Current Research

Atlantic Universities Geological Conference, Memorial University of Newfoundland, St. John's, Newfoundland, November 16 to 20, 1972.

Evolution of Closed System Type Pingos by P.A. BATSON, Dalhousie University, Halifax, N.S.:

During the summers of 1971 and 1972 the writer was a member of a Geological Survey of Canada field party under the supervision of Dr. J. Ross MacKay of the University of British Columbia. The work was concentrated in the Mackenzie Delta, Tuktoyaktuk Peninsula Region, Northwest Territories. (See Fig. 1, p. 74)

One of the geomorphological features studied was the closed-system type of pingo. There are about 1500 of these pingos in the above-mentioned region. Most are several hundred to several thousand years in age. There are however, young growing pingos. The total number of actively growing pingos could exceed 30. At present nine growing pingos are under observation.

The word pingo originates from the Eskimo word meaning hill. The Russian's term a pingo as a hydrolaccolith. This is very appropriate because it indicates the mechanism of formation of pingos. If one draws an analogy between a pingo and an igneous intrusive laccolith, their formations are quite similar. The intrusive water is like a magma and the ice core of a pingo is similar to that of a cooling intrusive magma. A cross section reveals that both are planar convex structures. The viscosity of the core ice is not affected by the pressure of overlying ice unless the ice actually melts. The stress is distributed laterally.

Pingos grow faster at the top than at the sides because of a steeper temperature gradient dt/dz (t=temperature, z=depth below surface). This has been shown in the laboratory and in the field.

A pingo in its drying stages collapses due to the melting of tension-crack ice and core ice, after a thermal and pressure equilibrium within the closed system has been reached. A thermokarst develops with the slumping of the pingos lacustrine sediments in the core region. Over several hundred years this karst will fill.

Fossil pingo structures of Ordovician age have been found in the Mouydir Region near Arak in southern Algeria. This is evidence for a possible Ordovician glaciation and post glaciation environment in North Africa similar to the Mackenzie Delta, Tuktoyaktuk Peninsula Region.

The study of closed-system pingos can be related to growth of permafrost on a larger scale. Permafrost has been the subject of great concern to oil exploration and mining companies. For example, if a company were to construct an island for a drilling platform, which has recently been done in Shallow Bay, Northwest Territories, permafrost aggradation in different soils has to be taken into consideration: hence Franz Meumann's equation $z = b\sqrt{t}$ where z is depth of freezing, t is time and b is a constant which is a function of the temperature conditions and physical properties of frozen and unfrozen soils. Closed-system pingos commence growth in large (200 m or greater in diameter) drained lakes where the lake was deepest and warmest. Deep lakes are less likely to have permafrost extending directly under them, because of the heat transfer between unfrozen lake sediments (water) and the permafrost. Such lakes could be utilized by oil exploration drilling crews to minimize the thermokarst action. Permafrost is also present in Labrador where iron ore is mined. Exposure of permafrost creates slump features in open-pit mining. Ice also has a tendency to shear along planes, breaking off in large blocks. To correct for this, different blasting techniques have had to be devised so that the ice will shatter into smaller blocks.

With the opening of Canada's north and the acceleration of oil and mineral exploration the presence of permafrost cannot be neglected nor can the fragile ecology associated with it either. Further research is necessary to cope with future engineering problems created by permafrost features.

The Study and Collecting Methods of Recent and Fossil Ostracoda by KEN PETERS and VALERIE SCHOLEY, St. Mary's University, Halifax, N.S.:

The purpose of this study is basically to collect and document the occurrence and variety of Ostracods found in the Halifax Inlet area. Phase I of the project to be followed later by other phases is being done under the supervision of Dr. Q.A. Siddiqui. Samples were collected from the littoral and sublittoral zones, with the resulting identification of assemblages for each zone.

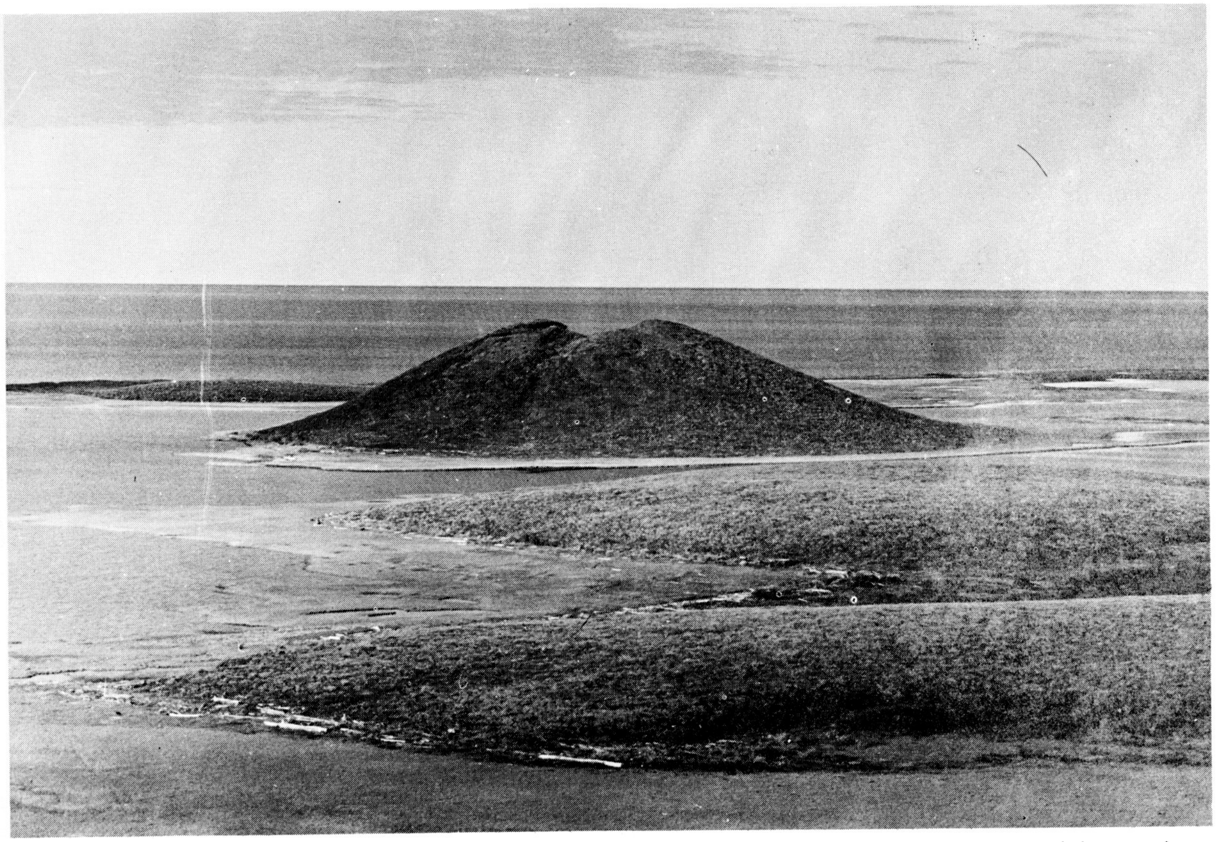


Figure 1: Pingo rising out of the flat landscape near the village of Tuktoyaktuk, Northwest Territories. (Photograph by Roger Belanger, Atlantic Oceanographic Laboratory, Dartmouth, Nova Scotia, Canada).

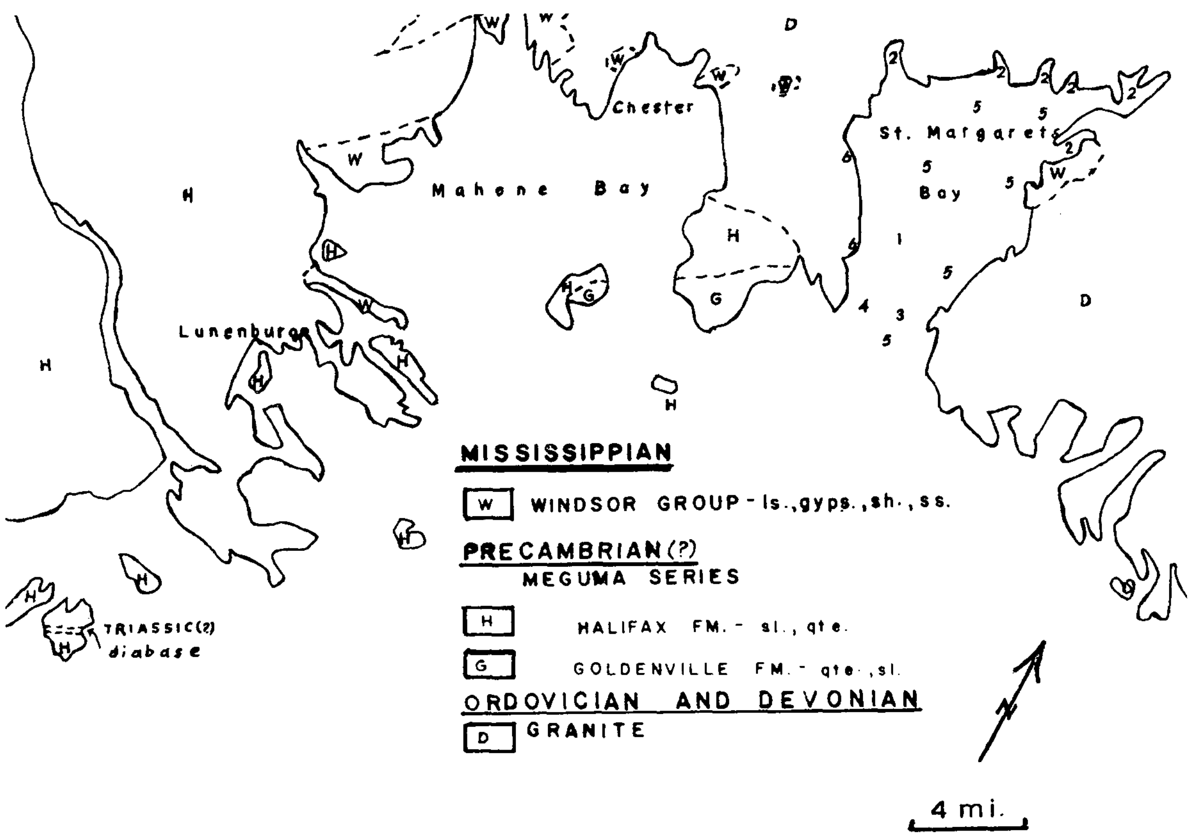


Figure 2: Map of St. Margaret's and Mahone Bays (see study on P. 75 by Lynn Smith, Mt. Allison Univ., Saskville, N.B.).

A Preliminary Report of the Geology of Taylor's Peninsula, Saint John, New Brunswick by ELISABETH SPATZ, University of New Brunswick, Fredericton, N.B.:

Recent work done on Taylor's Peninsula, begun in March by the writer and in the southern coast of New Brunswick, begun in June by members of the U.N.B. staff (Mr. Grant and Dr. Rast) has revealed recumbant folding in the Mississippian and Pennsylvanian strata of southern New Brunswick along the Bay of Fundy from Saint John to Point Lepreau.

The style of this deformation, which in part appears to be polyphase, resembles a large nappe-type structure with sub-horizontal cleavage. There is an F_2 axial planar crenulation cleavage as displayed in the area of Canaport, near Saint John. The area of Taylor's Peninsula appears to lie to the south of the thrust front, with the sedimentary beds being overturned with a sub-horizontal S_1 cleavage.

The Mississippian-Pennsylvanian beds of the area are gently dipping seaward with a sub-horizontal cleavage. Thirty miles to the west at Little Dipper Harbour, the results show a similar pattern. This is repeated at Canaport with the addition of an S_2 crenulation cleavage.

These results have led to the discovery of a large thrust front which has deformed the Mississippian-Pennsylvanian strata and which was formerly thought to be horizontal with no deformation.

In comparison to the horizontal S_1 cleavage of this front, the Acadian foreland has a characteristic vertical S_1 cleavage with severe folding.

The writer wishes to acknowledge the assistance of Mr. Neil Downey, Dr. P. Stringer and Dr. G. Pajari in the preparation of this paper. Further research is being conducted at the moment by Mr. Grant and Dr. Rast of U.N.B.

The Development of a Genetic Model for the Sturgen River Gold Area Volcanic-Sedimentary Belt by DEREK FAUST, Saint Francis Xavier University, Antigonish, N.S.:

The Sturgeon River Gold Area, in the Lake Nipigon region of northwestern Ontario, is part of an east-trending belt of metavolcanic and metasedimentary rocks of Archean age. The sequence lies along the boundary between two dominant east-trending lithologic structural units of the Superior Province (the Quetico and former Keewatin belts) and has played a central role in the synthesis of the Archean geologic history.

Interest in the belt came first in 1925 with the discovery of gold near the present town site of Beardmore and later near Geraldton. During the Second World War, the area was one of the prominant gold producing areas in Canada. Gold production has now falled off to virtually nothing. However the area is again being explored; this time for the sulphide mineralization which occurs in large concentrations along the belt.

The metavolcanic rocks of the area are thought to be part of an Archean island arc system the remains of which form the former Keewatin Belt. The island arc developed in an older, east-trending sedimentary basin in which the rocks of the Quetico had been depositing. The gradual change in the character of the volcanism from sub-aqueous basaltic flows to sub-aerial felsic to intermediate explosive events is accompanied by a change in the sedimentation from the quiet deep-water facies to heterogeneous, coarse shallow-water facies that reflect the close proximity of high topographical relief and active mechanical break down.

This interpretation is different from that of the popular theory for Archean crustal evolution which requires that the Keewatin be the source area for the Quetico metasediments.

Recent History and Surficial Geology of St. Margaret's Bay, Nova Scotia by LYNN SMITH, Mount Allison, Sackville, N.B.:

The attached map shows the St. Margaret's and Mahone Bay area of the Southeast coast of Nova Scotia. Halifax, off the map area, is to the northeast. This typical submerged coastline exhibits drowned valleys and prominent headlands, with rivers emptying their sediment into protected coastal bays and estuaries. (See Fig. 2, p. 74)

The study area includes St. Margaret's Bay and the area up to three miles outside the mouth. Its drainage area is over granite, Ordovician or Devonian in age; its contact with the older Meguma series cutting across the peninsula separating St. Margaret's from Mahone Bay. In the north and eastern portions of the Bay, drumlins are found onshore and as numerous islands (not shown on map). They also characterize the topography north of Mahone Bay.

Answers were sought to the following questions: (1) How fast are rivers pouring their sediment into coastal bays and estuaries, and how does this compare with the amount accumulated in the estuaries since the last glaciation approximately 10,000 years ago? (2) What is the distribution and composition of the different types of unconsolidated material in the bay? How does this relate to bedrock structure? How do these combined factors work together to determine the present configuration of St. Margaret's Bay? (3) What is the recent sedimentary history of the area? How has the bay evolved to its present state, particularly in the last 30,000 years?

Two seismic reflection systems were used to determine the nature of the material beneath the bay. A high-frequency (14,000 hz) echo-sounder gave high resolution of upper layers, with maximum penetration of 40 feet. A lower frequency Sparker system (300-1200 hz) was used for mapping sub-bottom reflectors (i.e. till and bedrock). Maximum penetration was 175 feet below the bottom.

Significant features of the bay can be divided into several major categories: (a) central deep basin [(1) on map]; (b) inlet areas [(2) on map]. (a) and (b) are two potential areas of sediment accumulation. (c) sill at mouth [(3) on map] with buried channel [(4) on map]; (d) shoal areas of till or reworked till in eastern and northern portions of bay plus till-covered bottom to south over sill [(5) on map]; (e) prominent ledge development at depths of 125 to 135 feet below datum; (f) bottom and sub-bottom reflectors outside the sill; (g) fault coastline [(6) on map].

The central basin is a true basin in bedrock. The highs around the basin are exaggerated by till cover; but, in general, the contiguous shape of the basin's northern, western, and southern boundaries is bedrock controlled. Its eastern boundary is uncertain; the shallows here could be mainly due to till deposits. Depth to basement within the basin is uncertain. Penetration was blocked by a conspicuous strong, flat-lying reflector which is covered by 7 to 10 feet of fine sediment in all sections of the basin. This could be a transgressive sand sheet.

The inlets, possible areas of sediment accumulation, completely lack fine-grained sediment except in protected coves. Channel and infilled channel structures are found here in till (possibly bedrock).

The sill across the mouth of the bay is a true bedrock high. Its deepest point corresponds with a partially-infilled channel which is apparently continuous from some point in the deep basin to the seaward side of the sill. This indicates that the bay is a modified river system.

The shoal areas in the northern and eastern part of the bay are till or reworked till. The aerial extensions of these underwater drumlins form the many drumlin islands (not shown on map) present in the northeastern bay section. In general, the same type of deposits are found over the sill, perhaps with a greater amount of reworking by wave action.

Ledge development at depths of 125 to 135 feet suggests a temporary stand of sea level between 8,000 and 9,000 years B.P. The ledges are characterized by strong reflectors indicative of a reworked till (gravel and sand) surface.

Bottom reflectors outside the sill are characterized by a complete absence of mud facies (weak, transparent reflectors). Reworked till appears to be much more homogeneous in comparison to that inside the bay, indicating a stronger winnowing and sorting by wave action outside the bay.

A fault coastline appears to control the western shoreline. There is a straight coastline, from the mouth of the Bay up to Mill Cove, parallel to the Deep Cove fault along the opposite side of the peninsula. Sharp gradients, both above and below the water surface, are matched by a rapid disappearance of basement below the basin sediment.

Further work to be done involves: (1) coring in deep basin to investigate possible transgressive sand sheet; (2) work with a more-powerful sparking system to penetrate to bedrock in the deep basin and along the eastern shore; (3) further investigation of fine sediment distribution to pick up possible relationship to areas of reworked till.

Glaciology of Cape Breton Island by RANDY WELLS, Acadia University, Wolfville, N.S.:

The popular concept of overriding Laurentide ice in the Maritime Provinces of Canada and the Gulf of St. Lawrence region, has been examined in terms of regional ice-flow patterns and other supporting data and is found wanting. A reinterpretation of the data, the glacial lineations, and other features presents a picture of localized, more or less, radial outflow from certain upland and lowland areas, as will be demonstrated in the history of the glaciology of Cape Breton Island.

It is therefore concluded that the Laurentide ice was not as active over the Maritime Provinces as has been generally believed and that the growth of Appalachian glaciers during the build-up of the last continental ice sheet may have effectively barred Laurentide ice from some parts of the region. The Laurentian channel served as an outlet that diverted Laurentide ice through Cabot Strait to the Atlantic Ocean. In evidence Prince Edward Island and Cape Breton Island do not show a pattern of Laurentide ice flow, and the Magdalen Islands remained unglaciated.

Reconnaissance Sampling and Geochemistry of Eastern Newfoundland Granitoid Rocks by CYRIL O'DRISCOLL, Memorial University of Newfoundland, St. John's, Nfld.:

During the summer of 1972, a geochemical study was done on the eastern Newfoundland granitoid rocks. This project was carried out as part of the federal Department of Regional Economic Expansion (DREE) program presently underway in the province. The summer's work was involved with sampling all those granitic intrusions in the Gander Lake Belt and the Avalon Platform, and one from the Central Mobile Belt.

The study was conducted by two students at Memorial University, who were hired as temporary staff of the Newfoundland Department of Mines, Agriculture and Resources. Work was done in close co-operation with industry and university.

The intrusions were sampled along roads, inland waterways, and sea coasts, and when this was insufficient, a helicopter and float plane were used. Approximately 1100 samples were collected and these are presently being analyzed for 20 elements by XRF methods.

It is hoped that this study will provide information of a regional nature which can be used to determine definite metallogenic characteristics of the area and provide a regional framework for future mineral exploration. A comparison of granites within and outside the Gander Lake Belt (which is sporadically mineralized) can be made, and elements can be defined which might be used as reliable indicators of mineralization.

Institute of Oceanography, Dalhousie University, Halifax, N.S.- A Portion of Ann. Report, 1972.

Marine Geology and Geophysics by R.D. HYNDMAN:

Heat Flow. Eighteen marine heat flow measurements have been made over the Mid-Atlantic Ridge near 45°N. The results differ markedly from theoretical cooling plate profiles, having low values near the crest and again 30-40 km away. We have ascribed the lows to convective water flow in the fractured, porous crustal rocks and to the heat absorbed in lower crustal metamorphic reactions (with D. Rankin).

Work on the radioactive heat production in the oceanic mantle has been completed (with F. Aumento).

Twenty-three heat flow measurements using the ocean probe technique have been made on two cruises in the southern British Columbia inlets. They show a pronounced zone of low heat flow inland of the coast, of the type characteristic of the landward side of sinking trenches. They thus substantiate the hypothesis that there is present (or very recent) sinking at least as far north as 51°N. The subsidence of the fjord zone may have occurred because of the thermal contraction associated with the development of the low heat flow zone.

Fifty radioactive heat generation measurements have been made in Nova Scotia granites by gamma spectrometry for association with heat flow, gravity and depth of explacement. Two new heat flows have been measured in lake bottoms using a coring device (Ph.D. student D. Rankin).

Heat flow measurements have been made in five holes to 200 m depth, and sediment physical properties have been measured, as part of Leg 26 of the Deep Sea Drilling Project, (J.O.I.D.E.S.), in the Indian Ocean. The heat flow results show that the standard ocean probe values are valid although the deep hole results have less scatter. There is some indication of a decrease in heat flow with increasing depth.

Geomagnetic Induction. A total of 22 geomagnetic variation and magnetotelluric sites have now been occupied in Atlantic Canada. The results have been analyzed through 'transfer functions' and 'transmission line analogy' numerical models. The maximum coast effect occurs near the coast rather than as expected, near the shelf edge. The result implies that there is very high electrical conductivity under the shelf, perhaps arising from salt layers and saline sediments. There appears to be a major deep conductivity contrast between the Appalachian and Canadian Shield geological provinces (Ph.D. student Norman Cochrane).

Marine Geophysics. A theory has been described for the development of subduction zones, considering the motion of lithosperhic plates relative to the underlying mantle. Western North America is an example of a continental plate overriding a subduction zone, while it is suggested that the western Pacific marginal basins are produced by the Asian and Australian plates receding from the sinking zones.

The history of opening of the Labrador and Norwegian Seas has been explained in terms of plate motions relative to a driving Iceland plume or upwelling. The ocean floor age versus depth curve of Sclater and others has been modified to account for the proximity of the plume so that the age and spreading rate of the Labrador Sea may be estimated. This method gives remarkable agreement with the history proposed from magnetic and other geophysical data by LePichon, Hyndman and Pautot.

A program of Mid-Atlantic Ridge geophysical data analysis has been completed (Ph.D. thesis, 1972, P.J. Bhattacharyya).

Publications

AUMENTO, F. and HYNDMAN, R.D., Uranium content of the oceanic upper mantle. Earth Planet. Sci. Letters. 12: 373-380 (1971).

HYNDMAN, R.D. and COCHRANE, N.A., Electrical conductivity structure by geomagnetic induction at the continental margin of Atlantic Canada. Geophys. J. 25: 425-446 (1971).

PYE, G. and HYNDMAN, R.D., Heat flow in Baffin Bay and the Labrador Sea. J. Geophys. Res. 77: 938-944 (1972).

HYNDMAN, R.D. and RANKIN, D.S., The Mid-Atlantic Ridge near 45°N. XVIII. Heat Flow Measurements. Can. J. Earth Sci. 9: 665-670 (1972).

__________, Plate motions relative to the deep mantle and the development of subduction zones. Nature. 238: 263-265 (1972).

__________, CLARKE, D.B., HUME, H., JOHNSON, J., KEEN, M.J., PARK, I. and PYE, G., Geophysical and geological studies in Baffin Bay and the Labrador Sea, in Offshore Eastern Canada, ed. P. Hood, Geol. Surv. Canada Paper (1972).

SRIVASTAVA, S., HYNDMAN, R.D. and COOCHRANE, N.A., Magnetic and telluric measurements in Atlantic Canada, in Offshore Eastern Canada, ed. P. Hood, Geol. Surv. Canada Paper (1972).

HYNDMAN, R.D., The evolution of the Labrador Sea. Can. J. Earth Sci. (1972).

Ocean tide loading

J.E. Blanchard initiated our program of measurement of tilts associated with ocean tide loading some years ago, and C. Beaumont and A. Lambert continued it, under M.J. Keen and R.D. Hyndman as supervisors. In brief we have measured the tilting of the earth caused by the loading by the ocean tides, and in particular by tides in the Bay of Fundy. We have used horizontal pendula designed by Melchior (Melchior tilt meters). We have also measured the associated change in the acceleration due to gravity with gravity meters borrowed from Earth Physics Branch and from Columbia University. We thought that, because the tilting under any given load (caused by the ocean) will depend on the earth beneath it, we could find out about the elastic properties of the earth beneath Nova Scotia. This tied directly to our other programs from Dalhousie, in explosion crustal seismology, for example, and indirectly to programs such as of time varying magnetic fields.

Beaumont and Lambert found that:

(1) The analysis of tilts and changes in gravity showed the structure beneath the Atlantic coast of Nova Scotia to be as we had predicted from a seismic experiment some years ago. That is, we confirmed by a completely different method the results of a rather crude experiment. It could not be anything like the structure that we had found beneath the Gulf of St. Lawrence, for example.

(2) That measurement of tilt and gravity provides powerful constraints on possible models of ocean tides in the Atlantic Ocean. There are many proposed models, and Beaumont and Lambert were able to show that a combination of a modified form of Dohler's map plus Zahel's theoretical map gave the best representation of the tidal load, and that loading measurements have great potential for the determination of the distribution of ocean tides.

It was at this stage that we appreciated that we could contribute to a knowledge of ocean tides, and at this stage that Garrett became interested, because of his studies on tides in the Gulf of Maine from the point of view of the viability of tidal power generation in the Bay of Fundy.

In assessing the viability of tidal power generation there, one needs to know what will be the effect on the tidal regime of the construction of dams in the upper reaches of the Bay of Fundy. It is becoming clear that no single investigation will produce an accurate assessment, but rather that the best estimate will be obtained from a number of inter-related studies. Important ingredients of these studies will be improved knowledge of the tides both within the Gulf of Maine and in the

Northwest Atlantic within a radius of a few hundred kilometres of the Gulf. The tides on the continental shelf will, hopefully be measured by Canada's shallow-water pressure gauge. To measure the tides in the Atlantic would require the deployment of several deep-water gauges, much more expensive and not readily available. It may be necessary to acquire some of them, but valuable knowledge may also be obtainable much less expensively from measurements of tilts in Nova Scotia, and New England. The work that Beaumont and Lambert have done already shows how such tilt measurements may be used to distinguish between different cotidal charts, and with additional measurements and improved knowledge of the tides on the shelf it should be possible to say a great deal more about the tides in the North Atlantic. It will be necessary to extend the measurements to include response to tidal constituents other than M_2.

We will have to make measurements subsequently in the Atlantic, on the Azores and Bermuda for example, because of (a) our interest in the whole North Atlantic, and (b) because of acquiring information on crustal structure beneath those islands, on one of which we already have drilled a 2600-foot hole into the volcanic rocks.

Our interest in earth structure beneath Nova Scotia, the Bay of Fundy and the Gulf of Maine arises because we are anxious to see if the crudely zoned crustal model of the Appalachians we proposed some years ago on the basis of seismic data, is correct, and if it really corresponds to the geological zoning proposed by Memorial University geologists. This is one of several complimentary ways to find out.

Geomagnetic Induction - R.D. HYNDMAN, Oceanography and NORMAN COCHRANE, Physics:

A total of 22 geomagnetic variation and magnetotelluric sites have now been occupied in Atlantic Canada. The results have been analyzed through "transfer functions" and "transmission line analogy" numerical models. The maximum coast effect occurs near the coast and is late Pleistocene to recent in age. A submerged tree stump was dated by radiocarbon as close to 1000 years B.P. Bottom cores were taken in the enclosed lagoon and palynological study of this material is underway. The project should be completed in 1973.

St. Margaret's Bay - M.J. KEEN, D.J.W. PIPER, and LYNN SMITH (Mount Allison University):

We began an investigation of St. Margaret's Bay in 1972 out of interest in the fate of sediment carried by rivers which drain Nova Scotia. Consequently besides beginning analysis of data on sediment load provided by the Water Resources Branch of the Department of Environment, we started a geological investigation of St. Margaret's Bay, a major inlet, formerly glaciated, of the Atlantic coast of Nova Scotia. Lynn Smith and Ruth Jackson used an MS26B echo-sounder and Alpine sparker (borrowed from Bedford Institute) from a 40-foot vessel in the summer of 1972. We worked with students from one of our undergraduate classes using a larger Edgerton sparker, and later with a magnetometer in the fall.

We have found that the Bay is genuinely silled; that is, depth to bedrock is over 100 metres beneath the deepest part of the basin, but only 80 metres approximately at the entrance to the Bay. The Bay's morphology has been extensively modified by till and by Holocene sediment. Drowned river channels lie beneath the present inlets, and the channel of the ancient River Hubbards is conspicuous. Plans include obtaining long sediment cores for biostratigraphic purposes in early 1973. It is interesting to note that there are very few (if any) complete studies of formerly glaciated inlets on Canada's east coast from 40°N to 85°N, and St. Margaret's Bay provides a very convenient place to work with undergraduates on marine problems.

Continental margin off Nova Scotia and the Grand Banks

A number of the members of the Institute (Dalhousie University) took part in the HUDSON cruise of the Atlantic Geoscience Centre, Bedford Institute, to the continental margin southeast of Sable Island, and to the Tail of the Banks in 1972. The chief scientist was Charlotte Keen and second scientist D.L. Barrett. The cruise results are still being analyzed of course, but among the more important results are the following.

(1) The magnetic anomalies of the Quiet Zone are lineated parallel to the Quiet Magnetic Zone Boundary. Basement (about 3 seconds two-way travel time below the sea floor) is also lineated, but magnetic highs and lows do not correspond to basement highs and lows in the way they would if induced magnetisation of basement were wholly responsible for the observed field. Consequently it is possible that the oceanic crust in the Quiet Zone exhibits magnetic reversals. So far no correlation with reversal schemes proposed for the Jurassic and Cretaceous has been attempted.

(2) The oceanic crust P-wave velocities increase towards the continental margin, and there is a spatial relationship between anomalously high crustal velocity and the magnetic Slope anomaly. This has not, to our knowledge, been reported before.

Inactive - Continental - margin sedimentation - D.C. EDGAR and G. HERB:

David Edgar has just started working on a reinterpretation of the sedimentation processes of the Laurentian Cone, for a Ph.D. with D.J.W. Piper. Most well studied deep sea fans have been built by beach-derived turbidity currents initiated by rip currents during storms. The Laurentian Cone probably differs in having mainly turbidity currents of slump origin. The effect of this on fan morphology and growth is being investigated.

Gregory Herb has begun work on diagenesis in Mesozoic and Tertiary clastic sediments from oil wells on the Nova Scotia continental shelf.

Physical behaviour of oil on beaches - BRUCE von BORSTEL:

Bruce von Borstel (working on an M.Sc. with David Piper) is studying the effects of sediment type, beach morphology, and sediment movement on beaches on the physical breakdown of oil polluting beaches on McNabs Island, Halifax Harbour. He has found that oil occurs both as small particles and absorbed on the surface of sand grains. Storms play a major role in redistributing oil, and this process is now being monitored in detail.

It is planned to extend this sort of work in the future to investigate oil distribution in bottom sediments of Halifax Harbour.

Beach and tidal flat studies

A little work - which will probably be expanded in the future - is being carried out on sediment movement on selected tidal flats and beaches in Nova Scotia. The particular interests are (i) the development of barrier complexes during the Holocene transgression and (ii) the role of winter ice in the development of unusual tidal flat features.

Publications

KEEN, M.J., JOHNSON, J. and PARK, I., Geophysical and geological studies in Eastern and Northern Baffin Bay and Lancaster Sound. Can. J. Earth Sci., 9, 689-708, 1972.

Modern Marine Sediments

Deep Water Silts and Clays - D.J.W. PIPER:

David Piper is working on a long term interest as to how silts and clays are distributed and deposited in deep water. Most of the terrigenous sea floor sediment of the oceans is mud; and by far the commonest sedimentary rock is shale: yet little is known about their sedimentology. The approach adopted at present is to attempt to infer depositional processes from bedding properties and regional distribution of modern and ancient deep sea muds.

Recent work has shown:

1. That in the Gulf of Alaska (Deep Sea Drilling Project material) the range in bedding properties of silt turbidities is as great as that in sand turbidities; and deposition from the head and body of a turbidity current can be distinguished.
2. Graptolitic mudstones in the Silurian result from rapid burial under the influence of currents in deep water; criteria for recognizing lower Paleozoic "pelagic" sediments can be drawn up.
3. Turbidites composed entirely of clay or silty clay are an important means of transporting fine grained sediment to the oceans.

Work planned or in progress includes:

1. Study of cores from the continental slope off Nova Scotia, in order to define depositional processes.
2. Study of selected continental slope sections on land, to recognize features intermediate scale between those found in cores, and those seen in seismic reflection profiles.
3. Study of ice-rafted sediments in the Antarctic Ocean from Leg 28 of Deep Sea Drilling Project.
4. Study of deep anaerobic shelf basins, in which there has been no bioturbation, to examine major shelf depositional properties, especially the importance of storms.
5. Work on the role of turbidity currents in transporting organic material (food) to the deep sea benthos.

Trench Sedimentation

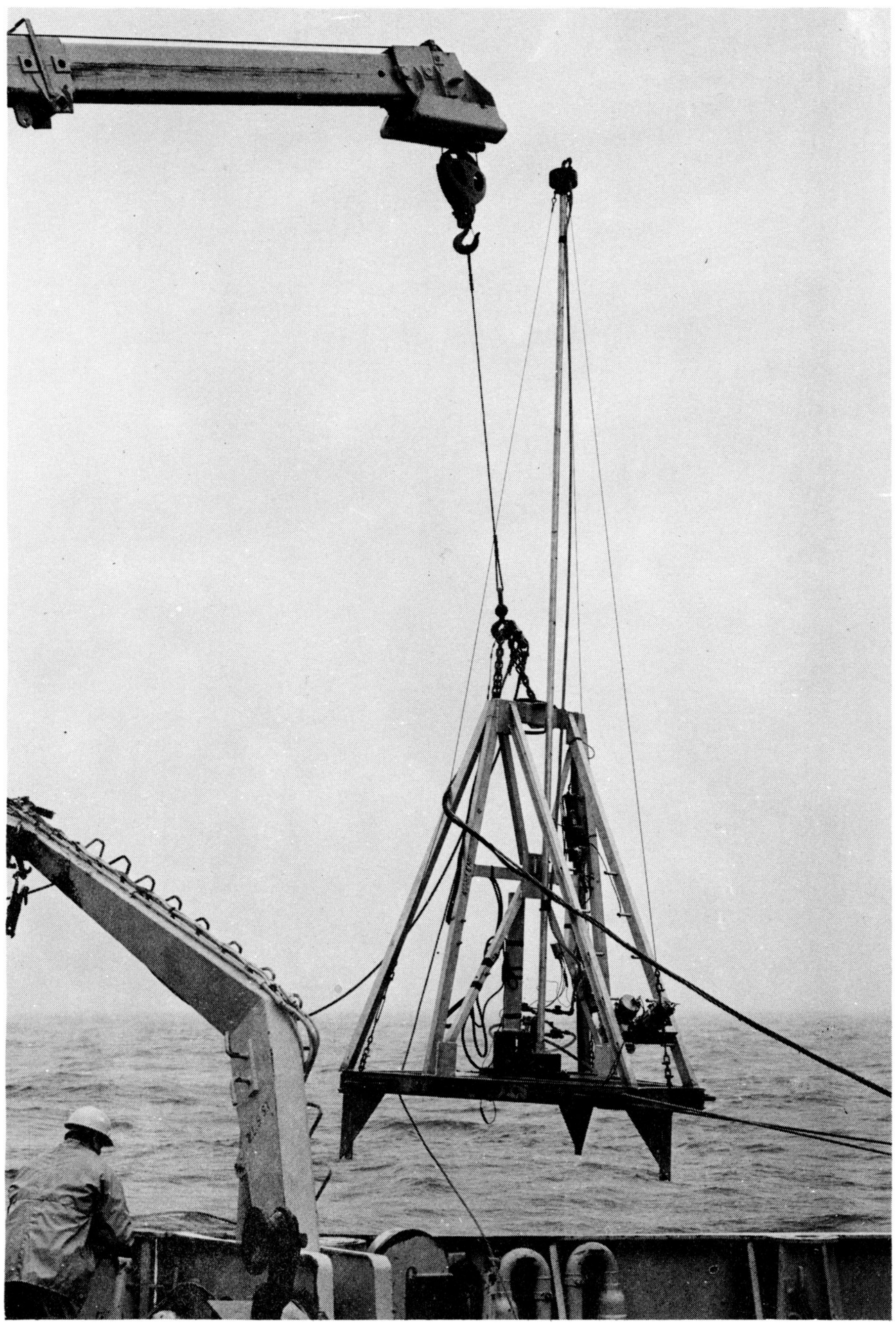
David Piper is also working on terrigenous sedimentation in ancient and modern trenches. Work is concentrated on material from Deep Sea Drilling Project Leg 18 from the Aleutian Trench. A sedimentological study has been completed; work on petrographic provenance is currently underway.

Underwater Electric Rock Core Drill by G.A. FOWLER, P.F. KINGSTON, W.C. COOKE and J. BROOKE, Atlantic Oceanographic Laboratory, Bedford Institute, Dartmouth, N.S.

A drill to recover rock from the ocean bottom has been developed and has undergone field trials during the past year. It is designed to operate in water depths to 330 m and penetrate to a depth of 6.3 m recovering a 2.54 cm diameter core.

During two cruises to the Gulf of St. Lawrence and northeast of Belle Isle the drill was operated on the bottom a total of thirty-one (31) times. These operations resulted in the recovery of approximately 17.3 m of rock from 83.7 m of penetration. The maximum water depth in these operations was 230 m.

Future work includes modifications to assure greater reliability and ease of maintenance but the basic mechanism will remain unchanged. Drilling operations will be conducted on a cruise to the southern Grand Banks and local eastern waters this coming field season.



Underwater electric rock core drill developed at the Bedford Institute of Oceanography, Dartmouth, N.S.