was infilled, and the Moosebar Member of the Malcolm Creek Formation represents the phase of maximum transgression of the sea.

The Gladstone Formation in the Alberta Foothills between the Crowsnest Pass and Smoky River can be divided into two informal units; a lower unit characterized by fluvial deposits and an upper part (Calcareous member) characterized by generally fine grained sediments containing diagnostic microfossil suites.

The lower unit represents aggradational deposits in alluvial valleys during transgression of the sea, and is generally more prevalent in the western Foothills and southern Plains. The upper unit, south of the North Saskatchewan River, contains an entirely nonmarine faunal suite, but between the North Saskatchewan and Berland Rivers, a mixed fresh and brackish water faunal suite is present. The southern sequence is interpreted as deposition in a lacustrine or inner estuarine environment and the northern sequence as outer estuarine to marginal marine. Equivalent beds in the upper part of the Gething Formation between the Smoky and Wolverine Rivers do not contain a marine fauna and were deposited in an alluvial-deltaic complex which extended eastward beyond the limits of the Foothills.

The Moosebar Member abruptly overlies the Gladstone Formation and is present in the Foothills at least as far south as the Clearwater River, considerably beyond the recognized limit of marine influence in the Gladstone Formation. A thin glauconite and pebble bed occurs at the base of the Moosebar Member in the central Foothills, but was not observed in more southerly sections. The pebbles are a lag deposit of the transgressing sea and the glauconite formed under slow sedimentation conditions during, and immediately following, the transgression. The upper part of the Moosebar Member, as well as the overlying Torrens and Grande Cache Members of the Malcolm Creek Formation represent deposition during regression of the Moosebar-Clearwater sea.

Events in the development of the Lower Cretaceous sequence in the Alberta Foothills can be extrapolated to the adjacent plains of Alberta and Saskatchewan where similar sedimentary sequences have been reported.

Ray, G.E. and **Wanless, R.K.**

THE AGE AND GEOLOGICAL HISTORY OF THE WOLLASTON, PETER LAKE, AND ROTTENSTONE DOMAINS IN NORTHERN SASKATCHEWAN; Canadian Journal of Earth Sciences, v. 17, p. 333-347, 1980.

Three U-Pb zircon and four K-Ar mineral age determinations from national topographic system (NTS) area Geikie River (SE) in northern Saskatchewan are presented and the geology of the region is described. The area lies within the Churchill Province of the Canadian Precambrian Shield and includes parts of the Wollaston, Peter Lake, and Rottenstone domains; the relationship between the geological histories of these domains and the age determinations is discussed. Zircon age measurements suggest a period of late Archean magmatism ca. 2500 Ma was responsible for both the Wollaston domain granitic basement and a suite of basic plutons in the adjoining Peter Lake domain.

The overall lithological differences of the presumed lower Proterozoic supracrustal rocks in the region are examined in the context of a plate tectonic model. This invokes late Archean continental rifting accompanied by limited volcanism close to the present Needle Falls Shear Zone, followed by continental separation and the generation of an Aphebian ocean basin. Deposition of shelf and deeper water sediments along the trailing edge of the Wollaston domain continental margin was followed by reversal of plate movement, oceanic subduction, and the formation of an island-arc complex. This marked the start of the Hudsonian Orogeny and was accompanied by the development of successive generations of granitic material, including the Wathaman batholith. The regional emplacement of this batholith ca. 1865 Ma ago is compared to other volcano-plutonic belts described elsewhere along Cordilleran-type continental margins.

On présente trois déterminations d'âges U-Pb sur des zircons et quatre déterminations d'âges K-Ar sur des minéraux pour la région cartographique de Geikie River (SE) dans le nord de la Saskatchewan et on décrit la géologie de la région. Cette région se trouve à l'intérieur de la province de Churchill du Bouclier précambrien canadien et comprend des parties des domaines de Wollaston, de Peter Lake et de Rottenstone; on discute de la relation entre les histoires géologiques de ces domaines et les déterminations d'âge. Les mesures d'âge au zircon suggèrent une période de magmatisme à la fin de l'Archéen, il y a environ 2500 Ma. Laquelle a été responsable du socle granitique du domaine de Wollaston et d'une suite de plutons basiques dans le domaine adjacent de Peter Lake.

On examine les différences lithologiques globales des roches superficielles, datant présumément du Protérozoïque inférieur dans cette region, dans le contexte d'un modèle de tectonique des plaques. Celui-ci implique une fissure continentale à la fin de l'Archéen accompagnée de volcanisme restreint à proximité de la zone de cisaillement actuelle de Needle Falls, le tout suivi d'une séparation continentale et de la genèse d'un bassin océanique durant l'Aphébien. Le dépôt de sédiments de plate-forme et d'eau plus profonde le long du bord de fuite de la marge continentale du domaine de Wollaston a été suivi d'un renversement du mouvement de la plaque, de subduction océanique et de la formation d'un complexe d'arc insulaire. Ces événements ont marqué le début de l'orogénèse hudsonnienne qui s'est accompangée du développement de générations successives de matériel granitique dont le batholite de Wathaman. On compare la mise en place de ce batholite, il y a environ 1865 Ma, à d'autres zones volcano-plutoniques décrites ailleurs le long de bordures continentales de type Cordillère.

Williams, G.L. and **Bujak, J.P.**

PALYNOLOGICAL STRATIGRAPHY OF DEEP SEA DRILLING PROJECT SITE 416A; in Initial Reports of the Deep Sea Drilling Project, v. 50, United States Government Printing Office, Washington, D.C., p. 467-495.

Samples from DSDP Hole 416A, Cores 53 to 9, contain both spores and dinoflagellate cysts. The palynomorphs indicate the presence of Kimmeridgian-Portlandian sediments (Cores 52 and 51) which are overlain by Berriasian (Cores 50 to 32), Valanginian (Cores 32 to 10), and Hauterivian (Core 9) strata.

Lentin, J.K. and **Williams, G.L.**

DINOFLAGELLATE DISTRIBUTION PATTERNS WITH EMPHASIS ON CAMPANIAN PERIDINIACEANS; American Association of Stratigraphic Palynologists, Contributions Series, no. 7, 46 p., 1980.

Three diagnostic peridiniacean assemblages, each with its own characteristic species, seem to reflect regional differentiation rather than local paleoecological control in Campanian sediments. These assemblages have been respectively named the Malloy suite, the McIntrye suite, and the Williams suite. The Malloy suite is restricted to tropical to subtropical paleolatitudes, the Williams suite is a warm temperature assemblage, while the McIntyre suite is interpreted as a boreal assemblage.

Winters, G.V. and **Buckley, D.E.**

IN SITU DETERMINATION OF SUSPENDED PARTICULATE MATTER AND DISSOLVED ORGANIC MATTER CONCENTRATIONS IN AN ESTUARINE ENVIRONMENT BY MEANS OF AN OPTICAL BEAM ATTENUANCE METER; Estuarine and Coastal Marine Science, v. 10, p. 455-466, 1980.

An optical technique was developed for the **in situ** estimation of estuarine suspended particulate matter (SPM) and dissolved, organic matter (DOM) concentrations in water. Measurements were made in the laboratory and the field, and attenuance coefficients were determined at wavelength bands centred at 475 nm and at 680 nm. Laboratory measurement of attenuance caused by Kaolinite suspensions and humic acid solutions were used to determine the wavelength selectivity or the 475 nm/680 nm band ratio for SPM and DOM.

The light attenuated by kaolinite suspensions and SPM is attributed to both absorbance and scattering ($A_p^{\lambda}+B_p$), but for dissolved humic acid, it is attributed only to absorbance, (A_y^{λ}). The optical band attenuance ratio (K) is constant for each type of substance, i.e. $K_p = A^{475}_p+B_p)/(A^{680}_p+B_p)$ and $K_y = A^{475}_y/A^{680}_y$. The factor K_p is dependent on the average particle characteristics and is constant for a given water mass. In this study K_p for the kaolinite and SPM was 1•2, and K_y was found to be 7•2 for dissolved humic acid.

Mathematical expressions, applicable to complex aqueous mixtures were formulated to differentiate between changes in attenuance coefficients resulting from (1) concentration variations of kaolinite suspensions or SPM and (2) dissolved humic acid or DOM [$(A^{680}_p+B_p)$ and A^{475}_y, respectively].

$$A(^{680}_{p}+B_p) = (K_y C^{680}-C^{475})/(K_y-K_p)$$

$$A^{475}_y = (C^{475}-K_p C^{680})/(I-K_p/K_y)$$

Yorath, C.J.

THE APOLLO STRUCTURE IN TOFINO BASIN, CANADIAN PACIFIC CONTINENTAL SHELF; Canadian Journal of Earth Sciences, v. 17, p. 758-775. 1980.

The Apollo structure of Tofino Basin, Vancouver Island continental shelf, represents a gentle fold that developed within Neogene marine mudstones and siltstones during the Pleistocene. Interpretations derived from side-scan sonar, single and multichannel seismic, and 3.5kHz profiles, in addition to observations made during submersible traverses as well as lithostratigraphic and biostratigraphic information from dart cores and the Shell Anglo Apollo J-14 well, provide the basis for a structural and kinematic analysis of the structure.

At the surface the structure is expressed as a curvilinear anticline, the axis of which is offset by a left-lateral wrench fault. Rotated conjugate left-lateral and minor right-lateral shears developed from the main wrench and dislocate strata within the structure's core. The anticline developed above a shallow detachment surface enclosed within the Neogene and Pleistocene successions. Motion along this surface was possibly induced by earthquake activity associated with the Nootka Fault and thus the structure possibly represents the effects of a gravitational slide.

La structure d'Appolo dans le bassin de Tofino, sur la plate-forme continentale de l'île de Vancouver, représente un pli de faible amplitude qui s'est formé au cours du Pléistocène dans les mudstones et les siltstones d'origine marine du Néogène. Les interprétations à partir des données du sonar à balayage latéral, des profils sismiques à chenaux simples et multiples, des profils à des fréquences de 3.5kHz, les observations faites durant des traverses en sous-marin en plus des informations lithostratigraphiques et biostratigraphiques de carottes enfoncées superficiellement et le puits Shell Anglo Apollo J-14 fournissent une base pour l'analyse structurale et cinématique de la structure.

A la surface, la structure se présente comme un anticlinal curviligne dont l'axe est décalé par une faille verticale avec rejet du côté gauche. Des plans de cisaillement conjugués de rotation avec mouvement à droite et moins souvent à gauche se sont développés à partir de la faille principale et ont disloqué les strates dans la structue du noyau. L'anticlinal s'est développé au-dessus d'une surface de décollement peu profonde comprise dans les successions du Néogène et du Pléistocène. Le mouvement le long de cette surface a peut-être été causé par l'activité sismique associée à la faille de Nootka et ainsi, la structure représenterait probablement les effets d'un glissement gravitationnel.

Yorath, C.J. and **Currie, R.G.**

SOME ASPECTS OF THE GEOLOGY AND STRUCTURAL STYLE OF THE VANCOUVER ISLAND CONTINENTAL MARGIN; Geological Association of Canada/Mineralogical Association of Canada, Program with Abstracts, v. 5, p. 88, 1980.

The Vancouver Island continental margin can be defined in terms of two separate basins which differ in structural and depositional style. The Scott Basin, situated beneath the continental shelf and slope off northern Vancouver Island, encloses Cretaceous and Tertiary slope-trench assemblages, arc volcanics and gabbros in a structurally complex terrain characterized by overturned folds and thrust faults. The Tofino Basin, located adjacent to central and southern Vancouver Island, is underlain by Tertiary clastics and volcanics. The volcanics are interpreted to represent a detached portion of Eocene oceanic crust, the southern limit of which is represented by the offshore extension of the Leech River Fault of southern Vancouver Island. Crustal pervasive thrust faults underlie the continental slope whereas supracrustal detachment faults have dislocated Neogene clastics beneath the shelf.