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ABSTRACTS OF PUBLICATIONS IN SCIENTIFIC JOURNALS BY OFFICERS OF THE GEOLOGICAL SURVEY OF CANADA, APRIL 1977 to MARCH 1978

Abbey, Sydney, Aslin, G.E.M., and **Lachance, G.R.**

RECENT DEVELOPMENTS IN THE ANALYSIS OF SILICATE ROCKS AND MINERALS; Rev. Anal. Chem., v. 3, p. 181-248, 1977.

A review is presented covering new developments in chemical, atomic absorption, spectrographic, x-ray fluorescence and other techniques for determination of major, minor and trace constituents in silicates. Text-books and standard reference materials are also discussed. There are 359 references and a supplementary bibliography of 61 items.

Agterberg, F.P.

FREQUENCY DISTRIBUTIONS AND SPATIAL VARIABILITY OF GEOLOGICAL VARIABLES; From Chap. 22 in Application of Computer Methods in the Mineral Industry, R.V. Ramani, Ed.; Soc. Min. Eng. AIME, New York, 1977.

This paper deals with frequency distributions in the field of mineral resource evaluation when a grid is superimposed on the study area and metallogenetically significant attributes are coded with respect to the cells of the grid. It is shown that the parameters of a negative binomial distribution for frequency of mineral deposits per cell can be derived from the parameters of a gamma distribution for the coded attributes. It is also shown that an exponential model for spatial correlation of cell values and Matheron's discrete Gaussian model for indirect transfer functions may provide a suitable methodology for relating cell value distribution to cell size.

Agterberg, F.P.

STATISTICAL METHODS FOR REGIONAL RESOURCE APPRAISAL; Can. Min. Metall. Bull., v. 70, no. 778, 1977.

Synopsis of initial results obtained by statistical analysis of data on sulphide deposits in the Canadian Appalachian region.

Annan, A.P. and **Davis, J.L.**

USE OF RADAR AND TIME DOMAIN REFLECTOMETRY IN PERMAFROST STUDIES; in Proceedings of the Symposium on Permafrost Geophysics, 12 October, 1976, prepared by W.J. Scott and R.J.E. Brown; NRC Tech. Memo. 119, p. 43-59, 1977.

The increasing exploitation of arctic resources has created a demand for high resolution information about the composition and physical state of the surficial geological material. Ground probing radar (GPR) and time-domain reflectometry (TDR) are relatively new geophysical techniques designed to meet this demand. The GPR is capable of providing high resolution information about the sub-surface electrical environment. The main limitation of the radar method is the relatively shallow penetration depth. In ice, water and coarse grained soils there is no difficulty in probing to depths of 5 to 10 m and greater. In silts and clays, penetration depths were less than 5 m with the equipment used for the experiments. The dielectric constants measured in situ lie in the range of 2 to 5 for sands and gravels and 4 to 8 in clays and silts.

Baragar, W.R.A. and **McGlynn, J.C.**

ON THE BASEMENT OF CANADIAN GREENSTONE BELTS: DISCUSSION: Geosci. Can., v. 5, p. 13-15, 1978.

Baragar, W.R.A.

VOLCANISM OF THE STABLE CRUST; in Volcanic Regimes in Canada, W.R.A. Baragar, L.C. Coleman, and J.M. Hall, eds.; Geol. Assoc. Can. Sp. Paper 16, 1977.

Three types of volcanic rocks are characteristic of volcanism of the stable crust: plateau basalts and related intrusives, alkali intrusive complexes, and felsite porphyries. All are related to extension faulting and their presence in the geological record is a sign of crustal maturity. The felsite porphyries, composed in part of ash flow tuffs, typically mark the termination of orogeny.

The plateau basalts are generally distinct from 'geosynclinal' volcanics (greenstone belts) in possessing a higher content of the 'incompatible' elements, most notably Ti, K, Ba, Rb, Sr, Zr, and Pb and in this respect are analogous to volcanics of the oceanic islands relative to those of the oceanic ridges. These are the chemical characteristics attributed to volcanic rocks derived from mantle plumes as is postulated for most of the oceanic islands and it is proposed that plateau basalts are the continental equivalents.

The history of the stable crust of Canada and adjoining regions is marked by an expanding area of volcanic activity in the Aphebian and Helikian Eras, indicative of expanding crustal stability, followed by a growing core of volcanic inactivity in Hadrynian and Phanerozoic times as volcanism shifts to the present easterly coastal regions. There it is related to the successive Wilson cycles of Atlantic openings and closings. Although plateau basalts and their intrusive equivalents presumably record mantle plume activity beneath the stable crust as long ago as the early Aphebian no evidence of crustal separation is apparent until late in the Helikian era. The alignment and general contemporaneity of the Keweenawan Seal Lake, and Gardar plateau basaltic provinces and intervening alkali intrusives of that time (ca. 1200 m.y. ago) point to the presence of pre-Grenvillian rifting within the region of the present Grenville Province. Subsequent separation of the crust along this proposed rift is suggested by the paleomagnetic evidence of Irving et al. (1974). Henceforth the pattern of modern plate tectonic movements became established.

Baragar, W.R.A., Plant, A.G., Pringle, G.J., and **Schau, Mikkel**

PETROLOGY AND ALTERATION OF SELECTED UNITS OF MID-ATLANTIC RIDGE BASALTS SAMPLED FROM SITES 332 AND 335, DSDP; Can. J. Earth Sci., v. 14, p. 837-874, 1977.

Closely spaced sample spanning 'flow units' at sub-bottom depths of 500 and 590 m in the drill hole at site 332B and a pillow at depth of 460 m, site 335, as well as a few individual samples at various depths in these holes and in the hole at site 332A, were studied with a view to determining compositional changes effected by submarine alteration. The rocks are predominantly plagioclase olivine phyric tholeiitic basalts, with the exception of the lower unit of 332B, which is

a picrite formed by the concentration of olivine megaphenocrysts in olivine tholeiitic basalt, is markedly flow-differentiated, and is assumed to be a sill. Three generations of plagioclase and olivine evident in some of the samples as corroded megaphenocrysts ($An_{86\ 78}$, Fo_{89}), euhedral microphenocrysts ($An_{76\ 72}$, $Fo_{85\ 84}$), and groundmass crystals ($An_{72\ 61}$, $Fo_{85\ 84}$), record a crystallization history that begins at depth, continues en route to the surface, and ends with quenching on the sea floor. Filling interstices of the groundmass are intergrowths, commonly submicroscopic, of pyroxene-plagioclase and dark, poorly resolved titanomagnetite-charged magmatic residue. The pyroxenes are augites, ranging to subcalcic and ferroaugite. In places, particularly near pillow and flow unit margins, magma residue partially or completely in-fills vesicle cavities (segregation vesicles). Volatile-bearing phases (notably chlorophaeites, saponite, palagonite, amorphous silica-bearing hydrous iron oxides, and carbonates) tend to be characteristic of the three principal sites in which they are found; palagonite in the glassy margins of pillows and (or) flow units, complex hydrous mineraloids adjoining veins, and chlorophaeites and saponites in the interstices of the crystalline matrix of rocks remote from veins. The latter have the aspect of primary minerals. Palagonitization results in gains in K, Fe, Ti, and Cl, and losses in Ca, Mg, and Na, but net gains and losses in the other sites are less certain. Hydration and oxidation of iron invariably accompany development of volatile-bearing phases, but there is no correlation between these parameters and variation in content of the other analysed elements. Principal component analysis shows that the major part of the compositional variation can be explained by primary factors. In these samples chemical exchange with seawater appears to be limited, possibly because of their rapid isolation by burial from the main body of ocean water.

Balkwill, H.R., Wilson, D.G., and **Wall, J.H.**

RINGNES FORMATION (UPPER JURASSIC), SVERDRUP BASIN, CANADIAN ARCTIC ARCHIPELAGO; Bull Can. Pet., Geol. v. 25, p. 1115-1144, 1977.

The name Ringnes Formation is proposed for a widespread, mappable succession of Upper Jurassic shales in the Sverdrup Basin. In outcrops, the formation is distinguished from underlying Savik Formation shales and overlying Deer Bay Formation shales by the presence of abnormally large calcitic and sideritic mudstone concretions. The concretions impart a distinctly lighter-toned aspect to the landscape than do the adjacent dark Savik and Deer Bay shales, so that the Ringnes Formation can be readily mapped at the surface. The type section for the formation is in central Amund Ringnes Island, where it is about 330 m (1100 ft) thick. Macropaleontological determinations indicate that the formation ranges from probably lower Oxfordian to early Lower Volgian. Preliminary studies of Ringnes microfaunas suggest their equivalence with those of the upper Oxfordian to lower Kimmeridgian sequence of western Siberia.

The Ringnes Formation is interpreted as a prodelta and distal-basin facies, approximately coeval with basin-marginal marine-shoreface and deltaic sandstones comprising the lower and middle parts of the Awingak Formation. Consideration of facies, sedimentary fabric, and faunal content lead to the suggestion that the distinctively large concretions of the Ringnes Formation originated as accretionary depositional mounds in a wide-ranging, shallow regime, and that those primary forms were enhanced diagenetically.

Archer, A., **Bell, R.T.,** Delaney, G.D., Godwin, C.I.

MINERALIZED BRECCIAS OF WERNECKE MOUNTAINS, YUKON; Geol. Assoc. Can., Abstr. with Prog., v. 2, 1977.

An important facet of the Bonnet Plume area near Fairchild Lake is the presence of over 60 breccias (about 2% of a 4000 km^2 area). These breccias are of 2 types. An older type comprising stratabound, mainly homolithic breccias related to acidic volcanism in the middle of an Aphebian (?) sequence. The younger type are heterolithic diatremes cutting pre-Rapitan strata at least 7000 m thick. Some apparent stratiform breccias may be concordant offshoots of these diatremes. Preliminary K/Ar dating suggests an age of 1.5 b.y. for the diatremes.

Blocks in the diatremes range from 100 m diameter down to finely cominuted matrix. Upward displacements of blocks are about 100 m. Individual diatremes commonly exceed 2 km in length and range from thin tabular to circular in form. Slab Mountain diatreme may exceed 9 km in diameter. K-feldspar, carbonates, Fe-oxides, and chlorite are significant components of the matrix; ilmenite, zircon, sphene, fluorite, and barite are present.

Thermal metamorphism in the lower part of the host sequence is to a calcsilicate assemblage. In the middle of the sequence irregular bleaching reduces dark grey rocks to green phyllites. Locally both breccia and border rocks are heavily carbonated; these may be also greatly enriched in iron oxides. Locally these altered rocks are feldspathized wherein barite, iron, copper, cobalt and uranium are important components but not always present together. Geochemical response over the breccias shows high Mo and Cu anomalies.

Yeo, G.M., Jefferson, C.W., Young, G.M., and **Bell, R.T.**

"MOLAR-TOOTH" STRUCTURES IN PROTEROZOIC ROCKS IN CANADA: Geol. Assoc. Can., Abstr. with Prog., v. 2, 1977.

Spar- and microspar-filled deformation structures resembling "Molar-Tooth" structures of Belt Supergroup carbonates are common in fine-grained mm-laminated carbonates of Proterozoic age in Canada. These structures have mm-thicknesses, cm-lengths and heights, variable spacing, orientation, and deformation, and locally compose over 30% of the rock. Associated sedimentary features include desiccation cracks, ripple marks, wavy and flaser bedding, sharpstone conglomerate, oolites, and stromatolites. Strikingly similar structures are common in Proterozoic rocks throughout the world, but are much restricted in the Phanerozoic. Opinions concerning the origin of such structures have been divided. Only negative or circumstantial evidence supports an organic origin. The structures are eogenetically filled shrinkage cracks which acted as strain markers during compaction of cohesive, typically algal-laminated host sediments. Although common in the Proterozoic, their preservation in most Phanerozoic rocks was prevented by metazoan bioturbation. Their validity as chronostratigraphic markers is doubtful, but they are useful indicators of shallow neritic conditions degree of sediment compaction, and possibly paleoslope.

Blake, W., Jr.

HOLOCENE GLACIER FLUCTUATIONS AND SEA LEVEL CHANGES IN ARCTIC CANADA: A REPLY; Geogr. Ann., Ser. A, v. 59, p. 253-256, 1977.

In response to a critique by J.D. Ives five topics related to the history of the Holocene in the Arctic Archipelago are discussed.

1. The term "postglacial" in the southeastern equadrant of the Queen Elizabeth Islands covers the period from 9500 to 9000 years B.P.; i.e., it spans most of the Holocene Epoch (the last 10 000 years). As yet there is insufficient data to permit subdivisions of postglacial time.
2. The major glacier pulsation which occurred in Baffin Island some 8500 to 8000 years ago, the Cockburn substage, was not discussed. Its effect was not noticeable during the early period of beach formations at Cape Storm, Ellesmere Island, because emergence was proceeding at a rate of approximately 7 m/century.
3. Evidence in southern Ellesmere Island is in agreement with the hypothesis that the oldest (ca. 5000 to 4300 radiocarbon years B.P.) period of glacier expansion during the Holocene was less extensive and less widely documented than the two younger intervals.
4. In connection with possible extrapolations to northern Ellesmere the importance of a sample of marine shells dating 10 000 ± 210 years (GSC-1815) is stressed. The fact that throughout the Queen Elizabeth Islands, older age determinations have been obtained on marine deposits near fiord mouths than on those at fiord heads, is indirect evidence for the existence of the Innuitian Ice Sheet.
5. Finally, although it is natural to expect a decrease in the availability of organic materials as the time of a major glaciation is approached, the fact is that a number of radiocarbon age determinations in the 10 000 to 9000 year-range have been obtained on terrestrial and marine samples from the east coast of Baffin Island (between 67°32' and 71°32'N).

Bornhold, D. and Summerhayes, C.P.

SCOUR AND DEPOSITION AT THE FOOT OF THE WALVIS RIDGE IN THE NORTHERNMOST CAPE BASIN, SOUTH ATLANTIC; Deep-Sea Res., v. 24, p. 743-752, 1977.

Suspended matter sampling shows that northward flowing Antarctic Bottom Water transports a significant volume of fine sediment (0.10 to 0.20 mg l^{-1}) into the northern Cape Basin. Echo-sounding (3.5 k Hz) records show that deep currents have excavated a moat 50 to 80 m deep at the base of the Walvis Ridge and have redeposited the sediments east of the moat in elongate swells up to 50 km long and 50 m high. Sea floor photographs indicate that present current velocities are probably less than 10 cm^{-1} and are unlikely to be capable of eroding compacted sediments.

Bostock, H.H.

THE COMPOSITION OF HORNBLENDE, GRUNERITE, AND GARNET IN ARCHEAN IRON FORMATION OF THE ITCHEN LAKE AREA, DISTRICT OF MACKENZIE, CANADA; Can. J. Earth Sci., v. 14, p. 1740-1752, 1977.

The compositions of seven pairs of coexisting hornblende and grunerite and five assemblages of coexisting hornblende, grunerite, and garnet from Archean silicate iron formation of low and medium metamorphic grade have been obtained by electron microprobe analysis. Important factors affecting the composition of the amphiboles are: (1) the Mg/Fe ratio of the iron-formation beds, which controls the gross Mg/Fe ratio of the amphiboles; (2) the alumina content of the beds, which affects the degree of alumina substitution in hornblende thereby altering the distribution of Mg and Fe in the coexisting amphiboles; and (3) the occurrence of iron-rich garnet, which produces higher Mg/Fe ratios in both amphiboles. A fourth potentially important factor, the oxygen fugacity, cannot be satisfactorily assessed with these data, but has not obscured the effects of the other three. Temperature of crystallization of the amphiboles was an important factor mainly insofar as it affected the crystallization of garnet in the alumina-rich rocks.

Four coexisting hornblende-cummingtonite pairs from metatuffs show similar control of Mg-Fe fractionation by alumina substitution in hornblende.

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

UNE AMÉLIORATION DE LA MÉTHODE À (TIGE FILETÉE) POUR LE DOSAGE DES ALCALINS RARES DANS LES ROCHES; Note de Laboratoire, Analusis, v. 5, p. 332-334, 1977.

On propose une modification de la méthode à tige filetée de Govindaraju, afin d'éliminer le besoin d'utiliser deux tampons différents pour le dosage des trois alcalins rares dans les roches silicatées.

Boyle, R.W.

IRON REDUCTION AROUND GOLD-QUARTZ VEINS, YELLOWKNIFE DISTRICT, NORTHWEST TERRITORIES, CANADA: DISCUSSION; Ec. Geol., v. 73, p. 100-111, 1978.

Boyle, R.W.

CUPRIFEROUS BOGS IN THE SACKVILLE AREA, NEW BRUNSWICK, CANADA; J. Geochim. Explor., v. 8, p. 495-527, 1977.

Two cupriferous bogs in the Sackville area of New Brunswick, Canada, are described. The organic matter (muck) in these bogs contains from 2 to 6% Cu, derived from cupriferous springs that carry copper in amounts ranging from 0.005 to 1 ppm. The source of the copper in the springs is unknown, but the metal probably originates from the leaching of cupriferous (chalcocitic) deposits in grits and conglomerates at the base of the Boss Point Formation of Carboniferous (Pennsylvanian) age.

The copper occurs in the muck as copper humate(s), the precise chemical characterization of which is unknown.

Examples of copper bogs related to copper mineralization in many parts of the world are reviewed, and it is pointed out that such bogs are good geochemical indicators of cupriferous deposits.

The moss, **Pohlia nutans,** grows in the springs in the copper bogs and in other wet sites in the area where large concentrations of copper occur. This moss is tolerant to large amounts of available copper and markedly accumulates the metal. When slightly chlorotic **Pohlia nutans** may indicate the presence of higher than normal amounts of copper.

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

LARGE-SCALE STRATIFORM AND INTRUSIVE SEDIMENTARY BRECCIAS OF THE LOWER PROTEROZOIC GOULBURN GROUP, BATHURST INLET, N.W.T.; Can. J. Earth Sci., v. 14, p. 2364-2387, 1977.

Two types of sedimentary breccia have been identified in the lower Proterozoic (1.7 to 2.5 Ga) Goulburn Group, Bathurst Inlet, N.W.T. One type is a single unit of strata-bound breccia consisting predominantly of sedimentary clasts surrounding large (up to 500 m in length) sheets of chaotically folded and brecciated allochthonous carbonates. This breccia, the Omingmaktook member of the Brown Sound Fm., is an olistostrome interpreted to have formed by slumping of carbonate sediments during differential basin subsidence and (or) evaporite solution. The other type of breccia occurs as intrusive dykes and large cylindrical bodies (up to 1 km in diameter) that cut through more than 2000 m

of Goulburn strata. The intrusive breccias also cross-cut and rework the olistostrome. These intrusive breccias: are of entirely sedimentary composition, and restricted to the upper Goulburn Group; are generally unsorted and exhibit both massive and flowage-layered textures; and contain quartz, dolomite, and minor tourmaline crystals. The intrusive breccias are interpreted as exhumed conduits through which trapped intrastratal fluids migrated to a post-Goulburn paleosurface. Intrusion of the breccia is interpreted to have been produced by the accumulation of pools of intrastratal fluids in structural traps, which under pressure intruded and stoped into overlying strata, eventually reaching a Goulburn paleosurface where they extruded mud flows and formed sedimentary volcanoes.

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

CAMBRIAN-SILURIAN STRATIGRAPHY OF BORGLUM ELV, PEARY LAND, EASTERN NORTH GREENLAND; Groenlands Geol. Unders., rapp. 82, 1977.

A sequence of Lower Palaeozoic carbonate and clastic rocks is described from Børglum Elv, Peary Land, eastern North Greenland, and briefly compared to Lower Palaeozoic sections elsewhere in Greenland and in Spitsbergen. Lower Cambrian clastic rocks of the Buen Formation are followed by dolomite of the Lower Cambrian Brønlund Fjord Formation (125 m). Succeeding dolomite and dolomitic limestone of the Wandel Valley Formation (320 m) of Early to Middle Ordovician age are overlain by limestone of the Børglum River Formation (430 m) of Middle to Late Ordovician age. Un-named Early Silurian dolomite and limestone formations (150 m and 320 m respectively) are followed by an un-named Middle Silurian black shale formation (c. 100 m) and at least 800 m of a late Middle Silurian and younger un-named flysch formation. Carbonate mounds, originating in the highest beds of the un-named Silurian limestone formation, occupy stratigraphic levels through the overlying black shale formation and into the flysch formation.

Chung, C.F., Divi, S.R. and **Fabbri, A.G.**

AN INTERACTIVE GRAPHIC PROGRAM FOR SIMULATING THE DISTRIBUTION OF TRANSFORMATIONS OF SEVERAL INDEPENDENT RANDOM VARIABLES; Proceedings of Computer Science and Statistics: Tenth Annual Symposium on the Interface, National Bureau of Standards, Washington D.C.; 1977.

An interactive graphic computer program for simulating and displaying the distributions of transformations and extremes of several independent continuous random variables is presented. The parameters and distributions of the initial random variables can be interactively altered. Simulated distributions of transformations and extremes using the Monte Carlo technique are displayed with estimated means and standard deviations.

Armstrong, J.A. and **Cecile, J.J.**

TWO MAJOR WISCONSIN LITHOSTRATIGRAPHIC UNITS IN SOUTHWEST BRITISH COLUMBIA; Can. J. Earth Sci., v. 14, p. 1471-1480, 1977.

Two lithostratigraphic units, Quadra Sand and the Cowichan Head Formation, are overlain by Vashon till and associated glacial sediments and underlain by Dashwood and Semiahmoo drift deposits in coastal southwest British Columbia. Each unit is formally described and stratotypes are presented.

Quadra Sand consists of cross-stratified, well-sorted sand, minor gravel, and silt deposited as outwash in front of glaciers advancing into the Georgia Depression at the beginning of the Fraser Glaciation. It is diachronous, deposition having commenced earlier than 29 000 years BP at the north end of the Georgia Depression but not until after 15 000 years BP at the south end of the Puget Lowland.

The Cowichan Head Formation, deposited during the Olympia nonglacial interval, underlies Quadra Sand and consists of parallel-bedded silt, sand, and gravel, in part plant-bearing. The unit is divisible into a lower marine member and an upper fluvial and estuarine member.

Coles, R.L. and **Currie, R.G.**

MAGNETIC ANOMALIES AND ROCK MAGNETIZATIONS IN THE SOUTHERN COAST MOUNTAINS, BRITISH COLUMBIA: POSSIBLE RELATION TO SUBDUCTION; Can. J. Earth Sci., v. 14, p. 1753-1770, 1977.

A qualitative correlation is observed between the northwesterly trending Coast Mountains Magnetic Anomaly, British Columbia, and a systematic, cross-trend variation of measured magnetizations within the more mafic rocks from the Coast Plutonic Complex between 50° and 51°N. This variation partly determines the form of the anomaly. A similar variation of magnetizations in more acidic rocks is not found. Quantitative modelling, however, indicates the presence of deeper, intense magnetizations below the high anomaly in the west. A magnetic crust as much as 40 km thick is consistent with geothermal studies in this region. The deep crust of Vancouver Island is less magnetic than that under the western Coast Plutonic Complex. The concentration of magnetic material may be a consequence of a subduction process, whereby water released by dehydration of the downgoing slab promotes partial melting, with subsequent uprising of heat and melt within a hydrous environment. The water tends to maintain a relatively high oxygen pressure, at least locally, and magnetite forms in the crystallization sequence. As subduction proceeds, this region cools and the magnetic material may then produce a high magnetic anomaly.

Currie, K.L.

A NOTE ON POST-MISSISSIPPIAN THRUST FAULTING IN NORTHWESTERN CAPE BRETON ISLAND; Can. J. Earth Sci., v. 14, p. 2937-2941, 1977.

Thrust faulting, apparently of major proportions, has been observed at five localities in northwestern Cape Breton Island and inferred as several more. The thrust blocks of Precambrian crystalline rocks and Horton Group clastic sedimentary rocks have over-ridden Windsor Group (Viséan-Namurian) rocks but not Riversdale Group rocks (Westphalian). Thrusting can be explained by sliding of material from an elongate horst extending from northern Cape Breton Island to southwestern Newfoundland which rose throughout Tournaisian and Viséan time.

Darnley, A.G., Charbonneau, B.W., and **Richardson, K.A.**

DISTRIBUTION OF URANIUM IN ROCKS AS A GUIDE TO THE RECOGNITION OF URANIFEROUS REGIONS; from Recognition and Evaluation of uraniferous areas; IAEA-TC 251 9; 1977.

Regional distribution of uranium over parts of the Canadian Shield has been determined by reconnaissance airborne gamma-ray spectrometry surveys carried out by the Geological Survey of Canada during the past seven years. Most of the areas surveyed are near the southern edge of the Precambrian Shield, or along the northwestern edge of the Shield, where Canada's known uranium occurrences are concentrated. The regions surveyed show prominent areas of above-average uranium content, either enclosing the known

uranium occurrences, or the prominent areas are older formations adjacent to the area of economic interest. It is also apparent that there are areas containing few occurrences where uranium concentrations are generally low. The observed association of uranium occurrences with areas of above-average regional concentrations of uranium is consistent with the geochemical cycle of uranium, whereby uranium is initially contained in igneous rocks, and subjected to weathering, which may concentrate the uranium in a variety of depositional environments. Regional uranium 'highs' located by reconnaissance surveys should be explored in more detail for significant uranium concentrations, either within the boundaries of the 'high' or in adjacent geologically related rocks.

Davis, J.L. and **Annan, A.P.**

ELECTROMAGNETIC DETECTION OF SOIL MOISTURE: PROGRESS REPORT I; Can. J. Remote Sensing, v. 3, p. 76-86, 1977.

The remote determination of soil moisture content requires a remotely detectable physical property of soils which is primarily dependent on moisture content. One physical property which holds promise of satisfying these conditions is the complex dielectric constant of the soil in the frequency band 10^7 to 10^9 Hz. Laboratory and field experiments employing time domain reflectometry (TDR) methods indicate the following: that the dielectric constant depends strongly on soil moisture and weakly on soil type, and density; that variations of several hundred per cent in the dielectric constant occur as moisture content varies for the range of moisture content normally encountered in the field; that an empirical relationship between dielectric constant and soil moisture exists.

Beltoas, S. and **Day, T.J.**

LONGITUDINAL DISPERSION IN A NATURAL CHANNEL; LESSER SLAVE RIVER; Alberta Res. Counc. Rep. REH/76/1, 30 p, 1977.

A comparison of file data and several one-dimensional analytical approaches for determining the longitudinal dispersion of fluid particles in a natural channel. Lateral sampling has enabled a clarification of the mixing length and reinforced the concept of the one-dimensional stage as characterized by almost identical but shifted time concentration curves.

Day, T.J.

DISCUSSION: RESISTANCE EQUATION FOR ALLUVIAL-CHANNEL FLOW; by D.E. Burkham and D.R. Dawdy; J. Hydraul. Div., A.S.C.E., October 1976; May, p. 582-587, 1977.

A discussion of the behaviour of the resistance law for flows over large bed particles (relative roughness of 3 or less). This behaviour is best described by simple power functions whose parameters are shown to vary with bed slope and roughness characteristics.

Day, T.J.

OBSERVED MIXING LENGTHS IN MOUNTAIN STREAMS; J. Hydrol., v. 35, p. 125-136, 1977.

Data on lateral mixing characteristics are presented, and show that mixing lengths for either centre or side injections of tracer slugs occur within a distance equal to 25 mean channel widths. Comparisons with conventional methods are made.

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

A NUMERICAL MODEL OF THE FRACTIONATION OF OLIVINE AND MOLTEN SULFIDE FROM KOMATITE MAGMA; Earth Planet. Sci. Lett., v. 39, p. 255-266, 1978.

A numerical model has been formulated that simulates the differentiation of mafic and ultramafic magmas by the fractionation of olivine and molten sulfide. The model is used to simulate the low-pressure differentiation of a komatiite magma series under both sulfide-undersaturated and sulfide-saturated conditions. Under sulfide-saturated conditions, the molecular ratio of olivine to sulfide removed from the silicate liquid is 39 ± 2. Separation of this relatively small proportion of sulfide melt results in significantly different chemical trends in derivative liquids and fractionated material than are produced in sulfide-undersaturated system, and this observation may be useful in mineral exploration. Comparison of the model results with published analyses of natural rocks indicate that the liquid equivalent members of the komatiite suite at Yakabindie, Western Australia, could be derivative liquids produced by fractional crystallization of olivine from a sulfide-undersaturated parental magma containing about 32 wt.% MgO. Derivation of a komatiitic pyroxenite with 20 wt.% MgO would require fractionation of 43.4 mol.% olivine whereas production of a komatiitic basalt with 12 wt.% MgO would involve removal of 58.5 mol.% olivine. Synvolcanic intrusive dunitic lenses at Yakabindie could have been produced by accumulation of material separated during about 3.8 mol.% fractionation of a similar parental magma, but the concentration of chalcophile elements in these bodies requires that the magma was sulfide-saturated.

Eckstrand, O.R.

MINERAL RESOURCE APPRAISAL AND MINERAL DEPOSITS COMPUTER FILES IN THE GEOLOGICAL SURVEY OF CANADA; Math. Geol. v. 9, no. 3, 1977.

The Geological Survey of Canada (G.S.C.) has been involved in national appraisal of resources of certain commodities for nearly two decades beginning with a national study of iron deposits in 1955. In 1972, the first national appraisal to rapidly estimate "total" resources of Cu, Pb, Zn, Ni, Fe, Mo, and U in Canada was carried out largely by economic geologists. This exercise produced, among other things, a better definition of G.S.C. needs for building computer files in support of mineral deposits studies and mineral resource appraisal. Objectives of this paper are threefold: (1) to outline general methodology for the kind of mineral resource appraisal carried out by the G.S.C. in 1972; (2) to identify types of information required in that appraisal; and (3) to indicate types of information on mineral deposits for which it seems advantageous for the G.S.C. to construct computer files, and how these files relate to mineral resource appraisal. Methodology is fairly straightforward for appraisal of reserves (known, measured resources), but is much more problematic for appraisal of undiscovered resources. For the latter, G.S.C. economic geologists make use of two basic concepts: the "deposit model," which is a generalized deposit type, distinguished by its geological attributes and host rock environment, and containing characteristic amounts of specified commodities; and the "metallogenic region," which is a geographic area of more or less homogeneous geology deemed favorable for the presence of a particular deposit model. Background information required for appraisal of undiscovered resources includes the following: (a) data on distribution and geology of Canadian deposits and occurrences; (b) data on geology of important, foreign deposits; (c) knowledge of Canadian geology, commensurate with metallogenic requirements; (d) knowledge of current theories of ore-forming processes; and (e) appreciation of the

amount, location, and effectiveness of past exploration in Canada. At present, only identity, location and certain simple geological features of Canadian deposits are considered practical for general computer file of mineral deposits. The fundamental activity of the G.S.C. in the sphere of mineral deposits is a number of broad studies on the geology of certain commodities in Canada carried out by economic geologists. Appraisal of mineral resources is based directly on the results of those studies, and is done by the same economic geologists. Construction of G.S.C. computer files is in response to needs defined by economic geologists, mainly in the context of their broad studies.

Eisbacher, G.H.

MESOZOIC-TERTIARY BASIN MODELS FOR THE CANADIAN CORDILLERA AND THEIR GEOLOGICAL CONSTRAINTS; Can. J. Earth Sci., v. 14, p. 2414-2421, 1977.

Paleogeographic maps for the clastic successions of Early Jurassic, Late Jurassic – Early Cretaceous, and Late Cretaceous – early Tertiary time depict important geologic features that have to be considered in modelling, the Mesozoic sedimentary basins of the Canadian Cordillera. The relative positions of clastic basins, reverse fault zones, and volcanic complexes suggest that the crustal elements underlying the western Cordillera were foreshortened and thickened increasingly from early Mesozoic to early Tertiary. Throughout the late Mesozoic the Canadian Cordillera displayed subdued topography. Uplift was dramatic and possibly of Andean proportions during the latest Eocene and Oligocene. Reconstruction of paleogeography along major right-lateral faults suggests the possibility that old basement trends of the cratonic foreland may have had a profound influence on structures west of the Rocky Mountains. In terms of plate tectonics the Mesozoic basins of the Canadian Cordillera are marginal or possibly intra-arc basins, and cannot be compared easily with the presumed forearc basin containing the late Mesozoic Great Valley Sequence of California.

Emslie, R.F.

ELSONIAN MAGMATISM IN LABRADOR: AGE, CHARACTERISTICS AND TECTONIC SETTING; Can. J. Earth Sci., v. 15, p. 438-453, 1978.

Paleohelikian Elsonian magmatism (~ -1500 to -1400 Ma) in central Labrador occurred in the interval following the Hudsonian Orogeny (~ -1700 Ma) and preceding the Grenvillian Orogeny (after -1200 Ma). Elsonian plutons, dominated by anorthosite and adamellite compositions, have physical and petrogenetic characteristics of anorogenic intrusions and were intruded into stable, continental crust; evidence to support the existence of a 'pre-Elsonian' orogenic event (thus making the intrusions postorogenic) is slim. An average depth of intrusion about 15-20 km implies that the ambient country rock temperatures were at or near the argon blocking temperature for biotite; strong uplift and cooling, during and (or) immediately following Elsonian plutonism, is the probable cause of 'Elsonian' ages in surrounding country rock terrane.

The Elsonian plutonic suite has characteristics consistent with derivation from bimodal magmatic processes. Products of basic magmas (relatively older) and of silicic magmas (relatively younger) are well represented but intermediate compositions are much less common and small in volume.

Consideration of the geological record succeeding Elsonian magmatism suggests that it was a precursor of a sequence of events that led ultimately to intracontinental rifting or incipient rifting.

Emslie, R.F. and Meyers, R.E.

THE HARP DIKES AND THEIR RELATIONSHIP TO THE HELIKIAN GEOLOGICAL RECORD IN CENTRAL LABRADOR; Can. J. Earth Sci., v. 14, p. 2683-2696, 1977.

The Harp olivine diabase dikes, of Neohelikian age, form an east-northeast trending swarm that cuts rocks of the Harp Lake Complex in central Labrador. The petrography, and rock and mineral chemistry of the dikes indicate that they are transitional in character between tholeiitic and alkalic compositions. The major element chemistry of the dikes is similar to basaltic magmas from other comparable continental settings and in particular closely resembles basalts and diabase sills of the Neohelikian Seal Lake Group.

Correlation of the Seal Lake – Harp dikes magmatism is suggested with two other groups of hypabyssal intrusions of olivine gabbro east and southeast of the Seal Lake synclinorium (Michael gabbros and diabase dikes in the Mealy Mountains complex). All of this basic magmatism may have been related to a Neohelikian zone of continental rifting or incipient rifting. Intrusion and extrusion of basic magma under conditions indicative of crustal extension closely follows, or is associated with, uplift and erosion of anorogenic anorthosite-'granite' complexes in other places in the world and is inferred to be a consequence of a continuing evolving process of mantle-crust interactions; in Labrador, the process began in the Paleohelikian with intrusion of major anorthosite-adamellite complexes.

Fabbri, A.G. and Kasvand, T.

AUTOMATIC COUNTING OF ALPHA-TRACKS FROM AUTORADIOGRAPHS OF RADIOACTIVE MINERALS; 8th Annual Automatic Imagery Pattern Recognition: Symposium Proceedings in AIPR, April 3-4, 1978, National Bureau of Standards, Gaithersburg, Maryland, p. 11-26.

An image processing approach is introduced for the automatic separation and counting of randomly distributed segments from binary images of autoradiographs of the alpha particle tracks emitted by radioactive minerals. The computer algorithms presented in this paper provide an alternative to cumbersome and tedious visual counting for statistical estimation. The computing strategy is structured to allow the computer programs to be adapted to a relatively small machine, i.e. a "minicomputer". This requirement puts certain constraints onto the structure of the programs and the amount of picture data that can be kept in the memory of the machine. The method described may be further developed for the automatic counting of overlapping fibers in general, such as asbestos fibers in air samples for pollution studies or fibers in pulp for paper manufacturing. It can also be used for the quantification of linear features from geological maps or aerial photographs. The output of the algorithm provides tables of labeled components which can be used for statistical analysis of the segments.

Franklin, J.M. and Mitchell, R.H.

LEAD-ZINC-BARITE VEINS OF THE DORION AREA, THUNDER BAY DISTRICT, ONTARIO; Can. J. Earth Sci., v. 14, p. 1963-1979, 1977.

The lead-zinc-barite deposits of the Dorion region are spatially associated with the unconformity between the Sibley Group (Helikian) and Archean and Aphebian basement rocks. The veins are coarse grained, and mineralogically zoned with galena-calcite in the central zone, sphalerite-quartz surrounding the central zone, and barite (± chalcopyrite) in the vein extremities. Veins occur near the pinch-out of the "Pass Lake formation" (basal Sibley Group), within the

dolomite of the overlying "Rossport formation," or in nearby basement fractures. Rossport dolomite, where it forms a vein wall, is highly altered to metal-enriched chert and calcite. Archean wall rocks are not altered.

Potassium-argon isotopic determinations on mica in Archean pegmatite immediately adjacent to a vein indicate that the transporting solutions were too cool to cause re-equilibration of the Ar within the mica. Sulphur-isotope data indicate equilibrium between galena and sphalerite yielding a depositional temperature range of 35-135°C, and disequilibrium between sulphide-sulphate pairs. Lead isotopes are highly anomalous, yielding a secondary isochron which indicates either an Archean, or more probably a mixed Archean-Aphebian, source of lead.

The deposits formed from metal leached from either basement rocks or breakdown of Sibley sandstone matrix. Metals and sulphate moved through the permeable sandstone, probably as chlorite-ion complexes, and precipitated at the sandstone pinch-out. Reduced sulphur, possibly derived from organic decay, and probably held in a gas trap at the sandstone pinch-out, caused precipitation of the sulphides by reaction with metal-bearing brines.

Fransham, P.B. and **Gadd, N.R.**

GEOLOGICAL AND GEOMORPHOLOGICAL CONTROLS OF LANDSLIDES IN OTTAWA VALLEY, ONTARIO; Can. Geotech. J., v. 14, p. 531-539, 1977.

Seventeen maps at a scale of 1:50 000 showing the distribution of sensitive clay deposits and associated landslides in Ottawa Valley have been compiled. The following map-units have been used: rock, till, and gravel older than the clay; sensitive clay associated with the Champlain Sea; sand and gravel overlying clay; and organic deposits overlying clay. Also shown on the maps are landslides that could be identified on aerial photographs and a line representing the maximum limit of marine transgression.

From data collected from several test borings, the sensitive clay has been divided into four distinct stratigraphic units. Visual identification criteria have been developed and average index properties are given. These results show that 'Leda' clay is not a clay with unique properties, but displays considerable variability. The four stratigraphic units have been related to the history of transgression and regression of the Champlain Sea. Many of the large landslides occurred early in the history of the area during a period when a considerably larger Ottawa River cut several broad channels through the sediment.

By combining the surficial geology and the stratigraphic profiles obtained by drilling it has been possible to classify sensitive clay slopes into two geologic settings. One setting consists of clay at the surface and the other has a thin layer of fine sand overlying the sensitive clay. The majority of the large retrogressive slides have occurred in slopes of the latter setting. A comparison study is being carried out on the two settings and some preliminary results are presented here.

Yong, R.N., Alonso, E., Tabba, M.M., and **Fransham, P.B.**

APPLICATION OF RISK ANALYSIS TO THE PREDICTION OF SLOPE INSTABILITY; Can. Geotech. J., v. 14, p. 540, 1977.

The problem of the prediction of stability or instability of natural clay slopes is examined in view of the random intrinsic nature of both soil properties and external actions. The probabilistic method of analysis appears to be a useful tool, which not only could account for these random properties but also could consider uncertainties derived from incomplete knowledge of pertinent model parameters and conditions of stability.

Using the familiar method of slices, the different sources of error have been incorporated into a first-order probability analysis of the simplified Bishop model in order to arrive at quantitative information concerning the probability of failure. Field and laboratory data from an instrumented test valley slope in the Ottawa region have been considered to arrive at an instability risk prediction of the test slope. The mean functions of the strength parameters have been made explicitly dependent on a number of statistical parameters to emphasize dependence on available data. The analysis distinguishes between statistical uncertainty, which comes from insufficiency of available data, and probabilistic uncertainty, which is a measure of random heterogeneity of the soil.

Sheeran, D.E., Dalton, C.J., **Fransham, P.**, and Fattah, I.

IN SITU RESPONSE OF MUSKEG TO DYNAMIC LOADING; 17th Muskeg Conf., Saskatoon, Sask., Sept. 1977.

The objective of this study has been to study the behavior and performance of highly compressible organic soils such as muskeg when subjected to traffic loading to determine the relationship between material instability and maintenance problems. Vast areas of Canada are covered by muskeg. The size and geometry of these deposits makes them difficult to avoid in the construction of transportation networks. In the case of efficient railroad service, strict tolerance limits must be maintained for differential settlements along the alignment and between adjacent rails. The stresses induced in the track subgrade result from the weight of the ballast and any associated fill and from large dynamic loads associated with train passage. These stresses result in long term settlements and large dynamic surface deflections, both of which lead to increased maintenance problems.

In order to properly assess the instability mechanisms leading to maintenance problems and to provide a basis for effective remedial actions, the in situ behavior of the track-muskeg subgrade system was monitored. A field site is described in which wheel loads, vertical deflections on the surface and at depth, and pore pressure response are measured with high speed recorders during train passage. Typical results are presented showing the component of dynamic surface deflection due to strain in the muskeg subgrade and the measured portions of elastic and permanent deflection associated with passenger and heavy freight trains.

Frebold, Hans and **Poulton, T.P.**

HETTANGIAN (LOWER JURASSIC) ROCKS AND FAUNAS, NORTHERN YUKON TERRITORY; Can. J. Earth Sci., v. 14, p. 89-101, 1977.

The Lower Jurassic Hettangian Stage is documented with certainty for the first time in the Canadian Arctic. It is represented by a basal Jurassic sandstone unit in the Bonnet Lake area of northern Yukon Territory. The two subzones of the Early Hettangian Planorbis Zone, i.e., the Planorbis Subzone and the Johnstoni Subzone, are indicated by poorly preserved **Psiloceras** sp. indet. and **Psiloceras (Caloceras)** cf. **P. (C.) johnstoni** (J. de C. Sowerby), respectively. The varied but poorly preserved bivalve fauna associated with **P. (C.)** cf. **P. (C.) johnstoni** includes **Prosogyrotrigonia**(?) sp. cf. **P. inouyei** (Yehara), **Cardinia** sp. cf. **C. hybrida** (J. Sowerby), **C.** sp. aff. **C. concinna** (J. Sowerby), **Pleuromya**(?) sp., **Meleagrinella** sp., **Oxytoma (Oxytoma)** sp., and **Parallelodon** sp. The bivalves closely resemble approximately coeval forms described from Japan. The above-mentioned faunas are figured as is a specimen of **Psiloceras** cf. **P. erugatum**

(Phillips), which was previously described from the Hettangian of southern Yukon. Other occurrences of the Hettangian in Canada and Alaska are reviewed.

Frith, Rosaline, **Frith, R.A.,** and Doig, R.

THE GEOCHRONOLOGY OF THE GRANITIC ROCKS ALONG THE BEAR-SLAVE STRUCTURAL PROVINCE BOUNDARY, NORTHWEST CANADIAN SHIELD; Can. J. Earth Sci., v. 14, p. 1356-1373, 1977.

Archean granitic rocks along the southern Bear-Slave boundary fall into three age groups: the oldest are 3000 Ma old intrusive tonalites and granodiorites that form the basement to the Yellowknife Supergroup; the second are syn-volcanic granitic intrusions of ∿ 2700 Ma; and the youngest are ∿ 2560 Ma granitic and migmatitic diapirs formed in part from supracrustal and granitic rocks. Two Proterozoic thermal events are recognized within the Slave Province. A ∿ 2300 Ma event may be related to early rift breakup of the Archean crust and is recorded in Rb-Sr whole-rock and K-Ar mineral systems. A ∿ 1970 Ma event was less intense but may be related to further rifting of the Archean and to fault-block depression of the Indin Lake supracrustal basin, the intrusion of a group of granodioritic stocks, and the formation of granitic pegmatite.

Within the Bear Province, evidence of a ∿ 2700 Ma intrusive event and a ∿ 2300 Ma thermal event are preserved in Rb-Sr whole rock systems. Practically all the granitic rocks of the Bear Province, including the Hepburn batholitic rocks, are thought to have been derived wholly or partly from Archean rocks. The main period of Hudsonian deformation and metamorphism was accompanied by a diapiric remobilization of the Archean basement about 1800 Ma ago. Twelve Rb-Sr isochrons, as well as other published geochronologic data from the region, support these conclusions.

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

TECTONIC SETTING AND SULPHIDE DEPOSITS OF THE HACKETT RIVER GREENSTONE BELT, SLAVE PROVINCE; Can. Inst. Min. Met., Ann. Meeting, Ottawa, April 1977.

Sedimentary belts of the Slave Province with associated volcanics and migmatite-intrusive complexes are partially separated by older granitic gneisses (∿ 3100 m.y.). The volcanics erupted along rifts which became sites of crustal foundering and development of troughs that filled with turbidites derived from the older granitic areas as well as from the volcanics. Present margins of the older gneisses may be close to the original margins of deposition of volcanics and of the thickest part of the basins of sedimentation. It is noteworthy that many base metal sulphide deposits are also close to older granitic gneiss margins.

The early Kenoran Orogeny (∿ 2700 m.y.) resulted in granitic uplift of basement and granitic plutons at the margins of the structural troughs. Further sedimentation and volcanism followed and the deeper supracrustal rocks were deformed and metamorphosed. Late Kenoran (∿ 2560 m.y.) renewed downwarping formed homoclinal acid to basic volcanic belts that face away from uplifted granitic areas containing remnant granitic basement rocks, extensive migmatites and undeformed granitic plutons.

Base metal deposits in the Hackett River greenstone belt occur at or near the volcanic-sedimentary interface. The Bathurst-Norsemines deposits are located near the tip of a volcanic wedge that overlies and interfingers with pre-volcanic sedimentary strata.

The Yava Deposit overlies a thick ash flow accumulation that is flanked by lavas. The ash flows are extensively welded. Welded tuffs are also found near the Bathurst-Norsemines deposits, so emergent, subaerial conditions prevailed in both areas near the times of deposition of the ore minerals. The relationships suggest that the deposits were formed close to the distal edge of the volcanic pile, probably in shallow water.

Fulton, R.J.

LATE PLEISTOCENE STRATIGRAPHIC CORRELATIONS, WESTERN CANADA; IUGS-UNESCO Int. Corr. Prog.; Prog. 73-1-24, Rep. 4, 1977.

A general correlation can be made of certain major late Pleistocene stratigraphic units in Western Canada. The precise age limits and the degree of synchrony of these are not known, however, it appears that Early, Middle and Late subdivisions of Wisconsin time that are used in eastern North America can be equally usefully applied in the west.

In the southern Cordillera the last Interglacial/Sangamon appears to have been followed by a cool period and then by an ice advance that covered the entire area. These events are placed in Early Wisconsin. Middle Wisconsin is characterized by nonglacial conditions that prevailed from beyond the limit of radiocarbon dating until the build up of the last ice advance /20-25,000 B.P./. The climate of this nonglacial at times approached that of present but at other times, particularly during late stages of the period, was cooler. Late Wisconsin ice covered the entire region.

In southwest Yukon a similar 3 part glacial-nonglacial-glacial situation appears to have occurred during the Wisconsin. In the central Yukon however evidence of major ice retreat during Middle Wisconsin has not yet been found.

The last ice advance and the later part of the preceding non-glacial period in the Interior Plains appear to correlate well with the Cordilleran record. The complexity of the deposits lying between the mid-Wisconsin break and the top of the Sangamon however suggests that the area may have been subjected to Early Wisconsin glacial fluctuations not recognized in the Cordillera.

Gandhi, S.S.

GEOLOGICAL SETTING AND GENETIC ASPECTS OF URANIUM DEPOSITS IN THE KAIPOKOK BAY--BIG RIVER AREA, LABRADOR; Geol. Soc. Am., Abstr., v. 9, p. 983, 1977.

The eastern part of the Kaipokok Uranium Province on the Central Labrador coast contains more than forty uranium occurrences hosted by sedimentary and volcanic units of the early Proterozoic Allik Group. The rocks were affected by the Hudsonian Orogeny about 1600 m.y. ago. The uranium occurrences fall into two broad groups represented by the Kitts and Michelin deposits. These two deposits are currently being developed. The Kitts deposit and several other occurrences are found along a long, narrow (approximately 20 km x 100 m) stratigraphic zone of argillitic and mafic tuffaceous rocks. The Michelin deposit and a number of small occurrences are located in an extensive area (about 120 km x 25 km) that is underlain by metamorphosed quartzo-feldspathic rocks of acidic volcanic and tuffaceous origin. The uranium occurs in tabular zones of disseminated mineralization that are roughly concordant to the host units and regional foliation.

It is postulated that the Kitts group represents syngenetic-sedimentary type mineralization, and that the Michelin group represents metamorphosed epigenetic type mineralization which was initially related to acidic volcanism. Field relations and laboratory studies including isotopic age determinations support these hypotheses.

Clarke, W.B., Top, Z., Beavan, A.P., and **Gandhi, S.S.**

DISSOLVED HELIUM IN LAKES: URANIUM PROSPECTING IN THE PRECAMBRIAN TERRAIN OF CENTRAL LABRADOR; Ec. Geol., v. 72, p. 233-242, 1977.

Measurements of dissolved helium, $^3He/^4He$, and neon have been made in 60 water samples collected from 56 lakes and ponds in the Kaipokok region in Labrador. Tritium was measured in 8 water samples. The aim of the survey was to search for excess ^4He from decay of uranium and its daughter products. Excess ^4He varied from $\sim$ 0% to 65% relative to the equilibrium solubility concentration at the temperature of the sample. $\delta(^3He)$, the helium isotope ratio anomaly relative to atmospheric helium, varied from +11% to -25%. Although the effect of tritium decay in the water prior to sampling must be considered, there is a good correlation between the lakes which have $\delta(^3He)$ -2% and lakes with excess radiogenic $^4He > 4\%$. The helium results when plotted on a map of the area show a remarkable fit with the locations of known uranium mineralization.

Garrett, R.G.

EXPLORATION GEOCHEMISTRY IN RESOURCE APPRAISAL; Math. Geol., v. 9, no. 3, 1977.

Exploration geochemistry is viewed in a resource appraisal framework and the various general methods are discussed in terms of their applicability at different stages of the appraisal exercise. The direct nature of geochemical exploration is emphasized and the various types of data that the surveys yield are discussed together with their modes of interpretation. It is shown how the data may be simply reduced to a probability form which will allow data from many sources to be utilized. The limitations of exploration geochemistry in resource appraisal are also discussed so that unnatural expectations may not be fostered and that geochemistry be placed correctly, and complementarily, with the other geoscience techniques of resource appraisal.

Garrett, R.G.

SAMPLE DENSITY INVESTIGATIONS IN LAKE SEDIMENT GEOCHEMICAL SURVEYS OF CANADA'S URANIUM RECONNAISSANCE PROGRAM; in Symposium on hydrogeochemical and stream-sediment reconnaissance for uranium in the United States; U.S. Dep. Energy, 1977.

A method for investigating minimum acceptable sample densities for reconnaissance geochemical surveys is outlined. A data set is sampled using montecarlo procedures and the subsets so produced at lower sample densities are statistically compared with the original data set to determine if they can be considered as being similar at a specified confidence level. The approach uses the concept of maintaining information content, this view is consistent with broad regional geochemical studies of major rock units. However, the results have to be viewed carefully from an exploration standpoint to ensure that the sample separation is not expanded so greatly that anomalous patterns can be placed between sample sites and so be undetected.

Gibson, D.W.

SEDIMENTARY FACIES IN THE JURA-CRETACEOUS KOOTENAY FORMATION, CROWSNEST PASS AREA, SOUTHWESTERN ALBERTA AND SOUTHEASTERN BRITISH COLUMBIA; Bull Can. Pet. Geol., v. 25, p. 767-791, 1977.

The Kootenay Formation in the Crowsnest Pass area occupies part of an eastward-thinning, narrow, linear band of Jura-Cretaceous strata comprising part of the Rocky Mountains Foothills and Front Ranges of Alberta and British Columbia. The formation is divided into three main stratigraphic units – a lower 'Basal Sandstone' member, a middle 'Coal-Bearing' member, and an upper 'Elk' member. The Basal Sandstone member, consisting of massive cliff-forming sandstone, is subdivided into two units, a newly recognized lower 'Unit B', formerly considered to be part of the Fernie Formation, and an upper 'Unit A'. The Coal-Bearing member comprises an interstratified sequence of siltstone, silty shale, mudstone, sandstone and conglomerate, with thin to thick seams of economically important low- to high-volatile bituminious coal. Fourteen major seams have been mined in the Fernie area of southeastern British Columbia, the amount varying with each seam. Coal seams generally become thinner and less numerous toward the east in the Alberta Foothills and Front Ranges. The Elk member consists of a thick, cliff-forming sequence of sandstone, siltstone, mudstone to shale, conglomerate and sparse, thin seams of coal. The conglomerate forms a thick and unusual lithofacies only in parts of the Fernie basin. The Kootenay Formation gradationally overlies strata of the 'Passage Beds' of the Fernie Formation, and is overlain disconformably, at most localities, by the Cadomin Formation of the Blairmore Group.

It is postulated that Kootenay strata were deposited as part of a north-to-northeasterly prograding clastic wedge, in the epicontinental Jurassic-Cretaceous sea. Sandstone of the Basal Sandstone member formed part of an elongate interdeltaic beach-barrier island and delta-front sheet sand system. Strata of the Coal-Bearing member are characterized by sedimentary relationships typical of deltaic, interdeltaic and alluvial-plain depositional environments. The Elk member represents deposition mainly in an alluvial plain, with the conglomerate and associated strata of the Fernie area interpreted as part of an alluvial fan.

Gordy, P.L., Frey, F.R., and **Norris, D.K.**

GEOLOGICAL GUIDE FOR THE CSPG 1977 WATERTON-GLACIER PARK FIELD CONFERENCE; Can. Soc. Pet. Geol., 93 p., 1977.

The geological guide is an overview of the stratigraphy and structure of the Cordilleran Foldbelt in and adjacent to Waterton-Glacier International Peace Park. It begins at Lundbreck, Alberta, on the Crowsnest River and extends to Marias Pass, Montana, at the headwaters of the Two Medicine River, a distance of 150 km.

In addition to a description of the geological setting of the excursion, the guide includes a series of geological maps embracing the region, tables of formations, structural cross-sections, and discussion of the major gas fields including the Waterton field which is one of Canada's largest. Differences in stratigraphic nomenclature between Alberta and Montana are identified.

The guide is the first systematic treatment of the geology of the eastern Cordillera where it straddles the International Boundary at the 49th Parallel.

Grasty, R.L., Richardson, K.A., and Knight, G.B.

AIRBORNE DETECTION OF SMALL RADIOACTIVE SOURCES; Am. Nuclear Soc. Symp., Las Vegas, March 1977.

Distortion of an airborne radioactivity profile results from the averaging effect of the sampling period; the longer the sampling period, the larger the reduction in the peak height of any anomaly present. In the detection of small radioactive sources an optimum sampling period can be selected on the basis of an acceptable reduction in amplitude of the narrowest anomaly, which for ground homogeneous in

depth is due to a vertical line source. It is shown that for a system flying at a speed of approximately 60 metres per second an altitude of 125 metres a sampling time of 0.5 seconds produces negligible distortion of anomalies from such sources.

As practical examples, two airborne radioactive surveys were carried out over areas known to contain small localized sources of radioactively contaminated land-fill. These detailed surveys over Port Hope in Ontario and Uranium City in Saskatchewan were flown with close line spacings and the recommended sampling time of 0.5 seconds. In the Port Hope survey the majority of the contaminated sites known from ground measurements were readily apparent in the airborne results. The anomalous areas in Uranium City were found to be related to radioactive mine waste rock which had been used for road-beds and land-fill in the construction of the town site.

Løvborg, L., **Grasty, R.L.**, and Kirkegaard P.

A GUIDE TO THE CALIBRATION CONSTANTS FOR AERIAL GAMMA-RAY SURVEYS IN GEOEXPLORATION; Am. Nuclear Soc. Symp., Las Vegas, March 1977.

In aerial measurements of natural, terrestrial radioactivity for geological mapping or uranium exploration, four-window gamma-ray spectrometers equipped with large-volume, cylindrical sodium-iodide detectors are commonly used. To convert the recorded count rates into equivalent ground concentrations of potassium, uranium, and thorium, it is necessary to know the stripping ratios, the height attenuation coefficients, and the sensitivities of the airborne spectrometer. Using both computational and experimental techniques, the values of these calibration constants have been estimated for spectrometers equipped with 102 mm (4 inch) thick cylindrical NaI(Tl) crystals and flown at nominal altitudes of 50 or 125 m. Provided the recommended window settings are used, the compilation presented will serve as a useful guide in the design, calibration, and operation of such survey systems.

Gower, J.F.R., **Grasty, R.L.**, and Oliver, B.M.

EXPERIMENTS WITH A STANDARD INERTIAL SYSTEM; Comptes rendus; 1st Int. Symp. on inertial technology for surveying and geodesy; Ottawa, Canada, Oct. 12-14, 1977.

Experiments were conducted with a Litton LTN-51 inertial navigation unit interfaced through its test port to a specialized data acquisition system.

The accuracy and drift characteristics of the system were determined from bench, truck and airborne tests. The in-flight drift characteristics were determined from repeated passes over coastal navigation markers utilizing a target sighting system mounted in the transparent nose of the aircraft. By using control points at least every 15 minutes and approximating the slow oscillatory drift error of the system by a cubic spline, theoretical studies showed that intermediate aircraft positions could be established to an accuracy of 10 meters at all times during a flight. This accuracy is comparable to that associated with map measurement error at the 1:50,000 scale. Higher accuracy was predicted when the control points were observed more frequently.

The system was tested experimentally by flying in both directions along a 27 kilometer highway with several significant bends. It was found that by using control points along the highway to establish the system drift, the positions of 28 intermediate points could be measured with a mean error of less than 10 meters in both longitude and latitude when compared to positions taken from a 1:25,000 scale map. A significant part of this error can be attributed to map measurement inaccuracies and to target position error related to altitude variation and sighting. It was concluded that a Litton LTN-51 inertial system can provide accurate aircraft positions at the 1:50,000 scale.

Gross, G.A.

METALLOGENETIC EVOLUTION OF THE CANADIAN SHIELD; from Correlation of the Precambrian, v. 2; A.V. Sedorenko ed.; "Nauka", Moscow, 1977.

Metallogenetic processes and related geological events in the Canadian Shield are identified over a period of 3000 million years. The geological history is incomplete with no evidence or documentation of events being preserved or discernible for long intervals of time during that period.

The metallogeny of each geological province of the Shield is considered separately recognizing that some broad regions of diverse origin have merged as crustal plates with distinctive sequences of events recorded in each unit. Provinces of the Shield are the Superior, Churchill, Grenville, Slave, Bear, Nutak and Southern. Correlations of geological events between provinces are still tenuous or problematical. The main metallogenetic features and processes giving rise to mineral deposits of significance in each province are reviewed, with consideration of special environmental factors that may have influenced mineral concentration.

Archean metallogeny is dominated by volcanogenic processes that gave rise to extensive development of iron-formations, stratiform base metal deposits, massive sulphides, gold and silver, nickel in basic and ultrabasic rocks and asbestos and non-metallic deposits. The basins of Proterozoic rocks overlying or infolded in the Archean, are characterized by Lake Superior type iron-formations, uranium bearing conglomerates and other deposits of volcanogenic derivation in this period. The basic intrusive complexes of Sudbury and Thompson Lake, bear outstanding concentrations of nickel, copper, ferrous and precious metals.

The Grenville Province with its complex geological history has the greatest variety of metallic and non-metallic mineral occurrences in the Shield. The most extensive intrusive masses of anothosite and gabbro known anywhere occur in this province and contain large concentrations of iron, titanium and vanadium.

The Churchill Province has many features similar to those in the Superior Province with a predominance of volcanogenic mineral occurrences. Some of the acid intrusive rocks are of genetic significance in the formation of radioactive mineral deposits.

Alkaline ring dyke complexes with a variety of metallic and rare earth minerals are a late stage metallogenic event in the Superior Province.

Volcanogenic processes were a dominating feature in the metallogenic evolution of major areas of the Shield. Work of recent years demonstrates that a variety of types of mineral deposits including iron-formations with sulphide facies, stratiform and massive sulphide deposits, nickel sulphides in basic and ultrabasic rocks, gold deposits, copper in granitic intrusions, as well as ultramafic rocks with non-metallic mineral resources are all related to the evolution of volcanic belts. The distribution of the tectonically mobile volcanic belts appears to have been controlled by major deep seated fracture patterns of the earth's crust that related to global orogenic systems.

Henderson, J.B.

ARCHEAN GEOLOGY AND EVIDENCE OF ANCIENT LIFE IN THE SLAVE STRUCTURAL PROVINCE, CANADA; from Chap. 5, in Chemical Evolution of the Early Precambrian; C. Ponnamperuma ed., Academic Press, 1977.

The Archean supracrustal rocks in the Slave Structural Province, Northwest Territories, Canada, consist of conformable sequences of mainly greywacke-mudstone turbidites of felsic volcanic provenance and of volcanic sequences that range from subaqueous mafic pillow lavas to subaerial felsic volcanic deposits. No sediments are known that indicate deposition under geologically stable conditions during this time. Preserved remnants of Archean basins consist of turbidite-filled basins with marginal volcanic buildups. All shallow water or subaerial sedimentary deposits that are known occur at these basin margins. The basins are separated by extensive, and in some cases, very complex granitic terrains that typically have intrusive relationships with the supracrustal rocks. Basement to the supracrustal successions, where identified or inferred, is everywhere granitic in composition. The time represented by the supracrustal succession at a given locality in the province is relatively short, possibly on the order of 15 million years. Evidence of life in the Archean of the Slave Structural Province is present but sparse. In places associated with the turbidites, carbonates, and certain volcanic environments there are units of black carbonaceous shales. This carbon may be of biogenic origin. More convincing evidence of life, however, is the occurrence of stromatolites in a volcanic-sedimentary sequence in the northern part of the province.

Westgate, J.A., **Hughes, O.L.**, Briggs, N.D., and Rampton, V.N.

TEPHRA MARKER BEDS OF LATE CENOZOIC AGE IN THE YUKON TERRITORY; Geol. Soc. Am., Abstr., v. 9, no. 7, p. 1222, 1977.

Geological studies in the Yukon Territory have revealed a detailed and diverse record of environmental change during the Late Cenozoic, but because of 1) the multiplicity of dispersal centres from which ice flowed into the Yukon, 2) presence of an extensive unglaciated zone with its several discrete sedimentary basins, and 3) poor chronological control beyond the present limit of ∿ 40,000 years B.P. for the radiocarbon dating method, confident correlation of local sedimentary sequences across the Territory has largely been impossible.

Late Cenozoic tephra, which is widespread both areally and stratigraphically in the northern Cordillera, is playing a significant rôle in improving this situation. Numerous distinctive units have recently been recognised on the basis of shard habit, mineral assemblage, composition of glass and FeTi oxides, and fission-track or radiocarbon age, but the extent of each layer is poorly documented at present.

Specifically, tephra beds have been located in Holocene sediments (e.g., White River Ash) and beneath McCauley and older tills deposited by glaciers of the St. Elias Mountains in SW Yukon. Tephra above Cordilleran till of Reid age promises to be a valuable marker in terrace deposits along the lower reaches of the Stewart River in central Yukon. Host sediments in the neighbouring Klondike district range from the "muck" deposits to alluvium of both high and low terraces; tephras here will help to elucidate the glacial history of the Ogilvie Mountains. Northernmost tephra occurrences are located in the Bluefish and Old Crow basins of the unglaciated portion of the northern Yukon.

Volcanoes in the Wrangell Mountains constitute the most likely source.

Jeletzky, J.A.

MID-CRETACEOUS (APTIAN TO CONIACIAN) HISTORY OF PACIFIC SLOPE OF CANADA; Paleont. Soc. Japan, Sp. Paper, p. 97-126, 1977.

Marine Aptian and Albian rocks of the Pacific slope of Canada are restricted to several successor basins completely isolated from mid-continental Albian seas. Their faunas form part of the North Pacific biotic province of the Tethyan Realm. Early and late Aptial rocks are present but are poorly fossiliferous and cannot be zoned as a rule. Albian rocks are represented by all substages and include (upward sequence): **Brewericeras lecontei, Brewericeras hulenese, Cleoniceras (Grycia) perezianum,** and **Desmoceras (Pseudouhligella dawsoni** Zones.

In the central part of Tyaughton Trough early early Albian (**Brewericeras lecontei** Zone) marine rocks overlie latest Aptian marine rocks with **Acanthoplites reesidei** gradationally. On its margins and in other depositional basins (e.g. in Vancouver area, on Queen Charlotte Islands, and in northwestern British Columbia) marine to nonmarine, commonly conglomeratic Albian rocks overlap pre-Aptian rocks transgressively and often discordantly. On Vancouver Island Aptian and Albian rocks are either absent (a hiatus) or represented by coarse, nonmarine clastics.

At the end of the Albian the seas retreated completely and permanently from the British Columbia mainland and became restricted to the Insular Trough of northern Vancouver Island and Queen Charlotte Islands. The Cenomanian and Turonian faunas of the trough remained part of the North Pacific biotic province. Only the broadly Cenomanian **Desmoceras (Pseudouhligella) japonicum** fauna was found in the argillaceous rocks of the Queen Charlotte Islands. However, early and late Cenomanian rocks are present on the Vancouver Island. Fossiliferous early Turonian shale with **Inoceramus labiatus** is known only on Queen Charlotte Islands but may be present elsewhere. Turonian (?mid-Turonian) shale of northern Vancouver Island with **Romaniceras (Yubariceras)** sp. appears to be the youngest known marine mid-Cretaceous rock of the Insular Trough.

The late Turonian and Coniacian appear to be the time of a general uplift of the Pacific slope of Canada when the seas also left the Insular Trough and only some nonmarine rocks were deposited in disconnected intermontane basins.

Katsube, T.J.

ELECTRICAL PROPERTIES OF ROCKS; in Induced polarization for Exploration Geologists and Geophysicists; Univ. Arizona, March 14-16, 1977.

Extensive work has been done on the electrical properties of rocks in the field of IP, oil exploration, geophysical research, lunar exploration and soil moisture detection. An outline of relevant knowledge from each field is compiled in section 2. In each of these fields a different approach has been taken in order to tackle their specific problems, so that the basic concepts that have developed are not necessarily identical. Problems that occurred in the field of IP exploration, such as the difficulty in differentiating between anomalies due to economic and non-economic ore deposits have led to the necessity for understanding a wider range of electrical properties. An intelligent integration of information from different fields is possible and has been done in the past. However, it is also necessary to develop certain general concepts and rules for theoretical or systematic linkage of the various electrical properties. These are outlined in section 1. Wide frequency spectrum data of rocks is studied in section 3 and the methods to determine the

electrical properties is discussed in section 4. General references on this subject are Parkhomenho (1967), Keller (1966, 1971), Ward (1967), Summer (1976) and Von Hippel (1954).

Katsube, T.J., Frechette, J., and **Collett, L.S.**

PRELIMINARY ELECTRICAL MEASUREMENTS OF CORE SAMPLES, DSDP Leg 37; in Aumento, F., Melson, W.G. et al., Initial Reports of the Deep Sea Drilling Project, Volume 37, Washington (U.S. Government Printing Office) p. 417-421, 1977.

Preliminary measurements have been completed on the electrical properties of core samples from the Deep Sea Drilling Project (6 samples from Hudson Deep Drill '74 site survey, and 10 samples from Glomar Challenger Leg 37). The frequency range of measurement is from 1.0 to 10^6 Hz, and the measured parameters are parallel resistivity (ρ_p) or resistivity and dissipation factor (D). Because the thickness of the core samples measured ranges from 2.0 – 3.0 cm, measurement problems occurred at the higher frequencies (mainly above 10^4 Hz). And because to date only the two electrode system has been applied, not all measurements are free from electrode effects at the lower frequencies. It is also not certain whether the samples have been measured under adequate conditions, since some of them have been saturated with seawater (Glomar Challenger samples), and others with ground water (Hudson samples). One of the parameters (ρ_{p_1}) which represents the resistivity of the samples is seen to range from 9.3 to 95 ohm-meters for the samples from Glomar Challenger Leg 37 drill holes, and from 120 to 540 ohm-meters for the grab samples from Hudson Deep Drill '74 site. The dissipation factor (D) ranges from 1.0 to about 700 for these samples.

Kerr, J. Wm.

CORNWALLIS LEAD-ZINC DISTRICT; MISSISSIPPI VALLEY-TYPE DEPOSITS CONTROLLED BY STRATIGRAPHY AND TECTONICS; Can. J. Earth Sci., v. 14, p. 1402-1426, 1977.

Cornwallis Lead-Zinc District in the central Canadian Arctic includes occurrences of galena and sphalerite with similar geological settings and controls on mineralization. It includes the Polaris deposit, with 25 million tons of about 19% grade ore, representing 4.7 million tons of metal.

The district occurs in and was controlled by the Cornwallis Fold Belt, a steep-sided anticlinorium of Proterozoic to Devonian formations, that overlies a basement horst.

Four controls on mineralization are: (A) deposits are stratabound within the Ordovician Thumb Mountain Formation; (B) ore occurs in brecciated dolomite, in contrast to usual limestone of the host formation; (C) deposits are located close to shale of the Cape Phillips Formation; and (D) the host formation was subject to erosion and karstification in Early Devonian time during Pulse 3 of the Cornwallis Disturbance.

Mineralization is of Mississippi Valley-type, having formed in carbonate rock by epigenetic processes. The sequence of stratigraphic and tectonic events leading to mineral formation was as follows:

(1) An Ordovician to Lower Devonian geosynclinal sequence was deposited, containing formations that could be a source of Zn, Pb, Fe, and S, as well as a potential host formation.

(2) The sequence was folded by three pulses of the Cornwallis Disturbance.

(3) Uplift in Early Devonian time allowed deep erosion that exposed the host Thumb Mountain Formation in anticlinal culminations.

(4) Caverns and pores developed in the upper part of that formation, by karst-type solution.

(5) During subsidence an unconformable sedimentary cover buried the host formation and its caverns to a considerable depth.

(6) Two formation fluids developed, with metal ions in one and sulphur ions in the other.

(7) These two brines migrated laterally and upward, and met in cavities in the Thumb Mountain Formation.

(8) In these cavities temperatures and other conditions were suitable and the brines precipitated the sulphides, galena, sphalerite, and pyrite.

Deposition probably occurred between temperatures of 52°C and 102°C, suggesting that the caverns were at depths of at least 1280 m (4200 ft). This probably occurred in Late Devonian time, prior to Pulse 4 of the Cornwallis Disturbance. Major structural events following mineral emplacement raised the occurrences to higher topographic levels where they became exposed.

Metal deposition in this model resembles the accumulation of petroleum in that the components were carried upward and laterally from source formations to structural culminations, and deposited there in open spaces that served as traps.

Kerr, J. Wm.

CORNWALLIS LEAD-ZINC DISTRICT; MISSISSIPPI VALLEY-TYPE DEPOSITS CONTROLLED BY STRATIGRAPHY AND TECTONICS: REPLY; Can. J. Earth Sci., v. 15, p. 460, 1978.

Kerr, J. Wm.

CORNWALLIS BOLD BELT AND THE MECHANISM OF BASEMENT UPLIFT; Can. J. Earth Sci., v. 14, p. 1374-1401, 1977.

Cornwallis Fold Belt is a north-trending anticlinorium more than 650 km (400 mi) long, that extends from the Precambrian Shield to the Sverdrup Basin. It is the folded and faulted sedimentary suprastructure that overlies Precambrian crystalline basement rocks of the Boothia Horst. The horst and fold belt represent lower and intermediate levels of the Boothia Uplift. Evolution of the Cornwallis Fold Belt includes two phases, formation and modification.

Formation. The basic structure of the Cornwallis Belt, a relatively simple, steep-sided, north-plunging anticlinorium, was formed in the interval from Proterozoic to Late Devonian time during several discrete phases of deformation that involved a similar stress pattern. These phases can be attributed to pulses of differential vertical uplift of the underlying Boothia Horst. The earliest phases involved periods of gentle arching of the crystalline basement and sedimentary cover in late Proterozoic and early Paleozoic times. The fold belt was formed mainly by the Cornwallis Disturbance (new name) which involved further differential vertical uplift, and comprised several pulses: (1) Early Silurian, mild, affecting only part of the belt; (2) Early Devonian, very strong, affecting the entire belt; (3) late Early Devonian, moderately strong, affecting the entire belt; (4) Late Devonian, moderately strong, affecting the entire belt. Each pulse was a cycle that began with uplift and erosion of the fold belt and shedding of detritus into the adjacent basins, and was followed by broader regional

subsidence and the resumption of deposition on the belt. Between pulses of uplift there was regional subsidence, during which the fold belt subsided less than the flanking basins and received less sediments.

Differential vertical displacement originated in the crystalline basement, occurring along fault zones that define the Boothia Horst, and are parallel to and controlled by a steep to vertical north-trending foliation. Faults extend into the sedimentary suprastructure comprising the overlying Cornwallis Fold Belt, and change gradually upward from vertical faults to high-angle reverse faults, overturned anticlines, and finally to asymmetric anticlines. Because the fold belt plunges north, this gradation sequence occurs from south to north in the exposed part of the fold belt. Structures formed by early pulses were rejuvenated by later pulses with the same sense of movement.

Modification. The basic structure of the Cornwallis Fold Belt was modified by other types of deformation during the interval from Late Devonian to the present. Many of the preexisting faults were reactivated, but with a different sense of movement. During the Late Devonian to Middle Pennsylvanian Ellesmerian Orogeny, southward overriding of upper levels of the sedimentary succession produced folds in the rocks east and west of the Cornallis Fold Belt which had not been previously deformed and could easily be displaced southward on an underlying décollement surface. The north-trending Cornwallis Fold Belt, however, was an obstacle to southward overriding in which the effects of overriding were reduced. Zones of interference structures developed near the margins, guided by older basement-controlled structures. Left-lateral faults were developed on the western margin and right-lateral movement is probable on the eastern margin.

The Cornwallis Fold Belt extends an unknown distance northward beneath the younger rocks of the Sverdrup Basin. These younger rocks were deposited during a long period of northward downwarping that began in mid-Mississippian time. This same downwarping caused an abrupt increase in the northward plunge of the fold belt.

During the Cretaceous-Tertiary Eurekan Rifting Episode the Cornwallis Fold Belt was fragmented by block faulting. The horsts form islands, and the grabens form submarine channels, some of which contain thick sections of semiconsolidated Cretaceous-Tertiary sediments. Numerous other normal faults that occur within the fold belt probably formed at this time. Cretaceous-Tertiary faults within the Cornwallis Fold Belt have a rectilinear pattern that was inherited from preexisting structures.

King, L.H. and Young, I.F.

PALEOCONTINENTAL SLOPES OF EACH COAST GEOSYNCLINE (CANADIAN ATLANTIC MARGIN); Can. J. Earth Sci., v. 14, p. 2553-2564, 1977.

A study of processed seismic reflection profiles along the eastern Canadian continental margin indicates the occurrence at depth of paleocontinental slopes of Cenozoic-Mesozoic age, generally in the vicinity of the present continental slope. The paleoslopes are of two general types, constructional and destructional, formed respectively by progradational processes and mass wasting. The inclined beds of the progradational sequence (clinoform beds) represent the constructional slopes and were probably formed at times when deposition was simultaneous on the shelf, slope, and rise. Conditions leading to the establishment of a relatively deep shelf edge would favor constructional slope formation and preservation. A relatively shallow shelf edge, common during times of low sea level, would promote cutback at the shelf edge and upper slope and lead to the formation of destructional slopes. The depth of the shelf edge is mainly established by the balance between rates of sedimentation and subsidence in conjunction with the processes arising from variations in sea level.

The sequence of constructional and destructional paleocontinental slopes varies widely along the Canadian Atlantic margin. On the western Scotian Shelf adjacent to the LaHave Platform the paleoslopes are mainly destructional and are in proximity, with only fragmental expression of former constructional slopes remaining. On the eastern Scotian Shelf and Grand Banks destructional paleoslopes are widely spaced in section between thick areas of constructional slope development. Paleoslopes along the northeast Newfoundland and Labrador Shelves are mainly constructional. The differences may be related to age of opening of the Atlantic Basin.

The type and distribution of paleocontinental slopes along a margin could influence the migration of hydrocarbons from the eugeocline to the miogeocline.

Klassen, R.A. and **Shilts, W.W.**

GLACIAL DISPERSAL OF URANIUM IN THE DISTRICT OF KEEWATIN, CANADA; Inst. Min. Metall., Helsinki Symposium, Agu. 15-17, 1977.

Preliminary results of reconnaissance and detailed-scale sampling of till as an aid to uranium exploration in areas of perennially frozen terrain are reported here. The research was carried out in the tundra of central Canada. Dispersal trains were defined by contouring concentrations of uranium in the clay-size (< 2mm) fraction of till: it was assumed that this fraction had scavenged uranium released by active-layer weathering in approximate proportion to the original content of unweathered physically transported components in the till. Resulting dispersal trains were mapped at scales that varied from hundreds of metres to hundreds of kilometres, depending primarily on the size, tenor, and resistance to erosion of the source as well as on lithological and topographical conditions in the dispersal area. Large regional trains with enhanced metal levels were mapped and seem to influence interpretations of local background and anomalous values. Regional dispersal trains of depressed metal levels ('negative' trains) were also seen to have an important effect on local background and anomalous values. Many large bedrock sources of uranium were detected at a sampling density of one per square mile, but some smaller zones of potentially economic-grade uranium mineralization have dispersal trains the detectable extent of which is simply too small to be intercepted by sampling at this reconnaissance scale.

Kurfurst, P.J. and **Veillette, J.J.**

TERRAIN ANALYSIS AND EVALUATION, ARCTIC ISLANDS, N.W.T.; in Geotechnical Aspects of Glacial Deposits, Proc. 30th Canadian Geotechnical Conference, 5-8 October 1977, Saskatoon, Sask., by The Canadian Geotechnical Society, section III, p. 43-68.

During a detailed study of the proposed Arctic Gas Pipeline Corridor an extensive program of surface and subsurface investigation was carried out in the Arctic Islands, N.W.T. Although this investigation covered a range of soil and rock materials, considerable effort was made to study and to evaluate in detail the glacial deposits of the area.

Both general surficial mapping and detailed subsurface engineering investigations made up the basis for terrain analysis. Several terrain regions were recognized and identified by differences in material texture, thickness, local relief, slope, age and origin of bedrock and surficial deposits. For detailed terrain assessment and analysis on Somerset Island, these regions were grouped and classified into six

larger units using the following factors: texture and soil performance, local relief, thickness of the unconsolidated deposits, plastic properties of the materials, and ground ice content.

Surface information, combined with results of subsurface drilling and laboratory engineering test, was integrated with the basic regional geomorphological data. The Unified Soil Classification System and the National Research Council of Canada guidelines, respectively were used for detailed description of soils and ground ice in order to evaluate soil performance as an engineering material.

Detailed discussion of subsurface exploration includes various techniques and equipment used and their suitability and effectiveness in frozen materials. Due to the size and remoteness of areas covered by these surveys, subsurface investigation had to rely heavily on lightweight portable drilling equipment.

Two groups of portable drilling equipment were used and tested with the objectives of increasing core production, depth of subsurface investigation, and mobility of equipment.

A man-portable coring auger capable of obtaining frozen cores to depths of several metres was required. Previous experience indicated that most power augers in current use had boring spindle speeds in excess of those desirable for consistent shallow coring in frozen ground. A Stihl 4308 power auger with adapted permafrost coring equipment was fully field tested and was found satisfactory. Using a three-man crew, up to four 3 to 4 m boreholes were drilled and sampled in one working day.

A lightweight vehicle-mounted drill capable of shallow drilling or coring in a wide variety of frozen materials, using both diamond drilling and augering techniques was field tested. This type of drill was required for specific site investigation where a high density of test holes or boreholes was essential. To keep the operational costs down, the drill and the carrier had to be designed for transportation by Twin Otter or Bell 206B helicopter.

An 8-wheeled argo all-terrain vehicle (ATV) was adapted to support a 3-metre mast to which could be added two small power sources for augering and diamond drilling.

Field tests conducted in permafrost and nonpermafrost terrains indicate that the ATV-drill can substantially increase borehole production while keeping the operating and transportation costs at a reasonable level.

Lewis, C.F.M. and **Anderson, T.W.**

BASIN DEPOSITS, A RECORD OF LONGTERM COASTAL EVOLUTION (RECESSION) IN THE GREAT LAKES?; Proc. Workshop on Great Lakes Coastal Erosion and Sedimentation, p. 109-115 (ed.) N.A. Rukavina, Dep. Environment Can., Burlington, Ontario, 1977.

Shoreline recession in the Great Lakes is discussed in terms of lake level changes, uplift, climatic and vegetative changes, and rates of accumulation of the basin sediments during the past 10 000 years. Holocene accumulation rates are compared with long-term lake level changes for six sites in Georgian Bay, Lake Erie and Lake Ontario. Sediment influx rates and lake-level rise generally show good correspondence, especially during the past 3000 years, and thus infer a measure of the contribution of bluff erosion to the offshore sediment record.

Lewis, C.F.M.

THE FREQUENCY AND MAGNITUDE OF DRIFT-ICE GROUNDINGS FROM ICE-SCOUR TRACKS IN THE CANADIAN BEAUFORT SEA; Proceedings of the 4th International Conference on Port and Ocean Engineering under Arctic Conditions Memorial University of Newfoundland, p. 568-579, 1978.

A study of the morphology of ice scours in the Canadian Beaufort Sea and their variation with water depth is described. Within specific bathymetric zones scour depth frequencies are distributed exponentially and Gumbel's extreme-value distribution is used to describe maximum scour depths. When combined with related information on sedimentation, the drift-ice regime, and sea level change, the statistical nature of ice-scour tracks is used to: (1) differentiate areas of contemporary and relict scouring, and (2) build a theory for estimating the rate of scour additions for various depths of ice keel penetrations beneath the seabed. Scour additions measured over periods of a few years by repetitive seafloor mapping are described also.

Long, D.G.F.

DEPOSITIONAL ENVIRONMENTS OF A THICK PROTEROZOIC SANDSTONE: THE (HURONIAN) MISSISSAGI FORMATION OF ONTARIO, CANADA; Can. J. Earth Sci., v. 15, p. 190-206, 1978.

The Mississagi Formation is a thick (up to 3.4 km) Proterozoic arenite sequence that forms part of the Huronian (lower Aphebian ∿2.2-2.5 Ga) succession of the north shore of Lake Huron, Ontario. The formation is characterized by planar and to a lesser extent trough cross-stratified medium to coarse feldspathic arenites, with only minor amounts of argillite and conglomerate. Although the formation lacks any regular systematic cyclicity, both thinning upward and fining upward sequences can be recognized in some sections. Paleocurrent roses for individual outcrops are typically unimodal, although some bimodal distributions are recognized. The bulk of the formation is interpreted to be the result of deposition in a fluvial environment, principally from bed load and mixed load streams. These rivers were probably marked by a braided stream pattern in which channels were characterized by intermediate to low sinuosites in high width to depth ratios. Regional paleocurrent and petrographic trends indicate that two major river systems were operative. One system flowed east and south from the Sault Ste. Marie – Elliot Lake region to meet a second, southwesterly flowing system originating in the Cobalt Plain. These systems met in the southern Huronian area, from where the coalescing river systems flowed south.

Hobson, G., Neave, K.G., **MacAulay, H.A.**, and **Hunter, J.A.**

PERMAFROST DISTRIBUTION IN THE SOUTHERN BEAUFORT SEA AS DETERMINED FROM SEISMIC MEASUREMENTS: in Proceedings of a Symposium on Permafrost Geophysics, 12 October, 1976, prepared by W.J. Scott and R.J.E. Brown; NRC Tech. Memo. No. 119, p. 91-98, 1977.

Approximately 40 000 marine seismic records, obtained from oil company exploration shooting and from government surveys, were examined for evidence of high velocity refraction events. Widespread areas containing shallow depth refractors with velocities in excess of 2.5 km/s have been interpreted as ice-bonded permafrost. Ice-bonded

permafrost is present for most of the shelf area to the east of 135°W. High velocities are absent to the west of 135°W. An initial attempt has been made to measure the thickness of the ice-bonded layer using a technique based on the attenuation ratio of the first arrivals.

MacLean, B., Jansa, L.F., Falconer, R.K.H., and **Srivastava, S.P.**

ORDOVICIAN STRATA ON THE SOUTHEASTERN BAFFIN ISLAND SHELF REVEALED BY SHALLOW DRILLING; Can. J. Earth Sci., v. 14, p. 1925-1939, 1977.

Cores of the bedrock underlying the southeastern Baffin Island shelf were recovered by underwater electric rock core drill at four localities. Cores from three of the localities consist of olive gray to dark yellow-brown slightly dolomitic limestones, in part burrowed and containing flat pebble conglomerate and breccia. Fragments of trilobites, brachiopods, crinoids, and other fossils including coral are present. Radiolarian wackestone was found at one locality where the rock also contains finely disseminated organic material. The strata have been assigned an Ordovician age (Caradoc) based on identification of chitinozoa, scolecodonts, and coral material. Depositional environments included shallow intertidal-subtidal, open shelf, and outer littoral-epibathyal. Core from the fourth locality is Precambrian biotite gneiss.

Seismic reflection and magnetic profiles have been used for correlation of the corehole data and to outline the geology of part of the southeastern Baffin Island shelf.

Matthews, J.V., Jr.

COLEOPTERA FOSSILS: THEIR POTENTIAL VALUE FOR DATING AND CORRELATION OF LATE CENOZOIC SEDIMENTS; Can. J. Earth Sci., v. 14, p. 2339-2347, 1977.

Coleoptera (beetle) fossils play an important role in paleoecological research, but as yet have contributed little information bearing on dating and correlation. The reason for this is that most Quaternary fossils represent extant species, precluding the evolutionary approach to dating, while the rarity and poor preservation of Tertiary beetle fossils, many of which are from extinct species, seriously limit their application to stratigraphic studies.

Tertiary beetle fossils recently discovered in Arctic Canada and Alaska are both well preserved and abundant. Most of them represent extinct species that are closely related to living forms, hence they have potential stratigraphic value. In one case treated herein comparison of fossils of an Alaskan Tertiary species with those of a related species from the Beaufort Formation on Meighen Island (Canadian Arctic Archipelago) implies that the latter sediments were deposited less than 5.7 Ma ago. However, this conclusion requires testing because it is at odds with the date on Meighen Island exposures reached by study of fossil plants. I submit that further study of the insect fossils from the Beaufort Formation and other late Tertiary sites with help resolve such problems of dating and correlation.

Quaternary beetle fossils have stratigraphic value even though fragments of that age represent for the most part only existing species. For example, it has been shown that late Pleistocene fossils of stenothermal Coleoptera species can provide a sensitive record of climatic change, and thus such fossils may be used for site to site correlation in areas where climatic history is well documented. In exceptional cases beetle fossils appear to provide a more accurate basis for correlation than even fossil pollen.

Matthews, J.V., Jr.

TERTIARY COLEOPTERA FOSSILS FROM THE NORTH AMERICAN ARCTIC; Coleopterists Bull., v. 31, p. 297-308, 1977.

Studies of fossil Pleistocene beetles in the Arctic indicate little evolution or extinction during the last million years. A few Arctic localities have yielded fine Tertiary beetle fossils, of late Miocene age. These older materials are of great evolutionary significance, as many apparently extinct species are included. Proper analyses of the fossil forms depend on an understanding of relationships among extant forms. Taxonomic revisions are therefore at their most useful when phylogenetic constructs have been included, ready for testing and refinement.

Morlan, R.E. and **Matthews, J.V., Jr.**

NEW DATES FOR EARLY MAN; GEOS WINTER 1978, p. 2-5.

Recent research in northern Yukon Territory has revealed new evidence about the first people in North America which will make it necessary to revise the estimated time of their coming. Bone tools 30 000 years old have been found, whereas previous estimates by some archaeologists put the first human inhabitants at 14 000 years ago.

The Yukon Refugium Project initiated interdisciplinary research in 1975. The focus is on archaeological finds, but paleoenvironmental studies cover a longer period of time than that of man's residence. An expected outcome of the project is an integrated picture of environmental change over more than 100 000 years.

McGregor, D.C.

LOWER AND MIDDLE DEVONIAN SPORES OF EASTERN GASPE, CANADA II. BIOSTRATIGRAPHY; Palaeontographica, Abt. B, v. 163, p. 111-142, 1977.

Well-preserved spores from the Gaspé Sandstone Group and the overlying Malbaie Formation of Gaspé Bay, described in Part I of this report (McGregor, 1973) are compared with spores of similar age from the Eifel region of Germany and elsewhere. They indicate that the upper beds of the York River Formation are late Siegenian or early Emsian; the Battery Point Formation ranges from early Emsian to early Eifelian; and the lower half of the Malbaie Formation is early to mid-Efelian.

The spore assemblages contain many species in common with those of the Stooping River, Kwataboahegan, Sextant, and Williams Island Formations of northern Ontario, and the provisional assemblage-zones of McGregor & Camfield (1976) are recognized. The transition from the "Lower Devonian" spores of the **caperatus-emsiensis** assemblage to the typically "Middle Devonian" spores of the **Gradispora** subassemblage begins at the lowest extent of the intervening **sextantii** subassemblage of mid-Emsian age, and is characterized by the incoming of **Apiculatisporis microconus** and **Dibolisporites echinaceus.**

The lower limit of the succeeding **Grandispora** subassemblage is late Emsian and marks one of the most striking changes in the Devonian spore record. Above this level large-spined specimens of **Grandispora** are present, and the spores are appreciably larger on average than the small to medium sized forms that typify most of the Lower Devonian.

Miall, A.D., Kerr, J. Wm., and Gibling M.R.

THE SOMERSET ISLAND FORMATION: AN UPPER SILURIAN TO ?LOWER DEVONIAN INTERTIDAL/SUPRATIDAL SUCCESSION, BOOTHIA UPLIFT REGION, ARCTIC CANADA; Can. J. Earth Sci., v. 15, p. 181-189, 1978.

The Somerset Island Formation of Somerset Island is a newly defined unit consisting of interbedded fine-grained, grey, planar-laminated dolomite and limestone, grey mottled limestone and dolomite, red quartzose siltstone and red dolosiltite. It forms a transitional unit between the limestone and dolomite of the underlying Read Bay Formation and the sandstone and conglomerate of the overlying Peel Sound Formation, and ranges in thickness from 150 to more than 400 m. The formation was formed predominantly in intertidal and supratidal environments and forms the lowest part of a regressive sequence that culminates in boulder conglomerates of alluvial fan origin in the Peel Sound Formation. The Somerset Island Formation is predominantly Pridolian in age, but may include some strata of Ludlovian and Gedinnian age.

The regressive sequence reflects a major pulse of the Cornwallis Disturbance of Boothia Uplift. A similar sequence occurs in Prince of Wales Island, although the lower part of the succession there contains conglomerate and sandstone, rock types that are absent in Somerset Island. These rocks are formally assigned to the Lower Peel Sound Formation but are of similar age to the Somerset Island Formation of the type area.

Rocks of similar facies to the Somerset Island Formation of Somerset Island comprise the upper member of the Drake Bay Formation on Russell Island and Member D of the Read Bay Formation of Cornwallis Island. The latter unit is younger than the Somerset Island Formation, reflecting a later commencement of regression in that area.

Morrow, D.W.

DOLOMITIZATION OF LOWER PALEOZOIC BURROW-FILLINGS; J. Sed. Petrol., v. 48, p. 295-306, 1978.

Dolomite in an upper Ordovician sequence composed of the Irene Bay and Thumb Mountain Formations on Devon Island in the Canadian Arctic Archipelago is confined to burrows. Micron-sized dolomite crystals may have formed in burrows contemporaneous with deposition because of seasonal salinity changes in the Irene Bay-Thumb Mountain shelf lagoon. These penecontemporaneous dolomite crystals formed nuclei for the selective precipitation of late diagenetic dolomite from dilute subsurface solutions. Post-lithification crystal growth during late diagenesis caused idiotopic dolomite fabrics with intercrystalline micrite to become more coarsely crystalline xenotopic fabrics with no intercrystalline micrite. Dolomite crystal growth was accompanied by a progressive decrease in strontium and sodium contents and by a lowering of the amount of excess calcium.

A possible rule regarding dolomite compositional variations is that high Mg/Ca solution ratios favor precipitation of more stoichiometric dolomite whereas low Mg/Ca solution ratios favour precipitation of calcium-rich dolomite with the exception that solutions of very low salinities will precipitate stoichiometric dolomite regardless of their Mg/Ca solution ratios.

Morrow, D.W. and Mayers, I.R.

SIMULATION OF LIMESTONE DIAGENESIS – A MODEL BASED ON STRONTIUM DEPLETION; Can. J. Earth Sci., v. 15, p. 376-396, 1978.

Limestone diagenesis has been simulated by a computer model based on strontium and zinc depletion in meteoric groundwater. This has enabled estimates to be made of the minimum number of pore volumes of groundwater that must have infiltrated many limestones and the accompanying degree of recrystallization that must have occurred in order to produce the observed reduction in the trace element concentrations. The amount of strontium lost by Barbados and Barbuda aragonite during early diagenesis indicates that the 0.05 value of Katz et al. (1972) for the distribution coefficient of strontium during the aragonite-to-calcite transformation is more accurate than the 0.14 value of Kinsman and Holland (1969). About 3000-6000 pore volumes of meteoric groundwater are required to transform aragonitic limestones on Barbados and Barbuda to low-magnesian calcite with average strontium contents of 1700 and 500 ppm, respectively. Generally, the model suggests that early diagenesis will not decrease the strontium contents of limestones below about 400 ppm.

Extrapolation to late diagenesis indicates that during the recrystallization of low-magnesian calcite, tens of thousands to hundreds of thousands of pore volumes of meteoric solution must pass through limestones to reduce their strontium contents to between 100 and 200 ppm. Variation in the degree of solution and reprecipitation of $CaCO_3$ that characterizes the residence periods of pore volumes of solution infiltrating low-magnesian calcite limestones affects the number of bulk recrystallizations, but has little influence on the total volume that passes through these limestones during late diagenesis.

Porosity differences and variations in groundwater acidity have more effect on limestone strontium contents during late diagensis than do the initial mineralogical differences. Facies-controlled porosity variations may have partly produced the range of strontium contents exhibited by ancient limestones.

The directional trends of strontium concentrations and the low average strontium content (143 ppm) in the limestones of the Dunedin Formation in British Columbia indicate that it underwent late diagenesis by solutions that, during their passage, had a residence period of many solution-reprecipitation events.

Zinc in solution does not undergo a significant increase in concentration during meteoric diagenesis because its distribution coefficient is greater than 1. The observed absence of directional trends of zinc within the Dunedin Formation supports this model prediction.

Abnormally high concentrations of strontium are retained in hydrocarbon-bearing limestones because the solution-reprecipitation process is inhibited by the presence of hydrocarbons. This suggests that strontium anomaly surveying would provide a useful adjunct to present hydrocarbon exploration techniques.

Mott, R.J.

LATE-PLEISTOCENE AND HOLOCENE PALYNOLOGY IN SOUTHEASTERN QUÉBEC; Géogr. phys. Quat., v. 31, p. 139-149, 1977.

Several relative and absolute pollen profiles from the Appalachian Region outline the vegetational history of the region. The earliest reliable date of 11,200 radiocarbon years BP, from the watershed area of the Mégantic Hills on the Québec-Maine border, dates the spruce pollen maximum,

indicative of spruce woodland conditions. A second site in the same area shows tundra conditions existed prior to this time, but no radiocarbon dates are available to indicate the length of time these conditions persisted. About 10,000 radiocarbon years BP or less, the character of the vegetation changed and closed forest conditions prevailed. Spruce was still present, but balsam fir and birch increased and other deciduous species appeared. The continued increase in thermophilous deciduous species and hemlock and white pine during early- and mid-Holocene resulted in forests in which these taxa were more prominent than at present. An increase in spruce and decline in thermophilous taxa in the last few millenia produced the extant forests types.

Mott, R.J. and Foster, J.H.

PRELIMINARY PALEOMAGNETIC STUDIES OF LAKE SEDIMENTS IN EASTERN CANADA; Géogr. phys. Quat., v. 31, p. 379-387, 1977.

Nine lake bottom sediment cores from small lakes in Eastern Canada, three of which were oriented to an azimuth, have been analyzed magnetically in an attempt to delineate the paleomagnetic character of the late-Pleistocene and Holocene sediments as an aid to stratigraphy and chronology. Secular variations are discernible in mineral sediments and in overlying organic sediments when intensities are strong enough to produce reliable results. Where organic content was high and intensities low, erratic results were obtained. Short segments of some cores, involving at most several centimetres, showed negative values for inclination, but whether or not these can be related to magnetic reversals or excursions or are spurious results, cannot be determined at this time.

Muller, J.E.

EVOLUTION OF THE PACIFIC MARGIN, VANCOUVER ISLAND, AND ADJACENT REGIONS; Can. J. Earth Sci., v. 14, p. 2062-2085, 1977.

The tectonic-stratigraphic evolution of Vancouver Island, a part of the Insular Belt, is reviewed as it relates to the other major tectonic belts recognized in the western Cordillera of Canada and the adjacent United States. The Pacific Belt, recognized south of the international border, is also identified in the west and south of the island. Oldest rocks of the Insular Belt are a late Paleozoic volcanic arc terrane and a crystalline 'basement' that is probably pre-Devonian. A thick Upper Triassic succession of tholeiitic pillow lavas and flows, overlain by carbonate-clastic sediments, rests in part on the Paleozoic. Elsewhere the tholeiite may represent oceanic floor, perhaps formed when the Insular Belt was fragmented and rifted off the continental margin far to the south. Above it the Early Jurassic volcanic arc with related batholiths may have been aligned with a similar terrane in the Intermontane Belt before the two belts assumed parallel positions in late Mesozoic time. An Upper Jurassic – Lower Cretaceous westward thickening clastic wedge indicates uplift and erosion of the volcanic arc in late Mesozoic time. Further west the 'inner Pacific Belt' of Jura-Cretaceous clastics and chert represent slope and trench deposits that have been deformed to mélange or converted to schist. They are coeval and homologous to Franciscan and Chugach Terranes and probably mark the late Mesozoic trench and subduction zone along the continental margin. The Coast Plutonic Belt represents the related volcanic arc, and pre-Cretaceous Insular Belt rocks, unconformably overlain by Cretaceous clastic sediments, represent the arc-trench gap and fore-arc basin. Until Lake Cretaceous time convergence of the Insular and Pacific Belts occurred along San Juan Fault. In early Tertiary time Eocene oceanic basalt (Outer Pacific Belt) and Jura-Cretaceous metasediments (Inner Pacific Belt) converged by underthrusting and (or) strike-slip faulting along Leech River Fault. In Late Eocene time the trench and subduction zone shifted westward to the present core zone of the Olympic Mountains and shifted again in Miocene time to its present position.

Nassichuk, W.W.

UPPER PERMIAN AMMONOIDS FROM THE CACHE CREEK GROUP IN WESTERN CANADA; J. Paleontol. v. 51, p. 557-590, 1977.

Eighteen species of Upper Permian ammonoids are described from the Cache Creek Group near Kamloops in southern British Columbia and near Atlin in northern British Columbia; included are representatives of **Propinacoceras** Gemmellaro, **Eumedilicottia** Spath, **Agathiceras** Gemmellaro, **Daubichites?** Popow, **Hyattoceras** Gemmellaro, **Neocrimites** Ruzhencev, **Adrianites** Gemmellaro, **Martoceras** Toumanskaya, **Stacheoceras** Gemmellaro, **Waagenoceras** Gemmellaro and **Paraceltites** Gemmellaro. The new species **Martoceras saundersi** n. sp., **Stacheoceras mongeri** n. sp. and **Waagenoceras canadensis** n. sp. are described. Ammonoids indicate an early Guadalupian (Wordian) age and closely resemble species from West Texas, Coahuila (Northern Mexico) and Sicily. At the Atlin locality, ammonoids are directly associated with a variety of fusulinaceans including the schwagerinid **Schwagerina** von Möller and the verbeekinid **Yabeina** Deprat; the latter is generally indicative of a Tethyan realm.

Norford, B.S.

OCCURRENCES OF ORDOVICIAN AND SILURIAN FAUNAS WEST OF THE ROCKY MOUNTAIN AND TINTINA TRANCHES, BRITISH COLUMBIA AND THE YUKON; Geol. Assoc. Can., Prog. with Abstr., v. 2, p. 40, 1977.

Ordovician and Silurian fossils are not known from most of the region west and southwest of the two trenches and only in the Saint Elias Fold Belt is there tenuous evidence of a faunal province distinct from that of the main part of western and northern Canada. Graptolites are known from a very few localities in the southern Omineca Crystalline Belt but are cosmopolitan forms that yield little evidence for or against faunal provincialism. Faunas are more extensive and more diverse in the Pelly-Cassiar Platform and on the western margin of the Rocky Mountain Trench in southeastern British Columbia but are extremely similar to those of sequences north of the Tintina Trench and east of the Rocky Mountain Trench and were part of the same faunal province.

Norris, D.K. and **Yorath, C.J.**

THE NORTH AMERICAN PLATE FROM THE ARCTIC ARCHIPELAGO TO THE ROMANZOF MOUNTAINS; The Ocean Basins and Margins – The Arctic Ocean; v. 5, Chap. 3, Plenum Publishing Corp., New York, 1978.

The paper describes the bedrock geology of northwestern Canada from the Coppermine Arch to the Romanzof Mountains north of Latitude 68°N and embraces portions of Canada's Continental Shelf, the Cordilleran Foldbelt, the Interior Platform and Banks Island of the Arctic Archipelago. The 1/1,000,000 scale geological map with four structural cross-sections is the first from which the structural style and stratigraphy of northern mainland Canada are compared and contrasted with those in the southwestern part of the Arctic Archipelago.

The stratigraphic succession is divided into five lithostratigraphic assemblages which are continuous from the northern mainland to the southwestern Archipelago and which are bounded by regional and interregional unconformities. It is cut by several arrays of right-lateral, strike-slip faults

which collectively were responsible for the tectonic evolution of the region beginning at least as far back as the Helikian. The continuity of both stratigraphy and structure reveal a common evolutionary history for the mainland and the western Arctic Islands. The oldest faults appear to flank the Cordilleran Orogen on the east and the youngest on the west, suggesting structurally controlled northern and western margins of the North American plate for more than the last one billion years of earth history.

Read, P.B. and **Okulitch, A.V.**

THE TRIASSIC UNCONFORMITY OF SOUTH-CENTRAL BRITISH COLUMBIA; Can. J. Earth Sci., v. 14, p. 606-638, 1977.

At five localities investigated in south-central British Columbia, Upper Triassic rocks are observed or inferred to unconformably overlie upper Paleozoic and older rocks. Paleozoic rocks beneath the unconformity show polyphase deformation and low-grade regional metamorphism which are absent in overlying rocks. Data from these and other localities define a regional angular unconformity of Late Permian or Early Triassic age on the western and southern margins of the Shuswap Metamorphic Complex. Permian and Triassic rocks preserve evidence of structural, sedimentary, and metamorphic events which permits separation of Triassic rocks into three fault-bounded tectonostratigraphic belts. The Eastern Belt contains the transition from miogeoclinal sedimentation throughout Triassic time in the Canadian Rockies to island arc volcanism in the Late Triassic to the west. Basal beds of the Triassic sequence become younger southwestward from the axis of the Early to Middle Triassic depocentre lying west of the Rockies. Rocks preserving Early Triassic deformation and metamorphism are restricted to the southwest corner of the belt and are truncated by the Pasayten Fault. The Central Belt, dominated by the products of Late Triassic volcanism in northern and central British Columbia, consists mainly of Middle (?) and Upper Triassic sediments in the south. Meagre evidence indicates that widespread deformation and low-grade regional metamorphism occurred just prior to the Late Triassic. Evidence for these events is not found beyond the faulted margins of the Central Belt. In the Western Belt, an Upper Triassic sequence of tholeiitic basalt and overlying calcareous sediments disconformably overlies Permian rocks. In the western Cordillera, low-grade regional metamorphism and minor plutonism characterize Triassic orogenies. Early Triassic orogenesis in the southwestern corner of the Eastern Belt is coeval with the Sonoma Orogeny and the Middle-Late Triassic orogenesis of the Central Belt represents the Tahltanian Orogeny.

Read, P.B. and **Okulitch, A.V.**

THE TRIASSIC UNCONFORMITY OF SOUTH-CENTRAL BRITISH COLUMBIA: REPLY; Can. J. Earth Sci., v. 15, p. 323-324, 1978.

Okulitch, A.V., Price, R.A., and **Richards, T.C.**

A GUIDE TO THE GEOLOGY OF THE SOUTHERN CANADIAN CORDILLERA CALGARY – MONTE CREEK – VERNON – OSOYOOS – PRINCETON – VANCOUVER; Geol. Assoc. Can., Guidebook, Trip 8, 1977.

Okulitch, A.V. and Peatfield, G.R.

GEOLOGIC HISTORY OF THE LATE PALEOZOIC-EARLY MESOZOIC EUGEOCLINE IN SOUTHERN BRITISH COLUMBIA AND NORTHEASTERN WASHINGTON; Geol. Assoc. Can., Prog. with Abstr., v. 2, p. 40, 1977.

Data from a region which underwent orogenic events from the mid-Paleozoic to Neogene allow construction of a fragmentary sketch of the evolution of a eugeoclinal terrane presently forming a salient extending 150 km east from the Okanagan Valley to the Kootenay Arc. A metamorphic complex formed largely in the Mesozoic from predominantly pre-Pennsylvanian rocks contains basement to the eugeocline. Some plutons in the complex may have been emplaced prior to the Pennsylvanian. Over and partly within the complex are Pennsylvanian and Permian eugeoclinal rocks in oceanic (Cache Creek Gp.) and arc (Anarchist Gp.) facies separated by a mixed zone containing ultramafic bodies. Deformation and low-grade metamorphism of the eugeocline in the Permo-Triassic was followed by unconformable deposition of Triassic sediments between a volcanic arc to the west (Nicola Gp.) and the craton. Eastern parts of the Triassic and older successions were folded prior to deposition of Lower Jurassic volcanic rocks. Pervasive plutonism, polyphase deformation and high-grade contact and regional metamorphism created the metamorphic complex in the Middle Jurassic to Early Cretaceous. Domal structures within the complex appear to be younger than the main orogenic phase, rising to present levels up to the Late Cretaceous. Subsequently, Eocene volcanic rocks were extruded on a surface of some relief. Volcanism was contemporaneous with regional uplift, subjacent thermal activity and extensive resetting of the K-Ar system in older rocks. The salient of eugeoclinal rocks appears to lie on older miogeoclinal successions and may have formed in several ways: westerly underthrusting of the craton and parts of its cover; migration of facies belts eastward in response to changing subcrustal tectonic regimes; or obduction of the eugeocline during eastward subduction.

Pedder, A.E.H.

CORALS OF THE LOWER/MIDDLE AND MIDDLE/UPPER DEVONIAN BOUNDARY BEDS OF NORTHERN AND WESTERN CANADA; in Western North American Devonian, ed. Murphy, Berry and Sandberg; Pol. Soc., Univ. Col. Riverside Campus, Mus. Contrib. 4, p. 99-105, 1977.

Most of the known coral faunas of the region can be dated in terms of conodont zones. International agreement has yet to be reached on the position of the Lower/Middle and Middle/Upper Devonian series boundaries. Possible positions for the first of these range from the base of the Czechoslovakian Zlichovian Stage to approximately the base of the German Eifelian Stage. Western and arctic Canadian coral faunas relevant to the problem are (1) **dehischens** associates, (2) probable **gronbergi** equivalents, (3) **inversus** associates, (4) probable **serotinus** equivalents, (5) post **serotinus** and questionably pre **pedderi** fauna, (6) **pedderi** associates. Evolution of **Utaratuia** from **Spongonaria** is possibly the most important single evolutionary step in development of Middle Devonian coral faunas of the region. This probably took place in post **serotinus,** and pre **pedderi** time.

Possibilities for the Middle/Upper Devonian boundary range from some level in the **varcus** Zone to at least as high as the base of the **insitus** Zone. Canadian coral faunas relevant to this problem are (1) Middle **varcus** associates, (2) late **varcus** associates, (3) **hermanni-cristatus** associates, (4) **insitus** equivalents and (5) Lower **asymmetricus** equivalents. Rugose corals are inexplicably scarce in western Canadian strata assigned to the **hermanni-cristatus, insitus**

and Lower **asymmetricus** Zones. Most important stages in the transition from typical Middle to typical Upper Devonian coral faunas in the region are (1) extinction of stringophyllids in Middle **varcus** Zone, (2) extinction of favositids and cystiphyllids, and appearance of **Neocolumnaria** in Upper **varcus** Zone, (3) appearance of **Sudetia** in **insitus** Zone and (4) appearance of horeshoe dissepiment bearing genera (**Macgeea, Pachyphyllum** and **Phacellophyllum**) in Lower **asymmetricus** Zone.

Poulton, T.P. and Callomon J.H.

A NEW SPECIES OF TRIGONIID BIVALVE FROM THE BOREAL BATHONIAN (JURASSIC) OF CENTRAL EAST GREENLAND; Bull. Geol. Soc. Denmark, v. 26, p. 155-159, 1977.

A brief description is given of **Vaugonia athena** sp. nov. from the Boreal Bathonian Ishmae Zone of Olympen, Jameson Land, one of the rare known representatives of the bivalve family Trigoniidae in the Boreal Realm of the Jurassic. Its affinities lie with Middle Jurassic species from western North America and with an early Bajocian species from northwestern Europe, but it differs from contemporaneous forms in the Bathonian of Britain.

Poulton, T.P.

DISTRIBUTION AND SIGNIFICANCE OF TRIGONIID BIVALVES IN THE MESOZOIC OF CANADA; Geol. Assoc. Can., Abstr. with Prog., v. 2, p. 42, 1977.

Bivalves of the family Trigoniidae Lamarck are an important element of many of the Late Triassic through Cretaceous faunas of western Canada, and they occur rarely in the Lower Jurassic faunas of the Canadian Arctic. Most species appear to be useful for recognition of biostratigraphic intervals to approximately the level of one or two stages, and identifications of many genera permit somewhat coarser biostratigraphic determinations.

Most Late Triassic species are radially costate and represent the genera **Minetrigonia** and **Myophorigonia.** A few other poorly understood species are present also. The pre-Middle Toarcian Early Jurassic species represent **Prosogyrotrigonia**(?), **Frenguelliella, Jaworskiella, Psilotrigonia, Vaugonia** and **Trigonia.** Middle Toarciaa through Oxfordian species dominantly represent **Myophorella, Trigonia,** and **Vaugonia,** with less numerous species of **Orthorrigonia**(?), **Scaphotrigonia** and **Anditrigonia.** Trigoniids occur rarely in Kimmeridgian through Valanginian rocks in Canada, where species of **Buchia** are abundant instead. Species of **Myophorella (Steinmanella), Apiotrigonia, Quoiecchia** and a new genus occur in the Hauterivian and Barremian stages. Aptian species are rare and poorly known. Younger Cretaceous species mainly represent **Myophorella (Steinmanella)** and **P. (Pterotrigonia). Apiotrigonia, Heterotrigonia** and the same new genus as occurs in older beds, are also present locally in Albian rocks. The genus **Yaadia** Crickmay is taken to be a junior synonym of **Myophorella (Steinmanella)** Crickmay.

The Canadian trigoniids are almost entirely endemic. The closest affinities of pre-Middle Toarcian species are with circum-Pacific species. Younger species resemble 'Tethyan' and northwest European forms.

Prest, V.K., Terasmae, J., **Matthews, J.V., Jr.,** and **Lichti-Federovich, S.**

LATE-QUATERNARY HISTORY OF MAGDALEN ISLANDS, QUEBEC; Maritime Seds., v. 12, p. 39-59, 1976.

The Magdalen Islands are located in the Gulf of St. Lawrence northwest of Cape Breton Island. For many years there has been disagreement as to whether or not they were glaciated. This study presents evidence which shows that the islands were definitely not overridden by Laurentide or other ice sheets during the entire Wisconsinan glacial stage though glaciers did exist near at hand on the Magdalen Shelf. The irregular upper limit of Demoiselle drift on the southern islands, as well as the varying elevation of shoreline sediments and a bouldery mantle of foreign stones on the northern islands, plus the apparent absence of marine shells in these sediments suggests that one or more glacial lakes may have covered the lower parts of the islands during the Wisconsinan. Such impoundments could have been created by glaciers from Newfoundland and Nova Scotia blocking Cabot Strait.

Wave-cut benches of probable interglacial age occur on several of the islands. Organic sediments – Portage-du-Cap peat – are found some 17 m (reported as 13 m) above present sea level at one site on Amherst Island. Wood from this unit has been dated at greater than 35 000 and greater than 38 000 years. Preliminary palynological evidence indicates that environmental conditions during deposition were more favourable than at any time during the Holocene. The peat contains macrofossils of insects, specifically the ground beetle **Oodes americanus** Dej., that have similar implications. Among the macrofossils are numerous fragments of marine hydrozoans.

Diatoms representing 119 taxa were found in the Portage-du-Cap peat. The complete absence of fresh water forms, marked dominance of marine littoral species, and the frequent occurrence of **Distephanus speculum,** a silicoflagellate requiring an open sea environment of normal salinity, suggest that the peat accumulated in a near shore marine environment. In addition, the abundant occurrence of warm water species having a southern distribution and the presence of the tropical species **Navicula irroratoides** corroborate the palynological and macrofossil evidence which suggest a warmer climate than at present. The Portage-du-Cap peat undoubtedly represents an interglacial stage, probably the Sangamon. In this regard it is noteworthy that these organic-bearing beds overlie some 3 to 15 m of gravel with northwest-dipping foreset beds of well rounded stones many of which are rotted or display deep weathering signs. Near the buried organics site, this gravel rests on red sandstones displaying burrows of the rock – boring clam **Zirphea** sp. over a vertical range of about 2 m. This horizon is some 3 to 4 m below the organic zone. The implications of this horizon with respect to the indicated Sangamon? sea level remain uncertain.

Reinson, G.E.

TIDAL-CURRENT CONTROL OF SUBMARINE MORPHOLOGY AT THE MOUTH OF THE MIRAMICHI ESTUARY, NEW BRUNSWICK; Can. J. Earth Sci., v. 14, p. 2524-2532, 1977.

The mouth of the microtidal Miramichi estuary, New Brunswick, is enclosed by a barrier-island system which is cut by two major tidal inlets. The submarine morphology adjacent to these inlets indicates the presence of large tidal deltas which formed predominantly by tidal-current processes. The extensive shoal water on the landward side of the barrier is due to the landward transport of sand through the inlets and the deposition of this sand as coalescing flood-tidal delta deposits. The creation of an artificial channel inside the main inlet in the late 19th century, and its maintenance since that time, have resulted in substantial channel-flow bypassing of the natural channel seaward of the barrier. This promoted the scouring of a new channel through the ebb-tidal delta shoal.

Large tidal deltas apparently are not common morphological features of estuaries on microtidal, barrier-island coastlines, but they do occur at the entrances of very large microtidal estuaries such as the Miramichi. In such cases they are usually completely subtidal, and much larger than tidal deltas of mesotidal estuaries reported in the literature. Rather than tidal range, the tidal prism, which takes into account both tidal range and estuary surface area, may play the major role in the formation of tidal deltas in both mesotidal and microtidal estuaries.

Rimsaite, J.

LAYER SILICATES AND CLAYS IN THE RABBIT LAKE URANIUM DEPOSIT, SASKATCHEWAN, CANADA; General Prog., Clay Min. Soc./Int. Comm. for study of bauxites, alumina and aluminium; p. 8-9, 1977.

In the Rabbit Lake uranium deposit, primary minerals are partly to completely altered to secondary coarse-grained phyllosilicates and clays, and locally replaced by carbonates, oxides and tourmaline. Brightly-coloured and bleached phyllosilicates determine the colour of host rocks thereby producing characteristic red, green and white alteration zones in the deposit. Using optical, chemical, electron microprobe, DTA-TG and X-ray analyses, uraniferous phyllosilicates, micas, chlorite, montmorillonite, serpentine, talc and kaolinite were identified and their distribution was studied in drill core samples from the U-mineralized zones and surrounding rocks in order to determine the relationship between superimposed alterations and these geological events: 1) retrograde metamorphism following Hudsonian orogeny 1.8 b.y. ago; 2) faulting and brecciation; 3) carbonatization; 4) uranium and sulphide-arsenide-selenide mineralizations; 5) weathering; and 6) oxidation. The most intensive alterations were observed along fractures, faults and breccias, and in regolithic and surface alteration zones. As a result of mechanical grinding, followed by hydration and chemical alteration, schists and gneisses are altered to rocks resembling arenites, quartzites and argillites. The fine-grained alteration products crystallize in situ pseudomorphously replacing the coarse-grained host. Where water moves on or through the rock, clays are transported in suspension and can be redeposited in fractures, or are washed out leaving void spaces, thereby increasing porosity and promoting disintegration of the rock. Chemical compositions and structures of the phyllosilicates depend on the mineralogy of original rocks and on alteration environments. The phyllosilicates in the upper part of the weathering zone are bleached, depleted of iron, potassium and uranium, and change from green uraniferous and common mica-chlorite intergrowths to bleached Al-Mg chlorites and montmorillonitic clays, whereas at or just above the groundwater table, they are brightly coloured and enriched in iron. Phyllosilicates associated with pitchblende are poorly crystallized, structural destruction being directly related to the uranium content of the rock.

Roddick, J.A. and **Woodsworth, G.J.**

RELATIONSHIP BETWEEN PLUTONISM, METAMORPHISM AND VOLCANISM IN THE COAST MOUNTAINS, BRITISH COLUMBIA; in Plutonism in relation to volcanism and metamorphism; IGCP – Circum – Pacific Plutonism Project, p. 1-14, Toyama, Japan, 1977.

Pendants and screens in the Coast Plutonic Complex show a pattern of regional metamorphism that spans the width of the belt. Peak metamorphic effects, marked by sillimanite and locally by clino- and orthopyroxene are confined to a narrow zone which in the Prince Rupert area coincides with the axis of the belt, but lies east of the axis in Bute Inlet map-area to the south. The transformation of synplutonic dykes and inclusions indicates that plutonism is a result of regional metamorphism and not its cause. Volcanism may or may not be associated with plutonism, but when it is, volcanism probably originates from the base rather than from the tops of plutons.

Ruzicka, V.

ESTIMATION OF UNDISCOVERED URANIUM RESOURCES IN CANADA; in Uranium Resource Evaluation; Energy Mines and Resources Canada, Report ER 77-1, p. 39-56, Ottawa, 1977.

Estimation of undiscovered uranium resources by the Uranium Resources Evaluation Section of the Geological Survey of Canada is based on: (1) geological analyses of areas containing known uranium deposits, their past production and identified reserves; (b) an assumption that geological features of economic interest of known areas can be extrapolated to similar areas; and (c) conceptual genetic models simulating processes leading to specific uranium mineralization.

Several computation methods, such as volumetric, geostatistical and MIMIC are used routinely or experimentally.

Two basic computerized files are used for storage and retrieval of geological parameters of economic significance: Uranium CANMINDEX comprising information on location, character and bibliographic references to individual occurrences, and URE-3 file containing information on geology and uranium mineralization of selected areas in Canada.

The undiscovered uranium resources are classified into two categories: Prognosticated Resources: estimated undiscovered uranium tonnages in known uranium districts beyond specific limits established for inferred ore, and Speculative Resources: estimated tonnages in areas where only occurrences are known, or in virgin areas.

Jambor, J.L., Sabina, A.P., Roberts, A.C., and Sturman, B.D.

STRONTIODRESSERITE, A NEW Sr-Al CARBONATE FROM MONTREAL ISLAND, QUEBEC; Can. Mineral., v. 15, p. 405-407, 1977.

Strontiodresserite occurs as vitreous to silky white coatings, some of which are atoll-shaped, in a silicocarbonatite sill at St-Michel, Montreal, Montreal Island, Quebec. The mineral is lath-like, with maximum dimensions 0.1 x 0.01 x 0.001 mm and is biaxial negative, 2V 42 1/2 (1)°, $n\alpha$ 1.510(4), $n\beta$ 1.583(2), $n\gamma$ 1.595 (calc.), Y parallel to elongation, X normal to it and in the plane of the plates. Microprobe analyses gave CaO 2.83, 2.90, 2.60; SrO 24.07, 24.25, 24.75; Al_2O_3 29.16, 29.12, 29.12 wt. %, Ba and Pb not detected, average (Sr,Ca): Al = 0.995:2.000. The mineral effecvesces in dilute Hcl and the similarity of its powder pattern with those of dundasite and dresserite suggests that strontiodresserite is (Sr,Ca) $Al_2(CO_3)_2(OH)_4 \cdot H_2O$. Strongest lines of the powder pattern are 7.93(10), 4.39(8), 3.002(7), 5.99(6), 2.63(6), 3.55(4). Orthorhombic dimensions calculated from the pattern are a 9.14, b 15.91, c 5.59Å, D(calc.) 2.76 g/cm^3 for the theoretical formula with Sr:Ca = 4:1 and Z = 4, D(meas.) 2.71 g/cm^3. Dundasite, dresserite, and strontiodresserite have the same general chemical formula, but they are not isostructural.

Jambor, J.L., Sabina, Ann P., and Sturman, B.D.

HYDRODRESSERITE, A NEW Ba-Al CARBONATE FROM A SILICOCARBONATITE SILL, MONTREAL ISLAND, QUEBEC; Can. Mineral., v. 15, p. 399-404, 1977.

Hydrodresserite occurs in an alkalic sill at Montreal Island, Quebec, as white spheres and hemispheres which

average about 2 mm in diameter and consist of radiating, fibrous, colorless crystals with a white streak, hardness of 3 to 4, and perfect cleavages {010} and {210}. Crystals are triclinic, elongate 001 , terminated (102), with prominent {010} and narrower {210}, a 9.79, b 10.42, c 5.62Å, α 96.05, β 92.20, γ 115.71°. The mineral is biaxial negative, 2V = 17°, nα 1.520, nβ 1.594, nγ 1.595, Z' parallel to elongation and X' normal to it. Strongest lines of the powder X-ray pattern are 8.52-10 (110); 3.42-7 (210); 3.10-6 (030,211); 8.75-4 (100); 4.26-5 (220).

Chemical analysis gave BaO 35.0, Al_2O_3 23.7, CO_2 21.8, H_2O 20.3, sum 100.8 wt %, corresponding to

$$Ba_{0.97}Al_{1.99}(CO_3)_{2.12}(OH)_{3.68} \cdot 2.87H_2O,$$

theoretically

$$BaAl_2(CO_3)_2(OH)_4 \cdot 3H_2O;$$

D(meas.) 2.80, D(calc.) 2.81 g/cm^3 for the theoretical formula with Z = 2. Hydrodresserite is unstable and gradually dehydrates to $BaAl_2(CO_3)_2(OH)_4 \cdot H_2O$ (dresserite) after passing through an intermediate phase (with $2H_2O$?). DTA, TGA, and static heating experiments indicate that several compounds form during the breakdown to $BaAl_2O_4$.

Scott, W.J. and Mackay, J.R.

RELIABILITY OF PERMAFROST THICKNESS DETERMINATION BY DC RESISTIVITY SOUNDING; in Proceedings of a Symposium on Permafrost Geophysics, 12 October, 1976, prepared by W.J. Scott and R.J.E. Brown; NRC Tech. Memo. No. 119, p. 25-38, 1977.

Between 1971 and 1975, about 30 Schlumberger resistivity soundings were made at various locations on the Tuktoyaktuk Peninsula in order to obtain estimates of permafrost thickness. Most of the soundings were made in lake basins which had been drained recently enough that permafrost is presently aggrading in them. During interpretation of these soundings it became apparent that particularly for those taken over thin permafrost, unique resistivity-depth functions were not obtainable. The problem of non-uniqueness is examined in the context of permafrost thickness determination.

Sen Gupta, J.G.

DETERMINATION OF TRACES OF RARE-EARTH ELEMENTS, YTTRIUM AND THORIUM IN SEVERAL INTERNATIONAL GEOLOGICAL REFERENCE SAMPLES AND COMPARISON OF DATA WITH OTHER PUBLISHED VALUES; Geostandards Newsletter, v. 1, N^O 2, p. 149-155, 1977.

Experimental results for most rare-earth elements, yttrium and thorium in several international geological reference samples are presented and compared with other published values, where available. The analytical method used to obtain these results involved a preliminary concentration of the rare-earth on milligram quantities of iron as carrier for atomic-absorption, flame-emission and spectrophotometric determinations, or on milligram quantities of Fe_2O_3, Al_2O_3 and SiO_2 as carriers for optical-emission spectrometric determination.

Shilts, W.W.

GEOCHEMISTRY OF TILL IN PERENNIALLY FROZEN TERRAIN OF THE CANADIAN SHIELD – APPLICATION TO PROSPECTING; Boreas, v. 5, p. 203-212, 1977.

Geomorphological (drumlins, ribbed moraine) and geochemical features associated with till in the District of Keewatin are arranged in belts or dispersal trains paralleling the main direction of ice flow. Both types of features can be related to chemical and physical characteristics of specific types of source rocks.

For dispersal studies in perennially frozen terrain, till samples were collected from mudboils at spacings of approximately 1.6 km. The texture of till samples varies significantly from sample site to sample site because of varying source-rock lithologies and periglacial processes. Thus, because fractions coarser than clay are mostly quartz and feldspar and contain very little metal after weathering in the active layer, they were removed by centrifugation so as not to mask the 'true' relative metal contents of samples The clay-sized fraction was separated from till samples and analyzed on the assumption that it contained scavenging phases that adsorb cations in proportion to those released by weathering of mineralized particles that were originally physically dispersed by glacial action.

Dispersal patterns of copper, zinc, nickel, and uranium were derived for approximately 1000 samples evenly distributed over a 2500 km^2 grid. From these maps, large dispersal trains of copper and nickel were found, and known areas of high potential for uranium and Cu-Zn mineralization were clearly indicated.

Sinha, A.K.

A THEORETICAL STUDY ON ELECTROMAGNETIC PROBING OF PERMAFROST TERRAINS; Can. J. Earth Sci., v. 14, p. 2388-2401, 1977.

A theoretical analysis has shown that a portable double dipole multifrequency electromagnetic system can be a viable tool for mapping the permafrost terrains of the northern areas for engineering purposes. In this analysis, the theoretical response of a two-layer permafrost terrain (with the frozen layer at the top underlain by the unfrozen sediments) has been obtained for three coil arrangement systems. Available data on the frequency variations of the electrical properties of the permafrost and the unfrozen layers have been considered in the simulations to make the models realistic.

The performance of the horizontal coplanar system is seen to be the best for mapping purposes, closely followed by that of the inclined-parallel system which is a null-coupled configuration. The study also considers the effects of the presence of a transition layer between the permafrost and unfrozen layers. The results indicate that the effects are greater when the parameters in the transition layer vary in an exponential fashion rather than in a linear fashion. The quadrature parts of the mutual coupling ratios are, in all cases, less affected by the transition layer than the in-phase parts. However, the resolution is better for the in-phase part when the permafrost thickness and frequency values are large.

Sinha, A.K.

INFLUENCE OF ALTITUDE AND DISPLACEMENT CURRENTS ON PLANE-WAVE EM FIELDS; Geophysics. v. 42, p. 77-91, 1977.

Airborne electromagnetic mapping by wavetilt measurement is especially suitable for highly resistive strata like the permafrost terrains of northern Canada. A theoretical study has been made on the influence of the altitude of the aircraft and displacement currents on the measured wave tilt values over a range of frequency from VLF (very low frequency) to BCB (broadcast band).

A computer modeling study has shown that the effects of displacement currents cannot be ignored over resistive ground if the frequency is greater than 100 kHz.

The altitude effect is significant beyond 20 m for medium frequencies and resistive ground. The phase of the wavetilt is almost always more sensitive to these factors than the amplitude. When the top layer is thicker than three skin depths in that layer, the effects of lower layers on the wavetilt is negligible. It is also apparent that before attempting to interpret wavetilt data over a layered medium, one should carefully determine the nature of the source field.

The results are readily applied to the Barringer E-phase System, an airborne EM technique which measures the quadrature part of the wavetilt at three frequencies from VLF to BCB range. If the effects of altitude and displacement currents are ignored, the calculated apparent resistivities from E-phase data will be much less than the true resistivities, even for moderately resistive ground. A graphical technique is presented for correctly estimating the resistivity values from two-frequency E-phase measurements when the electrical constants are not frequency dependent.

Stalker, A. MacS.

THE PROBABLE EXTENT OF CLASSICAL WISCONSIN ICE IN SOUTHERN AND CENTRAL ALBERTA; Can. J. Earth Sci., v. 14, p. 2614-2619, 1977.

The margin of a former Laurentide ice sheet is traced through southern and central Alberta, from the Saskatchewan border southeast of Medicine Hat to beyond Rocky Mountain House, southwest of Edmonton. This margin, which marks the limit of a significant glacier advance or readvance, is thought to represent the maximum extent of Laurentide ice on the Canadian prairies during Classical Wisconsin time. In the south this margin follows a well-developed hummocky moraine; in the north it is indicated mainly by a discordance in trend of ice-flow markings, a disruption of drainage, and a change in maturity of topography on either side.

Tempelman-Kluit, D.J.

YUKON MINERAL EXPLORATION HIGHLIGHTED BY NEW ZINC-LEAD DEPOSIT DISCOVERIES; Western Miner, Feb., p. 12-16, 1978.

Sinclair, P.D., **Tempelman-Kluit, D.J.**, Medaris, L.G. Jr.

LHERZOLITE NODULES FROM A PLEISTOCENE CINDER CONE IN CENTRAL YUKON; Can. J. Earth Sci., v. 15, p. 220-226, 1978.

Fresh spinel lherzolite nodules occur in basaltic tuff on the flank of a Pleistocene cinder cone built on Selkirk Lavas in central Yukon. The nodules are mineralogically and chemically similar to others from diverse localities. The texture and mineral chemistry are consistent with an upper mantle origin for the Selkirk nodules. Equilibration temperatures for the nodules have been determined to be about 1100°C.

Pissart, A., **Vincent, J-S.**, et **Edlund, S.A.**

DÉPÔTS ET PHÉNOMÈNES ÉOLIENS SUR L'ÎLE DE BANKS, TERRITOIRES DU NORD-OUEST, CANADA; Can. J. Earth Sci., v. 14, p. 2462-2480, 1977.

En plusieurs endroits de l'île de Banks, des actions non négligeables de déflation se produisent actuellement. La déflation s'exerce sur les alluvions des plaines alluviales et des plaines d'épandages fluvio-glaciaires, sur des sables éoliens précédemment stabilisés et aussi quelquefois directement sur des accumulations sableuses d'âge mésozoïque et tertiaire. Localement, les vents ont façonné des cailloux éolisés typiques.

La couverture végétale des surfaces soumises aux actions éoliennes est décrite en précisant les différentes espèces de plantes qui ont été observées.

Des dépôts éoliens du cours inférieur de la rivière Thomsen sont étudiés en détail. L'étude d'une coupe a montré que des polygones de fente de gel se sont développés pendant l'accumulation des sables. Elle établit, en outre, que des lentilles de glace de ségrégation peuvent se former à la partie supérieure du pergélisol, lorsque celui-ci s'élève suite à l'accumulation en surface de dépôts éoliens.

Deux datations au radiocarbone ont révélé que la sédimentation éolienne dans deux sites différents le long de la rivière Thomsen a débuté il y a 3790 ± 90 ans BP (GSC-2119) et 3460 ± 80 ans BP (GSC-2124). Des âges de 5800 ± 180 ans BP (GSC-2242) et de 8430 ± 120 ans BP (GSC-2419) ont été respectivement obtenus pour le début de la sédimentation éolienne le long de la rivière Bernard et sur la plaine d'épandage au sud-est de Sachs Harbour. En guise d'hypothèse il est avancé que l'initiation de l'activité éolienne, il y a environ 4000 ans, pourrait avoir été engendrée par un refroidissement du climat et un régime météorologique plus sec sur l'île de Banks.

Vincent, J-S., et Hardy, L.

L'ÉVOLUTION ET L'EXTENSION DES LACS BARLOW ET OJIBWAY EN TERRITOIRE QUÉBÉCOIS; GÉOGR. PHYS. ET QUAT., v. 31, p. 357-372, 1977.

Une nouvelle interprétation de l'évolution des phases lacustres des lacs glaciaires Barlow et Ojibway, à partir d'une synthèse des données recueillies sur le versant québécois des bassins de l'Outaouais supérieur et de la baie de James, est présentée. Ces nappes d'eau, qui existèrent entre environ 11,500 et 7,900 ans BP, furent les derniers d'une série continue de lacs qui suivirent la marge glaciaire laurentidienne depuis le début de la dernière déglaciation.

Les lignes de rivage associées à ces phases lacustres montrent que l'altitude maximale des plans d'eau se relève vers le nord-nord-est et que le relèvement différentiel varie entre 0.5 et 1.2 m/km. Le niveau des eaux était contrôlé par des séries d'exutoires localisés aux ruptures de pente le long de l'axe fluvial constitué par les vallées de l'Outaouais, de la rivière Des Quinze et du Kinojévis.

Le tracé des plans de déformation des niveaux lacustres comparé au profil longitudinal actuel de ces vallées montre, qu'au moment de la déglaciation, la ligne de partage des eaux fut déplacée loin vers le sud. C'est ce gauchissement temporaire de la surface qui a permis la rétention des eaux du Lac Barlow. Le relèvement isostatique différentiel a entraîné un lent retour de la ligne de partage des eaux jusqu'à sa position actuelle et par conséquent, un déplacement progressif des exutories vers le nord. La coupure entre les lacs Barlow et Ojibway est fixée arbitrairement au seuil d'Angliers, sur la rivière Des Quinze, qui représente la rupture de pente la plus importante de tout l'axe fluvial. Son émersion a confiné les eaux du lac Barlow au bassin du Témiscamingue et a donné naissance à un autre lac indépendant, le lac Ojibway, qui s'est agrandi vers le nord et le nord-est, sur le territoire nouvellement déglacié. Les derniers exutoires du la Ojibway furent probablement situés le long de l'actuelle ligne de partage des eaux. Lorsque les glaciers d'Hudson et du Nouveau-Québec se sont séparés, à la latitude de la mer d'Hudson, le lac s'est drainé rapidement vers le nord.

Wade, J.A.

STRATIGRAPHY OF GEORGES BANK BASIN: INTERPRETED FROM SEISMIC CORRELATION TO THE WESTERN SCOTIAN SHELF; Can. J. Earth Sci., v. 14, p. 2274-2283, 1977.

Based on the interpretation of reflection seismic profiles, five major reflecting horizons are correlated from the southwestern Scotian Shelf to Georges Bank. The Mesozoic-Cenozoic stratigraphy of Georges Bank Basin is interpreted to be similar to, but thicker than, the LaHave Platform and consists of 200 m of Tertiary and younger strata, 1000 m of Upper Cretaceous, 600 m of Lower Cretaceous, and 6300 m of Jurassic rocks. The post-Lower Cretaceous facies are interpreted to be clastic across the entire area, while the pre-Upper Cretaceous facies are interpreted to be predominantly clastic in the northern half and predominantly carbonates in the southern half of Georges Bank Basin.

Wagner, F.J.E.

PALAEOECOLOGY OF MARINE PLEISTOCENE MOLLUSCA, NOVA SCOTIA; Can. J. Earth Sci., v. 14, p. 1305-1323, 1977.

Fossiliferous Pleistocene sediments are present in western mainland Nova Scotia and on Cape Breton Island. Two ages of deposits are represented: post-glacial in the Minas Basin area and mid-Wisconsinan in the Yarmouth-Digby area and Cape Breton. The mid-Wisconsinan age is based on both radiocarbon and U-Th dates. Molluscan assemblages indicate water temperatures colder than at present at the time of deposition of the post-glacial sediments, and comparable to the present for the older deposits. Assemblages from the Yarmouth-Digby area are compared with those of similar age from Tobaccolot Bay, Long Island, New York, and from Nantucket Island, Massachusetts. Foraminifera, previously unreported, were found in sediments of both ages.

Wall, J.H. and Rosene, R.K.

UPPER CRETACEOUS STRATIGRAPHY AND MICRO-PALEONTOLOGY OF THE CROWSNEST PASS – WATERTON AREA, SOUTHERN ALBERTA FOOTHILLS; Bull. Can. Pet. Geol., v. 25, p. 842-867, 1977.

The upper Cretaceous in the southern Alberta Foothills is represented almost entirely by clastic sediments with a maximum thickness of about 14,000 ft (4270 m). This essentially uninterrupted sequence, in which all stages from the late Cenomanian through the Maestrichtian are represented, consists of alternating phases of marine, littoral or deltaic, and continental deposition. In ascending order, the major rock units consist of the Alberta Group (Blackstone, Cardium and Wapiabi Formations), Belly River, Bearpaw, Blood Reserve, St. Mary River and Willow Creek Formations. Of these units, the Blackstone, Wapiabi and Bearpaw are predominantly shale and marine in origin; the Cardium, Blood Reserve and lower part of the St. Mary River are somewhat arenaceous and represent littoral to deltaic regimes; the Belly River, most of the St. Mary River, and the Willow Creek consist of varying proportions of shale, siltstone and sandstone, and were deposited mainly under continental conditions.

A succession of 11 microfaunas is recognized in the Alberta Group and Bearpaw Formation. In order of decreasing age, with indicated environments in parentheses, these are the lower pelagic (outer shelf to upper bathyal) and **Pseudoclavulina** sp. (nearshore) in the Blackstone Formation; the **Trochammina** sp. 1 (nearshore), "**Anomalina**" (inner shelf), **Brachycythere-Bullopora** (inner shelf), **Anomalinoides henbesti** (middle shelf), upper pelagic (middle to outer shelf) and unnamed agglutinated (nearshore) in the Wapiabi Formation; and ostracode (supralittoral), arenaceous foraminiferal (nearshore) and **Gavelinella talaria** (offshore) in the Bearpaw Formation.

Woodsworth, G.J.

HOMOGENIZATION OF ZONED GARNETS FROM PELITIC SCHISTS; Can. Mineral., v. 15, p. 230-242, 1977.

Garnets from low-variance pelitic assemblages in the garnet and staurolite zones of the Mt. Raleigh area, B.C., generally show strong compositional zoning. A decrease in Mn outwards from the core is balanced by an increase in Fe and Mg. Zoning in garnets from the cordierite zone is weak or absent. Mn commonly increases slightly from core to rim; Mg shows a corresponding decrease. There is little or no Ca zoning in either high or low-grade rocks. At all metamorphic grades, the garnet rims are in partition equilibrium with adjacent ferromagnesian minerals. Ilmenite inclusions in low-grade rocks are in equilibrium with immediately adjacent garnet, but inclusions in cordierite-zone garnets are not in equilibrium with garnet.

The data suggest: (1) growth of zoned garnets by a fractionation-depletion process at lower grades; (2) homogenization of zoned garnets at temperatures above about 600°C; (3) modification of the bulk composition of homogeneous garnets by exchange equilibria involving garnet and cordierite; and (4) formation of Mn-rich rims on both high and low-grade garnets during retrogression of the garnet. Volume diffusion was the main process which created and modified the zoning in the cordierite zone, but was of only minor importance in lower grade rocks. The onset of significant volume diffusion may have initiated changes in the equilibria with other minerals.

Woodsworth, G.J. and **Roddick, J.A.**

MINERALIZATION IN THE COAST PLUTONIC COMPLEX OF BRITISH COLUMBIA, SOUTH OF LATITUDE 55°N; Geol. Soc. Malaysia, Bull. 9, p. 1-16, 1977.

Compared with the flanking Insular and Intermontane Belts, the Coast Plutonic Complex contains few mineral deposits. Two quartz-vein gold camps, one massive sulphide body, and one ultramafic complex have accounted for 18% of the copper, 29% of the gold, and all the nickel produced from British Columbia. Mineral deposits and occurrences are concentrated in two segments of the Coast Plutonic Complex that are adjacent to two mineralized segments of the Intermontane Belt. Pyrite, chalcopyrite, sphalerite and galena are the dominant sulphides regardless of age or type of deposit. Small, lenticular replacement bodies in skarn and schist are the most common deposits. Many of these are situated along the near northwest-trending faults. Pyritic massive sulphide bodies occur in Paleozoic(?) Early Cretaceous metamorphic rocks. Miocene porphyry copper and molybdenum deposits form a discontinuous chain running longitudinally through the Southern Coast Mountains. Older porphyry deposits are situated along and near the eastern margin and near the western margin of the southern Coast Mountains. Nickel-copper deposits are associated with an ultramafic complex at the southeast end of the Coast Plutonic Complex.

The distribution of mineral deposits among the lithologies of the Coast Plutonic Complex is similar to the distribution of accessory pyrite. Pyrite is abundant in pendant rocks, and about two-thirds of all known deposits occur in the pendants. In plutonic rocks pyrite is found

mainly in hornblende-rich diorites and quartz diorites, particularly those showing extensive chloritization, epidotization, or pink hydrothermal alteration. Almost all mineral deposits hosted by plutonic rock are in quartz diorite and diorite, and the plutonic rocks adjacent to most pendants are also quartz diorite or diorite. Few deposits have been found in the Central Gneiss Complex or in plutons immediately east.

Woodsworth, G.J., Pearson, D.E., and Sinclair, A.J.

METAL DISTRIBUTION PATTERNS ACROSS THE EASTERN FLANK OF THE COAST PLUTONIC COMPLEX, SOUTH-CENTRAL BRITISH COLUMBIA; Econ. Geol., v. 72, p. 170-183, 1977.

Machine-plotted maps of metal distributions, combined with field work, indicate the presence of a previously unrecognized regional zoning pattern in the Taseko Lakes and Pemberton map-areas. Mineral deposits occur in well-defined camps, the most productive of which has been the Bridge River gold camp. A distinctive asymmetric metal and mineral zoning pattern occurs in the Bridge River district. Two elongate, northwesterly trending centers of gold-bearing vein deposits lie within a larger area characterized by antimony minerals. The antimony zone is succeeded to the northeast by a mercury zone. This pattern is explained by mineral deposition under a regional thermal gradient decreasing outward from the eastern margin of the Coast Plutonic Complex, implying that mineralization occurred during or shortly after final cooling of the eastern margin of the Coast Plutonic Complex about 50 m.y. ago.

Porphyry deposits occur in geographically separate areas from most vein deposits. Porphyry mineralization occurred during the Late Cretaceous, early Tertiary, and Miocene. Copper-molybdenum-gold porphyry deposits characterize the first two events, whereas porphyry molybdenum deposits formed during the Miocene. Principal movements along the Yalakom fault predated mineral deposition in the Bridge River camp. Late Tertiary porphyry molybdenum deposits appear genetically related to Cascade volcanism rather than to plutonism of the Coast Plutonic Complex.