Frontier Geoscience Program

ANNUAL REPORT

1986-87

Energy, Mines and Resources Canada

Énergie, Mines et Ressources Canada

FRONTIER GEOSCIENCE PROGRAM
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Prepared by:
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Program Officer,
Frontier Geoscience Program.

FOREWORD

The Frontier Geoscience Program (FGP) is managed by a committee composed of senior departmental officials. This group determines and approves the general course of scientific activity in each of the tasks as well as the level of support. Members of the committee are:

Dr. W.W. Hutchison, ADM, Earth Sciences Sector (ESS),
Dr. R.A. Price, Director General, GSC,
Dr. J.G. Fyles, Deputy Director General, GSC,
Mr. G.D. Hobson, Director, Polar Continental Shelf Project.
Dr. J.E. Harrison, Senior Scientific Advisor, ESS,
Mrs J.E. McGill, Senior Scientific Co-ordinator, ESS.
Dr. D.D. Picklyk, FGP Program Officer.

In order to ensure that the best use is being made of available resources and that issues of interest to potential user are being addressed, an independent Technical Adisory Committee has also been formed. The committee has examined the program twice and produced two reports recommending a number of changes which have been implemented. The members of the committee and their affiliations are as follows:

Mr. L.P. Purcell, Husky Oil Limited (Chairman).
Mr. P.J. Savage, Pan Canadian Petroleum Limited.
Mr. T. Feuchtwanger, Gulf Canada Limited.
Professor I. Hutcheon, University of Calgary.
Professor Z. Hajnal, University of Saskatchewan.
Mr. M.G. Sheppard, Department of Mines and Energy, Newfoundland.
Mr. W.M. Young, Ministry of Mines and Petroleum Resources, B.C.
Mr. D.J. MacDonald, Department of Mines and Energy, Nova Scotia.
Mr. D.F. Sherwin, Canada-Newfoundland Offshore Petroleum Board.
Dr. G. Campbell, Canada Oil and Gas Lands Administration.
Dr. J.O. Brown, Jacques Whitford and Associates Limited.
Dr. J.P. Hea, Petroleum Resources Branch, EMR.
Dr. D.D. Picklyk, Secretary, Geological Survey of Canada.

FRONTIER GEOSCIENCE PROGRAM

BACKGROUND

Two relatively recent events have placed major demands on the Geological Survey of Canada Sector of the Department of Energy, Mines and Resources. The first is the discovery of oil and gas in the north and offshore on the east coast and their effect on evolving energy policies. The second is the extension of Canadian boundaries offshore to 200 miles, or beyond, to the edge of the continental shelf. This has resulted in an expansion of Canadian jurisdiction and commercial interest over an ocean area almost 60% of the Canadian landmass. These developments have place an unprecedented demand on the Geological Survey of Canada to provide essential background geoscience data to both industry and government. In order to satisfy the data requirments for current and anticipated exploration and development in the frontier areas, the Government approved the Frontier Geoscience Program in June of 1984 and the required resources were allocated to the Geological Survey of Canada. In general terms, the objective of the program is to ascertain the geological history and development for all frontier geological basins. This objective will be realized by:

- establishing a minimum capability to acquire, store, analyze and synthesize offshore geoscience information;
- systematically studying the sedimentary basins in frontier areas;
- developing new techniques and concepts; and
- strengthening research logistic support in environmentally hostile Arctic areas.

These general program objectives can be subdivided and restated in more specific geological terms as follows:

- to establish the deeper geological controls on the development of the sedimentary basins in frontier regions;
- to outline the internal geology and evolution of the basins;
- to elucidate the processes governing the generation, accumulation and preservation of hydrocarbons;
- to identify and analyze natural hazards and constraints to development;
- to provide the essential supporting research, development, analyses and synthesis, and;
- to supply data and support to a data base containing essential information necessary to appraise the nature and distribution of potential hydrocarbons within a basin.

The Frontier Geoscience Program was designed specifically to gather data, provide analysis, synthesize and disseminate information relating to the geology of frontier areas with special emphasis on the hydrocarbon potential of each region. For this reason, attention focuses exclusively on the sedimentary basins of each region. Results will be synthesized and compiled on a basin by basin basis resulting in packages of information on

logical geologic entities. In order to provide the information framework within which hydrocarbon exploration, exploitation, regulation and policy development can proceed, it is necessary to know the location of each of the basins as well as the general geology of their surrounding area and to have more detailed information on their shape, internal structure, origin and history of development. Information on the nature of any natural hazards or other constraints to exploration is also vital. If resources are discovered, further information required to design and operate production facilities will be essential. In addition to these basin specific studies, more generally applicable research on topics such as standardized stratigraphic sequences, origin and evolution of sedimentary rocks, geochemical change from organic matter to oil and gas and mathematical modelling will also be performed. In keeping with current government policy, involvement of non-government agencies within the private sector and universities is sought and encouraged for program delivery. The services provided range from data acquisition and interpretation to the provision of aircraft for logistic support in the Arctic.

In order to provide a framework for orderly scientific investigation and to avoid the duplication of research or the provision of service as well as to enjoy the economies of scale, the program has been subdivided into six tasks, each of which are further subdivided into components (which roughly correspond to a geologic basin) and individual projects within each component Of the six tasks, four are regional and relate to the four frontier areas of the country. These are:
The East Coast Task - which encompasses the entire east coast into Baffin Bay and includes Hudson Bay; the Arctic Islands Task - which includes the Arctic Continental Shelf; the Western Arctic Task - which encompasses the Beaufort-Mackenzie and northern mainland area and; the West Coast Task - which encompasses offshore British Columbia. The four areas are depicted on the accompanying sketch map where it will be noted that except for the Arctic Islands, the areas of interest are devoted to the offshore. The remaining two tasks are the Logistic Support Task - which provides centralized logistic service to research activities in the Arctic and; the Supporting Research and Development Task - which supports generalized research activities which are equally applicable in any of the four regional tasks, for example, geochemical studies.

The material contained within this report is updated annually and consists of a summary of results and progress for each component in each task as well as detailed reporting for each project within each component. The scientific results for the year in question are reported and the list of outputs is updated for each project. Resource utilization tables contain both the expenditure for the current year and a cumulative total for the life of the project.

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EAST COAST TASK TASK MANAGER: D.I. Ross

SCOTIAN SHELF COMPONENT Component Manager: D.I. Ross

COMPONENT SUMMARY: An extensive data base of industry seismic and well data has been acquired on the Scotian Shelf and this data is providing the primary source information for the compilation of the basin geology in the area. Interpretation of seismic data is giving us new structure and isopach maps in greater detail than available before. Well samples are being analyzed biostratigraphically to provide the detailed correlation needed to document burial histories and the paleogeographic evolution of the region. An intial contract for biostratigraphic analysis of four wells has been completed by LIB consultants as a start to compiling the palynology and micropaleontology for incorporation into the Basin Atlas. Award of further contract studies in 1987 will complete this analysis and enable the results to be integrated with lithostratigraphic and seismic data. Present lithostratigraphic studies have been using well logs and the available seismic data to extend the stratigraphy away from the Venture field across the Shelf. Vitrinite reflectance measurements on cuttings and core material from wells enables us to define the maturation profiles and to augment earlier syntheses based largely on spore colour. Information from PERD studies of the overpressures found at the Venture field are being incorporated into the synthesis. In 1983 the GSC was extensively involved in the compilation of geological data on the George's Bank as part of the preparations for the Canadian position on the boundary dispute with the United States at the International Court. This data has been further interpreted under the FGP program for incorporation into the Basin Atlas. The Boundary Dispute studies south of St.Pierre et Miquelon has provided a data base of seismic and aeromagnetic data which has been incorporated into the FGP studies on the Scotian Shelf and Grand Banks. A major emphasis has been the assessment of the hydrocarbon resources based on this new data. While the assessment and the seismic data which formed the basis for it, must remain confidential until the dispute with France is settled or at least under adjudication, the geological interpretations resulting from this work will ultimately form an important part of our under- standing of the northern extension of the Scotian Basin. Hopefully the majority of this information can be included in the Basin Atlas before publication. A new initiative for contract interpretation of the aeromagnetic data integrated with both onshore and other offshore data, has led to

a number of new interpretative products being produced and new insights into the continuity of geology between Nova Scotia and Newfoundland and the relationships between the basins, Orpheus graben, Sydney basin, Scotian basin etc. The Long Range - Cabot Fault system is the only system continuous from Newfoundland to Nova Scotia. The prominent Orpheus Fault extends towards Burin Peninsula, but is terminated before reaching Newfoundland. The newly identified Sydney Fault may represent the Humber/Gander boundary. Offshore surficial geology research and marine engineering geology are being integrated through field mapping, borehole studies, equipment development and the new engineering geology laboratory established as a special FGP thrust. Field mapping involves the use of high resolution acoustic and sidescan sonar techniques, supplemented where possible with sampling and borehole measurements. This is an area where little or no regional industry data exists, requiring the expensive acquisition of data in all regions of study. FGP resources are being used to complement and enhance the work initiated under the normal A-base programs of the Centre in this field. New technology development is important in this part of the program because cost-effective methods for regional sampling and in-situ measurements are not readily available for use on regular research vessels, particularly in the deeper waters of the continental margins. Data on the Sable Is./Banquerau Banks have been compiled under contract to produce a series of four surficial geology maps, bedform, grain size, sediment thickness and data distribution, at a scale of 1:250,000. These maps are being released through the GSC Open File system and will be incorporated into the Basin Atlas. Site specific studies in the Emerald Basin on the Scotian Shelf have begun to address research on the correlation of acoustic properties of the seabed with sediment physical properties. This research has two main foci; (1) the long term need to apply acoustic techniques for the determination of sediment physical properties ; and (2) to predict seismic reflection profiles using sample-measured properties in order to improve the resolution of geological features as determined from high resolution seismic reflection data. The Emerald Basin has been selected as the field site for the study because it provides up to 50 metres of relatively homogeneous fine-grained sediment in a setting within 100 km of Halifax and an extensive seismic reflection data set already exists for the area. Two cruises have provided an opportunity to gather large diameter piston cores on the Emerald Basin for testing acoustic compressional velocity, undrained shear strength and bulk density. Preliminary results show excellent correlation of velocity data with density. Detailed analyses, which include; - synthetic seismograms at each sample site using the measured density, velocity and acoustic source signature, - correlations between density, velocity and magnetic susceptibility, - determination of the relationship between shear strength

estimated material properties and the derived attenuation, are being carried out in cooperation with Dr. Larry Mayer at Dalhousie University.

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FGP Project Number: EC14-010 Project Officer: J.S. Bell

TITLE: Sedimentology, Geochronology and Hydrocarbon Potential of the Scotian Shelf.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	2.0	2.0	3.5
Contract	196.0	130.3	431.1
Other O&M	218.0	231.8	284.4
Capital	95.0	332.1	491.3

OBJECTIVE: To evaluate the potential of the Scotian Shelf for oil and gas generation and accumulation by conducting in-house sedimentological studies of individual formations to determine their composition, origin and depositional environment.

DESCRIPTION: Software to allow manipulation of digitized lithological data and production of facies maps, cross sections, isolith maps, fence diagrams, etc., will be developed under contract. Continued innovative development of quantitative stratigraphic methodology, utilizing in-house and contractor developed software. QUANSTRAT involves refinement of the Ranking and Scaling Project (RASC) and development of CASC (correlation and subsidence curves). BIOSTRAT development focuses on graphic correlation techniques. Both programs will result in refinement of existing zonations and correlations, materially assisting in the precise delineation of source rock and reservoir horizons, and leading to predictive models for hydrocarbon generation. Development of new, sophisticated analytical techniques and refinement of previous techniques, to identify and delineate potential hydrocarbon source units, determine organic matter content and their degree of thermal maturation, and quantify their oil and gas capability. The analytical techniques will include vitrinite reflectance, fluorescence, visual kerogen and total organic carbon, organic matter type, typing of biological markers; the latter provides information on oil to oil, and oil to source rock correlation as well as thermal maturation.

SCIENTIFIC RESULTS: Contract palynology and micropaleontology of 4 wells completed with contract report. Analysis of stress regime from well data has resulted in a consistent pattern of stress directions. Results presented as compilations for east coast in papers and conferences. Vitrinite reflectance on three wells completed and released on Open File. Rockeval analysis of samples from 2 wells completed in cooperation with ISPG. Lithostratigraphic studies initiated using well logs and seismic data to extend the stratigraphy away from the venture field for incoperation into the Scotian Shelf Basin Atlas. Contract interpretation of Laurentian Channel aeromagnetic survey and preparation of report on the geological correlations between Cape Breton and Newfoundland. Initiation of the Scotian Shelf Basin Atlas. Acquisition of X-ray Diffraction Equipment for core analysis and clay mineralogy.

OUTPUTS:

MACNAB, R., PLASSE, D., GRAVES, M., 1985. An index of commercially acquired potential field data in the East Coast offshore. Geol. Surv. Can. Curr. Res. Paper 85-1B, pp. 467-469. EARTH & OCEANS RESEARCH LTD., 1985. Index of commercially-aqcuired potential field data in the Canadian east coast offshore. Geol. Sur. Can. Open File #1158.

JACKSON. A.E., 1985. Sediment thickness map, offshore Eastern Canada. 1:2,000,000. Geol, Sur. Can. Open File #1177.

GRANT, A., MCALPINE, K., WADE, J.A., 1985. The contenetial margin of Eastern Canada - geological framework and petroleum potential. A.A.P.G. Wallace E. Pratt Memoir.

NANTAIS, P.T., 1985. A reappraisal of the regional hydrocarbon potential of the Scotian Shelf. Geol. Sur. Can. Open File #1175.

GRANT, A.C., MCALPINE, K.D., WADE, J.A., 1985. Offshore geology and petroleum of Eastern Canada. Energy Exploration and Exploitation.

CARTER, G.B., D'JORIO, N., GRADSTEIN, F.M., 1985. Geographic distribution of Cenozoic foramerifera dinoflagellates and spores in offshore wells on the Labrador and Scotian Shelves. Computers and Geoscience, Wichita, October 1985.

GRADSTEIN, F.M., WILLIAMSON, M., THOMAS, F., STAM, B., 1985. Micropaleontology of the Mesozoic-Cenozoic zonation for 52 wells: database on all sites; 23 plates with zone markers and estuarine bibliography. Paleozoic Canadiana.

NANTAIS, P.T. 1985. A re-appraisal of the regional hydrocarbon potential of the Scotian Shelf .Geol. Sur. Can. Open File #1175.

AVERY, M.P., 1985. Vitrinite reflectance (Ro) on the dispersed organics in the Mobil-Tecto-Petro-Canada Migrant N-20. Geol. Sur. Can. Open File #1172.

PODROUZEK, A.J., BELL, J.S., 1985. Stress ortientation from wellbore breakouts on the Scotian Shelf, Eastern Canada. Geol. Sur. Can. Curr Res. Paper 85-1B, pp. 59-62.
AVERY, M.P., 1985. Vitrinite refectance (Ro) of the dispersed organics in the Mobil-Texaco-Pex Olympia A-12. Geol. Sur. Can. Open File #1171.
HELLER, M., GRADSTEIN, W., GRADSTEIN, F.M., AGTERBERG, F., LEW, S., 1985. RASC. Geol. Sur. Can. Open File #1203.
ASCOLI, P., 1986. Berriasian and Valanginian foramîniferal zonation of the Atlantic margin of North America; "Benthos '86" (Third International Symposium on Benthic Foraminifera) Symosium Vol., Sept. 22-28, 1986, Natural History Museum of Geneva (GSC contribution 31086).
AVERY, M.P., 1986. Vitrinite reflectance (Ro) of dispersed organics from Shell Mic Mac H-86. Geol. Sur. Can. Open File #1436.
AVERY, M.P., 1986. Vitrinite reflectance (Ro) of dispersed organics from Shell Mobil-Tetco Eagle D-21. Geol. Sur. Can. Open File #1348.
AVERY, M.P., 1987. Vitrinite reflectance (Ro) of dispersed organics from Petro-Canada Shell Wenonah J-35. Geol. Sur. Can. Open File #1424.
AVERY, M.P., and HACQUEBARD, P.A., 1986. Recent coal petrographic and organic maturation studies at the AGC coal lab in Darthmouth. Cdn. Coal Petrographers Meeting, EMR CANMET (GSC contribution 20586).
BARR,S.M., RAESIDE, R.P., and LONCAREVIC, B.D., 1987. Geological correlations between Cape Breton Island and Newfoundland.Geol. Assoc. Can. Program with Abstracts, Saskatoon.
BARSS,M.S., LENTIN, J.K., and WILLIAMS, G.L., 1986. Alphebatic listing of dinoflagellate species. Cdn. Tech. Rpt. of Hydrography and Ocean Sciences. DILLON, W.P., MANHEIN, F.T., Jansa, L.F., PALMASON, G., TUCHOLKE, B.E., and LAND,R.S., 1986. Resource potential of the western North Atlantic Basin. Decade of North American Geology, vol. 1, The North Atlantic (GSC contribution 39686). ERVINE,W.B., and BEL, J.S., 1986. Subsurface in-situ stress magnitudes from oil well drilling records: an example from the Venture area, offshore eastern Canada.Cdn. Jour. Earth Sci. (GSC contribution 30186). HOLSNER, W.T., JANSA, L.F., PERETSMAN, G.S., and WADE, J.A., 1986.Evaporite deposits of the North Atlantic rift. Am. Assoc. Pet. Geol. Special Volume (GSC contribution 26686). JANSA, L.F., and DROMART, G., 1986. Deep water stromatolite bioherms in Late Jurassic carbonates off Nova Scotia. Research Symposium on Reefs, Banff. JANSA, L.F., and PE-PIPER, G., 1986. Occurrences anf geology of late middle Jurassic - early Cretaceous igneous rocks on the eastern North American continental shelf. Am. Assoc. Pet. Geol. Bull. (GSC contribution 31386).

JANSA, L.F., and PE-PIPER, G., 1986. Geology and geochemistry of middle Jurassic and early Cretaceous igneous rocks on the eastern North American continental shelf. AGC Open File Rpt. #1351.
LAKE, P.B., 1986. WELLSYS: a database on wells of offshore eastern Canada. BIO internal report. TAYLOR, F.J.R., SARGEANT, W.A.S., FENSOME, R.A., and WILLIAMS, G.L., 1986. Standardization of nomenclature in flagellate groups currently treated by both botanical and zoological codes. Taxon.
THOMAS, F.C., 1986. Taxonomy and stratigraphy of selected Cenozoic benthic foraminifera, Canadian Atlantic margin. Micropaleontology (GSC contribution 33786).
THOMAS, F.C., 1986. Lower Scotian Slope foraminifera - their taxonomy and occurrence. Cdn. Tech. Rpt. of Hydrorography and Ocean Sciences (GSC contribution 38286).
WADE, J.A., 1986. The stratigraphy of Georges Bank basin and relationships to the Scotian basin. DNAG Series vol. 9 (GSC contribution 29886).

FGP Project Number: EC14-060 **Project Officer: D.J.W. Piper**

TITLE: Engineering Geology- Development and Application of Capabilities in Physical Properties and Modelling and Acquisition of Surficial and Engineering Geology Information.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	3.0	3.0	4.5
Contract	160.0	302.2	477.9
Other O&M	37.0	503.7	691.0
Capital	495.0	310.8	845.0

OBJECTIVE: To provide a new capability in geotechnical engineering assessment and research in support of regional surficial (200m) geology related to constraints to offshore development. To provide baseline data and expertise on the distribution of surficial geologic materials, stratigraphic correlation, seabed features and processes in the Scotian Shelf area; to ensure a scientific understanding of site-specific constraints to development.

DESCRIPTION: Laboratory facilities for specialized marine geotechnical testing will be developed in 1985-86. New laboratory equipment will include x-ray diffraction, simple shear, triaxial testing, velocimeter, microprocessors and peripherals, consolidometer and x-radiography instrumentation. The laboratory will be used for specialized in-house testing to supplement routine geotechnical analyses. Contract development of new field sampling and in-situ measurement equipment will be initiated in 1986, as well as the purchase and/or adaptation of existing technology. Contract drilling services will be used to obtain geotechnical information beginning in 1986. Contract services will also be utilized to develop numerical modelling processes of relevance to constraints to development; for example, for slope analysis, fluid migration through surficial sediments, wave effects on pore pressure, sediment erosion and transport, seabed scouring. Research in physical properties will include static and dynamic properties controlling seabed stability, properties affecting sediment transport, gaseous sediment, diapirism, and relations between geotechnical and acoustic properties. Numerical modelling will be directed towards hazard prediction. Property determination will be related to regional geologic investigations. Stratigraphic and mapping innovations will concentrate on computer-assisted methods of updating open file maps, improvement of methods for identification of palynomorphs, improved methods of isotopic and other geochemical dating and correlation techniques, improvement of acoustic and other remote sensing methods, acceleration of regional stratigraphic mapping programs and investigation of specific hazards, and improved land-sea stratigraphic correlations.

SCIENTIFIC RESULTS: Acquisition of equipment for geotechnical laboratory and initiation of specialized physical properties analysis of offshore and borehole data. Analysis of data obtained on the joint borehole project with PetrCanada at the Cohassett site on Sable Island has been completed. Due to weather conditions at the time of drilling, the drill string was lost and samples were only obtained to 46m bsb instead of the projected 150m, limiting the value od the data obtained. The borehole log has been integrated in the interpretation. The investigation of isotopic methods of determining paleosalinity has concentrated on samples from the Labrador Sea at this time. Seven cruises to acquire surficial geological information on the east coast of Canada, including three on the Scotian Shelf and margin areas, were mobilized and successfully completed.

OUTPUTS:

AMOS, C.L., KNOLL, R., 1986. The Quaternary sediments of Banquereau, Scotian Shelf. A.A.P.G. Bulletin.

DURLING, P.W., FADER, G.B., 1986. Geological assessment of shallow faults and structural disturbances from the eastern Scotian Shelf and Laurentian Fan. Geol. Sur. Can. Open File #1371.

MEDIOLI, F.S., SCHAFER, C.T., SCOTT, D.B., 1986. Distribution of recent benthonic foraminifera near Sable Island, Nova Scotia. Cdn. Jour. Earth Sci., v. 23, pp.985-1000.

ATLANTIC GEOSCIENCE CENTRE, 1985. Preliminary 1:5 m Quaternary geology map and 1:2 m surficial features map of offshore Eastern Canada. Geol. Sur. Can. Open File #1076.

AMOS, C.L., 1986. CSS Dawson cruise 86041. AGC Internal Report.

AMOS, C.L., 1986. Quaternary deposits on Scotian Shelf observed from the submersible Pisces IV. Can. Jour. Earth Sci. (GSC contribution 45186).

AMOS, C.L., and MORAN, K., 1986. Sable Island borehole/geotechnical borhole site selection. Geol. Sur. Can. Open File #1341.

AMOS, C.L., and Taylor, B.B., 1986. Sediment stability monitoring - Cohassett site A-52. Geol. Sur. Can. Open File #1423.

DAVIDSON, S., and AMOS, C.L., 1986. A re-evaluation of Sedld and Sed2d: sediment transport models for the continental shelf. Geol. Sur. Can. Open File #1342.

SONNICHSEN, G.V., FADER, G.B.J., and MILLER, R.O., 1986. Compilation of seabed sample data from the Scotian Shelf, the western Grand Banks of Newfoundland and adjacent areas. Geol. Sur. Can. Open File #1430.

GRAND BANKS COMPONENT Component Manager D.I. Ross

COMPONENT SUMMARY: The Grand Banks of Newfoundland is a particularly appropriate region to study the deep crustal structure of the Atlantic passive margin and to attempt to define the history of evolution of the sedimentary basins along a rifted margin. It is the site of both a normal rifted and transcurrent margin. The location exhibits not only some deep sedimentary basins of significant petroleum potential, but further seaward, is characterized by a "starved" margin setting providing an opportunity to examine the nature of the ocean-continent transition without the hindrance of thick sediments. Newfoundland, and the adjacent offshore region, is also the primary location of the Lithoprobe East studies, an important component of the national Lithoprobe program sponsored by NSERC, EMR and Industry with participants from University, Government and Industry laboratories. The opportunity of integrating FGP deep crustal studies with the Lithoprobe studies to provide a complementary data set has resulted in early emphasis of the FGP deep crustal studies being concentrated on the Grand Banks margin. To date the FGP efforts have resulted in the acquisition of seven deep seismic reflection lines across the northern and eastern margins, seismic refraction measurements over the southwest margin, and aeromagnetic coverage of the Jeanne d'Arc and northeast Newfoundland basins. Because of the petroleum industry interests in the eastern and northeastern Grand Banks, this work has resulted in considerable discussion between AGC scientists and industry representatives, both in the definition of work to be undertaken and in the interpretation of results obtained. During the year a major effort has been placed on the interpretation of seismic data obtained for the Boundary Studies program in the area of the exploration moratorium south of the islands of St. Pierre and Miquelon. While of primary importance for establishing a knowledge base for Canada's position in the dispute with France, this data base is also of key importance in completing our understanding of the geology of the Grand Banks. To this end the results of this work are being integrated with interpretations of industry seismic data from other areas of the Grand Banks. Considerable support has been forthcoming from oil companies with data in the areas of interest. Shot point and velocity data has already been provided by several companies and all companies have agreed to provide basic data and expressed interest in continuing technical discussions as the Basin Atlas compilation proceeds. Contract interpretation of the high resolution aeromagnetic data obtained south of Newfoundland in 1985 has identified structural trends with possible onshore linkages and lithofacies at several crustal levels through magnetic zonation (figure 3.3). Three types of magnetic basement were recognized: deep crustal, underlying

Meguma and Avalon; younger and shallower, consisting of Late Precambrian to Devonian rocks; at least two later magnetic horizons corresponding to Triassic-Jurassic dykes and Early Cretaceous volcanics. The success of the Laurentian Channel and Orphan Basin aeromagnetic projects has led to the contracting of further aeromagnetic coverage on the Grand Banks being 9 FGP Annual Report 1986-87 planned for 1987 to complete the high resolution coverage of the Grand Banks basins. Emphasis continues to be placed on the preparation of the Basin Atlas for the Grand Banks region. To this end, contract biostratigraphic analysis of well data is well in hand and a new geophysicist has been hired to compile and interpret the large industry seismic data base available. Geochemical and maturation studies are being carried out on well data to provide information on the regional maturation variations. Included in these compilations will be the new insights obtained from the acquisition and interpretation of seismic data recently obtained by EMR across the southern St. Pierre Bank and outer Laurentian Channel. Surficial geological studies that have been carried out over a number of years across the Grand Banks will form part of the Basin Atlas compilation. A shallow (<100m) borehole program is planned as an important part of ground-truthing the surficial studies in the areas of potential development. Although initially planned for 1986, the downturn in industry activity on the Grand Banks and funding limitations, precluded the initiation of the proposed borehole program. Instead the emphasis has been on completing the mapping of the Whale Bank area and beginning the preparation of a series of surficial geology maps for the Banks. Two 1:250,000 series of maps, one for the Hibernia area and one for the Flemish Pass region have been completed under contract. Maps of bedform and surficial sediment thickness have been prepared for each area. These maps will be released through the GSC Open File system and incorporated into the Grand Banks Basin Atlas.

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FGP Project Number: EC24-020 Project Officer: J.S. Bell

TITLE: Sedimentology, Geochronolgy and Hydrocarbon Potential of the Grand Banks.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	2.0	2.0	2.5
Contract	287.0	257.6	560.2
Other O&M	203.0	87.4	152.8
Capital	66.0	23.2	112.2

OBJECTIVE: To access the hydrocarbon potential of the Grand Banks through specific expanded sedimentological studies of well data, including sandstone diagenesis and clay mineralogy, reservoir occurrence and origin, and depositional environments.

DESCRIPTION: A geopressure study of East Newfoundland Basin will be implemented in 1987 as a sequel to the Sable Island Study. An optimum biostratigraphic zonation for the Mesozoic-Cenozoic offshore of eastern Canada will be developed utilizing several groups of microfossils and existing data bases. A major phase will be the implementation of QUANTSTRAT, using the BIOSTRAT and RASC data bases. This should result in more precise correlations of source and reservoir rocks. In-house resources will be used for the generation of the analytical data relating to foraminifera, ostracods, spores, pollen and dinoflagellates. Contractual studies will be needed for analyses of the nannofossils and calcareous dinoflagellates. Existing techniques for maturation studies will be refined to provide immediate access to S1, S2, Tmax and TOC measurements. Such data will provide the necessary quantitative control for related maturation and source rock studies, including visual kerogen, fluorescence, vitrinite reflectance and biological marker analyses. The results in total should lead to more precise, predictive models for maturation and basin evaluation as the project progresses. Typing of biological markers will allow oil to oil and oil to source rock correlation. Synthesis of data will allow the reconstruction of depositional environments, the timing and mode of generation, and evaluation of level of maturation. Deep seismic reflection and aeromagnetic coverage will be obtained in 1987 to provide control for crustal studies.

SCIENTIFIC RESULTS: Preliminary studies on maturation and thermal modelling for the Jeanne d'Arc Basin carried out. Acquisition of 208 km of additional multichannel seismic data on St. Pierre Bank, processing and interpretation as part of contribution to resource assessment of moratorium area. Interpretation of seismic data acquired under Bilateral Boundary Studies program in the St. Pierre area, definition of plays and assessment of hydrocarbon potential. Contract interpretation of Laurentian Channnel aeromagnetic survey data and integration into geological description of southern Grand Banks. Purchase of additional industry seismic data for incorporation into regional synthesis of Grand Banks geology. Initiation of Grand Banks Basin Atlas.

OUTPUTS:

MACNAB, R., LONCAREVIC, B.D., COOPER, G., GIROUARD, P., SHOUZHI, F., 1985. A regional marine mulitparameter survey south of Newfoundland. Geol. Sur. Can. Curr. Res. Paper 85-1B, pp. 325-332.

MACNAB, R., PLASSE, D., GRAVES, M., 1985. An index of commercially acquired potential field data in the east coast offshore. Geol. Sur. Can. Curr. Res. Paper 85-1B, pp. 467-469.

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FGP Project Number:EC24-050 **Project Officer: D.J.W. Piper**

TITLE: Engineering Geology - Development and Application of Capabilities in Physical Properties and Modelling and Acquisition of Surficial and Engineering Geology Information.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	2.0	2.0	3.3
Contract	181.0	122.3	156.8
Other O&M	45.3	52.5	158.6
Capital	74.0	66.3	221.3

OBJECTIVE: To provide a new capability in geotechnical engineering assessment and research in support of regional surficial (200m) geology related to constraints to offshore development. To provide baseline data and expertise on the distribution of surficial geologic materials, stratigraphic correlation, seabed features and processes in the Grand Bank area; to ensure a scientific understanding of site-specific constraints to development.

DESCRIPTION: Laboratory facilities for specialized marine geotechnical testing will be developed in 1985-86. New laboratory equipment will include x-ray diffraction, simple shear, triaxial testing, velocimeter, microprocessors and peripherals, consolidometer and x-radiography instrumentation. The laboratory will be used for specialized in-house testing to

supplement routine geotechnical analyses. Contract development of new field sampling and in-situ measurement equipment will be initiated in 1986 as well as the purchase and/or adaptation of existing technology. Contract drilling services will be used to obtain geotechnical information beginning in 1986. Contract services will also be utilized to develop numerical modelling processes of relevance to constraints to development; for example for slope analysis, fluid migration through surficial sediments, wave effects on pore pressure, sediment erosion and transport, seabed scouring. Research about physical properties will be related to regional geologic investigations and include analyses of static and dynamic properties controlling seabed stability, properties affecting sediment transport, ice-seabed interaction, gaseous sediment, diapirism and relations between geotechnical and acoustic properties. Numerical modelling will be directed towards hazard prediction. Stratigraphic and mapping innovations will concentrate on computer-assisted methods of updating open file maps; improvement of methods for identification of palynomorphs; improved methods of isotopic and other geochemical dating and correlation techniques; improvement of acoustic and other remote sensing methods; acceleration of regional stratigraphic mapping programs and investigation of specific hazards; and improved land-sea stratigraphic correlations.

SCIENTIFIC RESULTS: Acquisition of equipment and development of geotechnical laboratory facilities. Successful completion of cruise on CSS Hudson to map Whale Bank area and finalization of surficail geology map sheet. Data set complete, contract preparation of map half completed. Palynological data from ODP Legs 94, 104 and 105 has been used to develop Plio-Pleistocene biostratigraphic standards for N. Atlantic with direct implications for Grand Banks studies. Results are being published in ODP reports and will be used in Basin Atlas compilations. Regional distribution of shallow Tertiary strata being investigated in conjunction with initiatives under PERD funding. Drilling of research geotechnical borehole postponed to 1987 field season because of lack of industry activity and opportunity to develop joint project with shared funding. Additional funds in 1987 should provide the opportunity to proceed with this important initiative.

OUTPUTS:

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NORTHEAST NEWFOUNDLAND COMPONENT Component Manager: D.I. Ross

COMPONENT SUMMARY: Emphasis during 1986-87 has been on the interpretation of the deep seismic lines shot in 1984 and 1985. These data cross two important tectonic features; Mesozoic-Cenozoic sedimentary basins and the rifted continent-ocean margin. The primary objective is to understand the origin and evolution of these features and to apply that understanding to thermal history models of the sediments, an important factor in source rock maturity. The results may have important consequences for continental pre-drift reconstruction as oceanic crust appears to extend farther landward in the Newfoundland Basin than some recent studies have indicated. Five petroleum companies participated as equal partners with the GSC in the acquisiton and interpretation contracts of the northeast Newfoundland Basin aeromagnetic data. Staff from the major companies have been invited to comment on the proposed continuation of this work in 1987.

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FGP Project Number: EC34-030 Project Officer: C.E. Keen

TITLE: Deep Geology and Evolution of the Rifted Continental Margins Around the Grand Banks and N.E. Newfoundland.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	3.0	3.0	9.0
Contract	280.0	276.9	3652.0
Other O&M	253.1	727.4	908.3
Capital	209.8	291.0	967.0

OBJECTIVE: To acquire and interpret deep seismic reflection and refraction data, aeromagnetic and gravity (including satellite gravity) data in order to define the deep geological controls, thermal history, seismic stratigraphy, and evolution of the rifted continental margins and sedimentary basins around the Grand Banks.

DESCRIPTION: The work will be conducted by AGC scientists, primarily in the Regional Reconnaissance Subdivision, using contract seismic operators, processing companies and aeromagnetic survey companies, to acquire data. Because of their unique expertise in Canada, University of New Brunswick personnel will be used to evaluate the use of satellite gravity data. Part of the deep seismic work will be an EMR contribution to LITHOPROBE. Some may also allow ODP site definition.

SCIENTIFIC RESULTS: Joint industry/government contract interpretation of Orphan Basin aeromagnetic survey completed. Interpretation of Laurentian Channel aeromagnetic survey completed (see EC24-020). Contract evalustion of satellite gravity data with U.N.B. completed and analysis techniques applied in trial region of north Atlantic. Seismic refraction studies across N.E. Newfoundland margin successfully completed and data obtained integrated with deep seismic reflection, industry seismic and aeromagnetic data as part of several papers on the deep crustal structure of the area. Development of computer system to process and display geophysical data and interpretative models continued to provide interactive structure modelling capability for scientists.

OUTPUTS:

Contractors reports on the seismic refraction surveys northeast of Newfoundland and across the eastern Grand Banks and margin, the use of satellite gravity data and the completion of geophysical surveys in northeast Newfoundland and the Grand Banks have been received. "Lithopobe East": Results from Marine Deep Seismic Reflection lines across the Appalachians and the Continental Margin Northeast of Newfoundland", papers presented at annual meeting of the Canadian Society of Exploration Geophysicists and Geological Association of Canada.

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MUDFORD, B.S., 1986. A quantitative analysis of lithosperic thinning by simple shear. Can. Jour. Earth Sci. (GSC contribution 26786).

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LABRADOR/BAFFIN COMPONENT

Component Manager: D.I. Ross

COMPONENT SUMMARY: The Labrador Sea Basin Atlas is scheduled to be the first in the series of East Coast Atlases to be completed, with compilation of the Atlas scheduled for finalization early in 1988. This Atlas was scheduled first because of the presently static and reasonably finite data base available and a perceived need to take advantage of the industry knowledge and information now before it is lost. The work is proceeding in cooperation with PetroCanada and other petroleum companies who have worked on the Labrador shelf. It follows two main thrusts; 1) contract analysis of biostratigraphy and lithostratigraphy of well samples and the integration of the resulting data into a series of paleo-environment maps, 2) compilation of industry seismic information and preparation of time-structure and isopach maps. Much of the regional Quaternary and surficial geology studies on the Labrador shelf were nearing completion under Abase funding prior to the initiation of the Frontier Geoscience Program. FGP funds and the schedule for completion of the Labrador Basin Atlas, has resulted in some acceleration to the preparation of the resulting maps which are being prepared at a scale of 1:1 million for publication in a Memoir of the Labrador Shelf. They will be included at a scale of 1:2 million in the Labrador Sea Basin Atlas. In 1985, the Joides Resolution drilling vessel of the Ocean Drilling Program in which Canada is a member country, drilled one hole in Baffin Bay and two in Labrador Sea. FGP studies in Baffin Bay have been limited to support of the ODP Leg 105 drilling program and some additional bedrock and surficial studies on the southeast Baffin Island shelf. The Labrador Sea Atlas will benefit substantially from the compilation and interpretation of seismic, gravity and magnetic data over the Labrador Sea which has been carried out over a number of years and formed a major part of the data base established to develop the scientific basis for the Leg 105 drilling.

FGP Annual Report 1986-87

FGP Project Number: EC44-040 Project Officer: J.S. Bell/ C.E. Keen

TITLE: Basin Evolution, Sedimentology, Geochronology and Hydrocarbon Potential.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	2.5	2.5	3.5
Contract	351.0	229.9	277.3
Other O&M	226.0	23.4	82.6
Capital	66.0	62.2	169.0

OBJECTIVE: To establish a formal stratigraphic zonation for the Cretaceous-Tertiary in Baffin Bay, through seismostratigraphic and sedimentological studies carried out to establish marker horizons from shelf to slope to deep sea and to determine their composition and depositional environment.

DESCRIPTION: Seismostratigraphic analysis of multichannel and well/core data and the sedimentological studies of specific units will be implemented in 1985-86 with hiring of a Petroleum Geophysicist, and will continue throughout the program. Biostratigraphic zonation will be based on foraminifera, spores, and dinocysts and will incorporate data from wells drilled in the last five years complimented by shallow cores obtained by BIO and NORDCO seabed drills, cores obtained through Canadian participation in the Ocean Drilling Program, and contract drilling to 500 feet in selected locations. Development of the seabed rock core drilling facility will be implemented in 1984 with sampling in Baffin Bay scheduled for 1985. Deep seismic reflection and refraction , aeromagnetic, and gravity (including satellite gravity) data will be acquired beginning in 1987, in order to define the deep geological controls, thermal histroy, seismic stratigraphy and evolution of rifted continental margins and sedimentary basins around Baffin Bay.

SCIENTIFIC RESULTS: Contract studies of biostratigraphy and lithostratigraphy completed and results integrated on a well by well basis to develop paleoenvironment maps for inclusiom in Basin Atlas. Agreement reached with PetroCanada and BP to

incorporate interpretative industry data into Atlas compilation. Contract compilation of industry seismic data and interpretative products for Basin Atlas initiated. Stress regieme studies incorporated in east coast analysis and reported in several papers. ODP Leg 105 studies largely completed for icorporation into BasinAtlas preparation. Basin Atlas specifications completed and required products and completion schedules established. Compilation initiated on schedule.

OUTPUTS:

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WOODSIDE, J.M., 1986. Notes for DNAG gravity map. DNAG volume on "Geology of the continental amrgin off eastern Canada.
WOODSIDE, J.M., McCONNELL, K., LONCAREVIC, B., RUPERT, J., SHIH, K.G., COOPER, 1986. Report on the processing of AGC marine gravity data.
WOODSIDE, J.M., 1987. Quadrennial review of AGC gravity activities. Report of Canadian National Committee for IUGG.

FGP Project Number: EC44-220 **Project Officer: D.J.W. Piper**

TITLE: Engineering Geology- Development and Application of Capabilities in Physical Properties and Modelling and Acquisition of Surficial and Engineering Geology Information.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.0	1.0	2.2
Contract	82.0	31.7	88.3
Other O&M	41.5	18.0	153.3
Capital	116.5	14.9	197.0

OBJECTIVE: To provide a new capability in geotechnical engineering assessment and research in support of regional surficial (200m) geology related to constraints to offshore development. To provide baseline data and expertise on the distribution of surficial geologic materials, stratigraphic correlation, seabed features and processes in the Labrador/Baffin Bay areas, including fjord areas, to ensure a scientific understanding of site-specific constraints to development. 1985

field studies in Baffin Bay will provide regional data directly related to ODP drilling and will be integrated with results from the ODP program.

DESCRIPTION: Laboratory facilities for specialized marine geotechnical testing will be developed in 1985-86. Contract development of new field sampling and in-situ measurement equipment will be initiated in 1986 as well as the purchase and/or adaptation of existing technology. Contract services will also be utilized to develop numerical modelling processes of relevance to constraints to development, for example for slope analysis, fluid migration through surficial sediments, wave effects on pore pressure, sediment erosion and transport, seabed scouring. Research in physical properties will be related to regional geological investigations and include static and dynamic analyses of properties controlling seabed stability, properties affecting sediment transport, gaseous sediment, diapirism, and relations between geotechnical and acoustic properties. Numerical modelling will be directed towards hazard prediction. Stratigraphic and mapping innovations will concentrate on computer-assisted methods of updating open file maps; improvement of methods for identification of palynomorphs; improved methods of isotopic and other geochemical dating and correlation techniques; improvement of acoustic and other remote sensing methods; acceleration of regional stratigraphic mapping programs and investigation of specific hazards; and improved land-sea stratigraphic correlation.

SCIENTIFIC RESULTS: Acquisition of equipment and development of geotechnical laboratory facilities. Comiplation of maps for memoir on Labrador completed. These maps will be incorporated into the Labradoe Basin Atlas in 1987. Expected date for submission of memoir for publication 1988. Participation on CHS survey on board CSS Baffin in N.E. Baffin Shelf and collection of surficial geological data for incorporation in Basin Atlas and to complement studies being undertaken under NOGAPin the adjacent Arctic Island channels. Palynological data from ODP Legs 94, 104 and 105 hsa been used to develop Plio-Pleistocene biostratigraphic standards for N. Atlantic with direct implication for Grand Banks studies. Results are being published in ODP reports and will be used in Basin Atlas compilations. Work on the improvement of foram biostratigraphy in the Cartwright saddle is in progress.

OUTPUTS:

MACLEAN, B., WILLIAMS, G.L., SANFORD, B.V., KLASSEN, R.A., BLAKENEY, C.P., JENNINGS, A., 1986. A reconnaissance of the bedrock and surficial geology of Hudson Strait: preliminary results. Geol. Sur. Can. Curr. Res. Paper 86-1B.

MACLEAN, B., WILLIAMS, G.L., JENNINGS, A., BLAKENEY, C.P., 1986. Cumberland Sound N.W.T.: Investigations of bedrock and surficial geology. Geol. Sur. Can. Curr. Res. Paper 86-1B.

ANDREWS, J.T., ASKU, A.E., KELLY, M., KLASSEN, R.A., MILLER, G.H., MODE, W.N., MUDIE, P.J., 1985. Baffin Bay, Baffin Island, and west Greenland during the last interglacial/glacial transition: land/ocean correlations. Quaternary Research.

CLARK, P.U., JOSENHANS, W.H., 1986. Late Quaternary land-sea correlations, northern Labrador and Labrador Sea. Geol. Sur. Can. Curr. Res. Paper 86-1B.

ROGERSON, R.J., JOSENHANS, W.H., BELL, T., 1985. A 3.5 kHz acoustic survey of Nachvak Fjord, northeastern Labrador. Geol. Sur. Can. Curr. Res. Paper 86-1A, pp. 221-228.

DABROS, M.J., MUDIE, P.J., 1985. An automated microscope system for image analysis in palynology and micropaleontology. Geol. Sur. Can. Curr. Res. Paper 86-1A, pp. 107-112.

FARROW, G.E., SYVITSKI, J.P.M., ATKINSON, R.J.A., MOORE, P.G., ANDREWS, J.T., 1985. Baffin Island Fjord macrobenthos: bottom communities and environmental significance. Arctic.

ATLANTIC GEOSCIENCE CENTRE, 1985. Preliminary 1:5m Quaternary geology map and 1:2m surficial features map of offshore Eastern Canada. Geol. Sur. Can. Open File #1076.

JOSENHANS, W.H., KLASSEN, R.A., ZEVENHEUZEN, J., 1985. The Quaternary geology of the Labrador Shelf. Can. Jour. Earth Sci. AKSU, A.E., MUDIE, P.J., and MACKO, S., 1986. Upper Cenozoic paleoclimatic - oceanographic hostory of N. Labrador Sea, Baffin Bay and the Arctic Ocean. Second International Congress on Paleoceanography, Session on Polar Seas Geological Record, Sept., 8-12, 1986, At Woods Hole.

JOSENHANS, H., WOODSWORTH-LYNAS, C., 1987. Enigmatic linear furrows on the seabed of the upper continental slope of the northwest Labrador Sea. Geomarine Letters (GSC contribution 52386).

JOSENHANS, H.W., 1987. Glacial and glacomarine sediments of the Labrador Shelf and Nachvack Fjord. Geol. Assoc. Can. Newfoundland Section , Spring Meeting, St. John's Nfld., March 10, 1987.

JOSENHANS, H.W., BARRIE, J.V., and KIELY, L.A., 1987.Mass wasting along the Labrador Shelf margin; Submersible observations. Geomarine Letters (GSC contribution 49986). JOSENHANS, H.W., 1987. Report on Pisces IV cruise 85-061. B.I.O. Cruise report.

MACLEAN, B., 1986. Cruise report Hudson 85-021. Internal report.

PRAEG, D.B., MACLEAN, B., PIPER, D.J.W., and SHOR, A.N., 1986. Study of iceberg scours across the southeast Baffin shelf and slope using the Sea Marc I midrange sidescan sonar. Geol. Sur. Can. Curr. Res. Paper.
PRAEG, D.B., SHOR, A.N., MACLEAN, B., and PIPER, D.J.W., 1986. Sea Marc I sidescan sonar survey line across the southeast Baffin slope, northwest Labrador Sea. Geol. Sur. Can. Open File #1254.
SILVA, A., DADEY, K., JOSENHANS, H., and LAINE,E., 1986. Geotechnical analysis of Labrador shelf sediments and the influence of ice contact processes. Geol. Sur. Can. Open File #1395.

FGP Project Number: EC44-520 **Project Officer: D.I. Ross**

TITLE: Canadian Participation in the Ocean Drilling Program.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.5	0.5	0.5
Contract			
Other O&M	900.0	900.0	1406.3
Capital			

OBJECTIVE: This project provides for part of the Canadian participation in the Ocean Drilling Program. The objectives of this participation are to obtain: Scientific and technological information , expertise and technology in frontier regions for: the oil and gas and the mineral exploration industries; the scientific communities in general; and for the definition of Canada's outer limits offshore. Technical information and advances with direct industrial application; the opportunity to test and develop new products and to identify and exploit new technological advances.

DESCRIPTION: These objectives will be attained by participation in scientific and technological studies at sea and in the laboratory, development of technology and its testing at sea, dissemination of information concerning opportunities and results to industry, government and universities, participation in international research activity.

SCIENTIFIC RESULTS: Leg 109 Mid-Atlantic Ridge/Kane Fracture Zone. Emphasis on improved knowledge of crustal accretion mechanism at an active spreading centre. Rejean Hebert (U. Laval) Canadian participant. Leg 110, Barbados North. Emphasis on geohydrological and structural styles associated with an active accretionary margin, by coring, logginf and a series of downhole experiments within the Barbados forearc. Kate Morgan (AGC) and Patrick McLellan (PetroCanada) were the Canadian participants. Leg 111, Costa Rica Rift. Emphasis was on deepening a previous deep basement hole and sampling and logging the hole to document the lithostratigraphy, alteration history and geophysical properties of the ocean crust. Hodaka Kawahata (U. of Toronto) and John Malpas (Memorial U.) were Canadian participants. Leg 112, Peru Margin.Emphasis on the tectonic history of the convergent margin and the paleoceanographic history and related diagenetic history of sediments deposited under coastal upwelling of the Peruvian continental slope. Phil Hill, Janice Masters (AGC) and Rob Landridge (Queen's U.) were Canadian participants. Leg 113, Weddell Sea. Emphasis on the development of the Antarctic water masses through the Cenozoic and to detail the onset and subsequent development of continental glaciation in Eastern Antarctica. Chris Pereira (Memorial U.) was the Canadian participant. National Ocean Drilling Program workshop in Montreal (Sept. 25-27), chaired by Felix Gradstein (AGC), resulted in a number of ideas for collaborative projects and the discussion of some 25 drilling proposals for inclusion in a volume of "Canadian Proposals for the Ocean Drilling Project". The volume, arranged in five chapters; 1. Hydrothermal and magmatic processes, 2. Downhole measurementsand drilling technology, 3. Paleoceanography and climate, 4. Tectonic margins, arcs and trenches, 5. Deep sea sedimentology and geochemistry; has been published by the Secretariat through Dalhousie University.

OUTPUTS:

BOILLOT, G., et al 1986. Resultats preliminaires de la campagne 103 du JOIDES RESOLUTION (Ocean Drilling Program) au large de la Galicia (Espagne): sedimentation et distension pendant le "rifted" d'une marge stable; hypothese d'une denugation tectonique du manteau superieur. C.R. Acad. Sc. Paris, T.301, Serie II, 1985.

SRIVASTAVA, S.P., ARTHUR, M.A., 1985. Preliminary report Leg 105 of ODP. Initial report of Leg 105.

ARTHUR, M.A., SRVIASTAVA, S.P., 1985. JOIDES RESOLUTION probes high latitude paleoceanography and tectonics of Baffin Bay - Labrador Sea. Nature.

SRIVASTAVA, S.P., ARTHUR, M.A., 1985. Drilling beyond the Arctic Circle; ODP Leg 105. Geotimes.

BOILLOT, G., et al 1985. Evolution of passive continental margin. Nature. BOILLOT, G., et al 1985. Rifting processes and possible tectonic denudation of the upper mantle on the Galacia margin (Spain): preliminary results of ODP Leg 103. Geotimes.
JANSA, L.F., 1985. Paleoceanography and the evolution of the North Atlantic Ocean basin during the Jurassic. Geol. Soc. Amer. Decade of North American Geology Series.
Williams, G.L., 1985. The Deep Sea Drilling Project - a decade of review. Can. Pet. Geol. Bull.
ARTHUR, M.A., and SRIVASTAVA, S.P., 1986. Sipboard party Leg 105 86/11 Cenozoic history of bottom-current activity and drift sedimentation in the Labrador Sea. Results of ODP Leg 105, AGU Meetimg San Fransisco.
BELL, J.S., 1986. In-situ stress magnitudes and orientations from oil well drilling and logging records and possible applications in ODP holes. ODP Logging School - Oceanographic Research Institute Tokyo, Japan, Nov., 5-6, 1986.
GRADSTEIN, F.M., and HORNE, Louisa, V.B., (eds.), 1987. Canadian proposals for the ocean drilling program. Dalhousie University Press, Halifax, N.S., pp. 296.
HILL, P.R., 1987. ODP Leg 112 - Getting well-up on upwelling. Canadian ODP Newsletter.
MUDIE, P.J., 1986. Palynology and dinoflagellate biostratigraphy of DSDP Leg 94, Sites 607 and 611, North Atlantic Ocean. Initaial Report DSDP, vo. 94, Washington (U.S. Govt. Printing Office) (GSC contribution 18186).

PALEOZOIC BASINS COMPONENT Component manager: D.I. Ross

COMPONENT SUMMARY: Because of the limited commercial interest in the Paleozoic Basins of eastern Canada at the time of the initiation of the Frontier Geoscience Program, studies in the Gulf of St. Lawrence and Hudson Bay have been conducted under a single project. Work to date in the Gulf of St. Lawrence has concentrated on two main aspects: a) the acquisition of deep seismic lines across the tectonostratigraphic units of the Canadian Appalachians and the Magdalen Basin, and b) a compilation and interpretation of industry seismic data in the region. Approximately 1100km of deep seismic data (20 second two-way travel time) was acquired under contract by GSI in 1986. The seismic lines traverse among other features, the Orpheus graben, a Mesozoic extensional feature; the Sydney and Magdalen basins, Permo-Carboniferous extensional basins; and the Anticosti basin, an Ordivician-Devonian foreland basin. The deep seismic data are being interpreted together with gravity, magnetic and industry seismic data, to focus on the relationship between deep crustal structure and the origin and evolution of these basins. As a start to the compilation and interpretation of industry seisimc information in the region, MacGregor Geosciences was contracted to review industry interpretative maps available from the COGLA files and prepare a consistent compiled map of the Windsor formation normalized to the available well information. Substantial discrepancies found in these interpretations resulted in miss-ties of up to 150 msecs which had to be levelled out in the preparation of the maps of base, top and thickness of the Windsor that were produced as part of the contract. An assessment of quality of data was carried out for data in the area of the Magdelan Basin for future use. This work will be greatly enhanced over the coming year through a joint project with SOQUIP of Quebec. While not presently a priority area for hydrocarbon exploration, the Hudson Bay area does exhibit geological similarities with the Michigan Basin and could prove to have similar hydrocarbon potential. It is also a large gap in our knowledge of the geology of Canada and as such must be considered within the framework of a program on frontier geological research. In recognition of this, and with the support of the FGP Advisory Committee, the GSC undertook a field project in Hudson Bay in 1986 to acquire regional seismic data to complement the existing industry data. Participants included representatives from, Manitoba Department of Mines and Energy, Carleton University and the University of Quebec at Montreal, along with scientists from three division in the Geological Survey and contract staff from McElhanney Services. 2500 kilometres of multichannel seismic data was obtained on two tranverses across the Bay, along with a full suite of shallow seismic and sidescan sonar data. The seismic data obtained has

greatly improved the definition of Paleozoic rock units in the Bay, particularly zones of reefal development and collapse structures due to dissolution of salt (figure 4.4). These structures appear to underlie extensive areas of the Bay and are directly analagous to the horizons that provide trapping mechnanisms for hydrocarbons in the Michigan Basin. Industry scientists have expressed particular interest in data obtained over the northern portion of the Bay and discussions for collaboration in further processing and interpretation of the data are in progress. The opportunity of having a research vessel in the area was used to acquire additional surficial geological data which will be critical in understanding the Quaternary geology of the area and the history of glacial advance and retreat. Continuing limited work is planned in this area as resource and ship opportunities permit.

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FGP Project Number: EC54-160 Project Officer: J.S. Bell

TITLE: Stuctural geology, sedimentology, basin evolution, hydrocarbon potential of Paleozoic Basins.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	3.5	3.5	4.5
Contract	1562.0	1103.3	1121.7
Other O&M	175.0	168.7	172.0
Capital	6.0	6.0	6.0

OBJECTIVE: To determine the structure and evoluntionary history of the Hudson Bay and St. Lawrence basins through integrated geological and geophysical studies.

DESCRIPTION : The Paleozoic Basins of Eastern Canada include basins in the Gulf of St. Lawrence, Ungava-Foxe and Hudson Bay regions. The regional geology and resource appraisal of theses basins have either been neglected for a decade or not seriously studied. The extensive seismic data must be appraised and integrated with well data. The study will be initiated in-house in 1985 with contract support in compilation and analysis as appropriate. Deep seismic reflection data acquisition is planned for Hudson Bay and Gulf of St.Lawrence in 1986-87 to investigate the underlying controls on the formation and evolution of the basins. The data, if acquired will contribute to the Lithoprobe studies.

SCIENTIFIC RESULTS : This project covered activities in Gulf of St. Lawrence and Hudson Bay including the acquisition and processing of deep seismic data in the Gulf of St. Lawrence. Gulf of St. Lawrence. Acquisition and processing of 1000km of deep seismic data across the tectonstratigraphic units of the Canadian Appalachians and the Magdalen Basin. Preliminary interpretation of seismic data and development of model for evolution of the basin. Contract compilation of existing industry seismic data and interpretation to develop isochron of Windsor Formation completed with recommendations for future work. Initiation of discussions with SOQUIP to establish joint project

for compilation and interpretation of data as part of preparation of Basin Atlas. Study of variation of vitrinite refectance with depth to estimate depth of overburden removed as first step in preparation of data for basin Atlas. Hudson Bay. Continued compilation of industry seismic data for bedrock mapping (Sanford). Successful completion of cruise on CSS Hudson including contract acquisition of 2500 km of high resolution multichannel seismic data on two traverses across the Bay. Initiation of contract for processing seismic data. Integration of cruise data with industry information to develop plans to follow-up bedrock sampling cruise in 1987.

OUTPUTS:

LAKE, P.B., 1986. WELLSYS: A datbase on wells of offshore eastern Canada. BIO Interal report.

MACLEAN, B., WILLIAMS, G.L., SANFORD, B.V., KLASSEN, R.A., BLAKENEY, C.P., and JINGS, A., 1986. Investigation of of the bedrock and Quaternary geology of Hudson Strait. INSTAAR 15th Arctic Workshop, Boulder, Colorado.

VONK, A.M., 1987. Vitrinite reflectance (Ro max) of coal samples Irving-Chevron-Texaco Cablehead E-95. Geol. Sur. Can. Open File #1620.

VONK, A.M., 1987. Vitrinite reflectance (Ro max) of coal samples from Soquip et al. Naufrage No. 1. Geol. Sur. Can. Open File #1619.

VONK, A.M., 1987. Vitrinite reflectance (Ro max) of coal samples from Soquip et al. Tyrone No. 1. Geol. Sur. Can. Open File #1618.

WEST COAST TASK TASK MANAGER: R.B. Campbell

TOFINO BASIN COMPONENT Component Manager: R.G. Currie

COMPONENT SUMMARY: The major data acquisition objectives for this component have been met so that most of the effort over the next two years can be devoted to interpretation and synthesis. The acquisition and compilation of potential field data, both magnetics and gravity, over the basin has been completed and these data will be interpreted. Multichannel seismic data has been acquired over the basin, largely processed and preliminary interpretations have been published. These data have been released as an open file. A modest field program is planned for FY 1987-88 to collect additional seismic profiles across the basin using in-house resources. Geological field studies of adjacent Vancouver Island will be submitted for publication during the year. The data base required to understand the distribution of surficial sediments and the modern sedimentary regime has been compiled. This data base has been supplemented by a long range sidescan sonar survey of the adjacent slope and margin. Sidescan mosaics and detailed bathymetric maps of the area have been published. A synthesis report on ther surficial geology and hazards to development is scheduled for completion in FY 1988-89. It is anticipated that a report incorporating all geoscience data and an atlas will be available in draft form by March 31, 1989.

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FGP Project Number: WC16-210 Project Officer: C.J. Yorath

TITLE: Geology and Structure of Tofino Basin.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)			
Contract	35.0	33.5	318.6
Other O&M	36.5	47.0	63.0
Capital	100.0	91.8	107.3

OBJECTIVE: To conduct stratigraphic, biostratigraphic, structural, geochemical and thermal maturation studies of the subduction complex offshore Vancouver Island.

DESCRIPTION: Potential field and seismic refraction data from related projects will be integrated with geological studies conducted on the Olympic Peninsula and Vancouver Island. Cuttings and cores from existing and new wells will be examined. Thermal and subsidence models of Tofino basin will be constructed.

SCIENTIFIC RESULTS: Offshore multichannel reflection seismic profiles were subjected to a preliminary interpretation for presentation at scientific meetings and inclusion in publications noted below. Geological surveys of adlacent Vancouver Island were completed and substantial progress was made on a GSC Bulletin. Acquisition of aeromagnetic data over the basin was completed.

OUTPUTS:

SUTHERLAND-BROWN, A., YORATH, C.J., ANDERSON, R.G., DOM, K., 1988. Geological maps of southern Vancouver Island, Lithoprobe I. Geol. Sur. Can. Open File #1272.

YORATH, C.J., CLOWES, R.M., MACDONALD, R.D., SPENCER, G., SAWYER, B.S., DAVIS, E.E., HYNDMAN, R.D., ROHR, K., SWEENET, J.F., CURRIE, R.G., HALPENNY, J.K., and SEEMAN, D.A., 1987. Marine multichannel seismic reflection, gravity and magnetic profiles, Vancouver Island Continental Margin and Juan de Fuca Ridge. Geol. Sur. Can. Open File #1661.

YORATH, C.J., BRANDON, M.T., ORCHARD, M.J., PARRISH, R.R., and SUTHERLAND-BROWN, A., 1986. Fossil ages and isotopic dates from the Paleozoic Sicker Group and associated intrusive rocks. Curr. Res. Part A, Geol. Sur. Can. Paper 86-1A, pp. 683-696.
YORATH, C.J., GREEN, A.G., CLOWES, R.M., SPENCER, C., KANASEWICH, M.T., BRANDON, M.T., and SUTHERLAND-BROWN, A., 1986. Seismic reflection imaging of the subducting Juan de Fuca plate. Nature, vol., 319, pp. 210-213.
YORATH, C.J., CLOWES, R.M., BRANDON, M.T., GREEN, A.G., SUTHERLAND-BROWN, A., KANASEWICH, E.R., and SPENCER, C., 1987. LITHOPROBE - southern Vancouver Island: Cenozoic subduction complex imaged by deep seismic reflections. CJES, vol., 24, pp. 31-51.

FGP Project Number: WC16-470 **Project Officer: B.D. Bornhold**

TITLE: Surficial Geology - geomorphology and neotectonics.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)			
Contract	41.5	126.1	126.1
Other O&M	60.0	60.0	60.0
Capital	130.0	127.8	126.1

OBJECTIVE: To carry out detailed mapping of the continental slope and shelf morphology, to study the geology, shallow structure and tectonics of the slope environment and to identify the nature and magnitude of sedimentary and tectonic processes on the slope and shelf and their potential impact on exploration and development.

DESCRIPTION: Analysis of SeaMARC 11 imagery will be carried out to identify the principal morphological elements of the slope and shelf, to interpret the nature and distribution of processes controlling the slope morphology.

SCIENTIFIC RESULTS: Compilation of long range sidescan sonar mosaics and detailed bathymetry of the basin margin was completed. A preliminary interpretation of the long range

sidescan data is in progress which indicates that the morphology is highly correlated with the relative plate motions off western Canada. Results have been presented at a number of scientific meetings.

OUTPUTS:
DAVIS, E.E., CURRIE, R.G., SAWYER, B.S., 1986. The application of swath bathymetric and acoustic image mapping to contemporary problems in maritime geoscience. Canadian Petroleum Association Colloqium IV: Land, Sea and Space - Today's survey challenge. A. Lachapelle, chairman, pp.41-68.
DAVIS, E.E., CURRIE, R.G., SAWYER, B.S., 1987. Maritime geophysical maps for western Canada. Geol. Sur. Can. preliminary maps 2-1987 to 17-1987 inclusive.

FGP Project Number: WC16-480 **Project Officer: E. Davis**

TITLE: SeaMARC II Acoustic imagery and bathymetry of the margin.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)			
Contract	220.0	215.6	215.6
Other O&M			
Capital	96.0	96.7	96.7

OBJECTIVE: To map and acoustically image the continental slope off western Canada to establish the nature and location of deformational features and their relationship to sedimentary basin formation and geological hazards.

DESCRIPTION: This will will be conducted as a joint scientific project with the Hawaii Institute of Geophysics, University of Hawaii. Field program to be completed by September 1, 1985.

SCIENTIFIC RESULTS: SeaMARC II cruise sucessfully completed. Approximately 30,000 sq km of acoustic imagery collected as well

as magnetic and gravity data along 3000 km of ship's track. Post survey processing largely completed as well as the preliminary compilation of mosaics. Data to be released in FY 86-87. Abstracts submitted for poster sessions at the Circum-Pacific Conference and the International Association of Sedimentologists Congress.

OUTPUTS:

DAVIS, E.E., CURRIE, R.G., SAWYER, B.S., 1986. The Application of Swath Bathymetric and Acoustic Image Mapping to Contemporary Problems in Maritime Geoscience. Canadian Petroleum Association Colloquium IV, (in press).

QUEEN CHARLOTTE COMPONENT

Component Manager: R.G. Currie

COMPONENT SUMMARY: The major accomplishments to date include the acquisition and compilation of aeromagnetic data over the basin, compilation of surficial data and a report on seabed hazards in Hecate Strait survey's of surficial swediments and geomorphology in Dixon Entrance, an extension of the geothermal database over the basin and continuing stratigraphic and biostratigraphic studies of the Queen Charlotte Islands. The program proposed for the next two years will complete the gravity coverage of the basin and yield interpretive reports on all potential field data over the basin. The acquisition of multichannel seismic data which will help elucidate both the deep and shallow structure of the basin particulairly as it will be conducted in conjunction with a major refraction survey. The surficial studies will be extended to provide data and synthesis reports in a consistent format for the entire basin. The expanded geothermal database will provide one of the constraints required to model the subsidence history of the basin. Substantial resources will be devoted to geological studies of the region adjacent to the basin.

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FGP Project Number: WC26-190 Project Officer: B.D. Bornhold

TITLE: Surficial Geology- Geomorphology and Neotectonics.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)			
Contract	66.0	65.4	107.3
Other O&M	0.0	22.4	22.4
Capital	100.0	81.5	134.7

OBJECTIVE: To conduct detailed surveys of sediment distribution and sedimentology and seabed morphology and its relationship to the recent tectonics of the northern Queen Charlotte Islands and Dixon Entrance; to assess the degree to which tectonic effects on surficial geology might impact on offshore development (eg. slope failures, faulting). To carry out detailed mapping of the continental slope morphology, to identify potential hazards to offshore development, to study the shallow structure and tectonics of the slope environment, and to identify the nature and magnitude of sedimentary and tectonic processes on the slope and their potential impact on exploration and development.

DESCRIPTION: Contract surveys using precision echo-sounding, sidescan sonar and grab sampling will be carried out between Langara Island and Rose Spit off northern Graham Island during three field seasons. Analysis of results will include preparation of: detailed bathymetric maps, comparison of previously aquired bathymetry with new data, maps and discussion of surficial sediment distribution, surface morphology, including bedrock outcrop and structural elements (fault, joint set and fold orientation), and identification of sedimentary effects due to faulting, seismic activity, uplift or subsidence, and an assessment of the likely impact of such effects on offshore exploration and development. Maps will be compiled at a scale of 1:25,000 with more detailed maps in areas of special interest. Initially (1986-87) studies of slope morphology will be undertaken using SeaMARC II acoustic imagery, together with shallow and intermediate penetration seismic profiling. In 1987-88 and 1988-89 detailed investigations of specific target areas will be undertaken using submersible observations, high resolution seismic, possibly deep-towed acoustic imagery, coring

and photography. Analysis of SEAMARC II records will be carried out to identify the principal morphological elements of the slope, to infer the nature and the distribution of processes controlling the slope morphology, and to identify 'type' areas for detailed investigation. These interpretations will be incorporated into an atlas of acoustic imagery for the slope areas, maps of the morphological elements, and a report describing the geomorphology of the slope. Detailed studies of 'type' areas identified above will address specific questions such as magnitude and frequency of slope failures, nature of erosion and transport of sediments in canyon systems, and characteristics of inter-canyon areas..

SCIENTIFIC RESULTS: Compilation and regional interpretation of Hecate Strait was completed.

OUTPUTS:

Offshore Surveys and Positioning Ltd., 1985. Nearshore sedimentation and recent tectonics, Virago Sound, northern Graham Island. Geological Survey of Canada Open File.

BORNHOLD, B,D., 1986. Bathymetry, surficial sediments and seabed morphology off northwestern Graham Island, Queen Charlotte Islands, B.C. Geol. Sur. Can. Open File #1280.

CONWAY, K.W., 1986. Data report on the surficial geology of Hecate Strait. Geol. Sur. Can. Open File #1349.

BARRIE, J.V., 1987. Surficial geology of Hecate Strait, Britich Columbia Continental Shelf. Geol. Sur. Can. Open File #1682.

FGP Project Number: WC26-200 **Project Officer: R.G. Currie**

TITLE: Magnetic Surveys - Data Acquisition and Interpretation.

RESOURCES ($1,000's)			
	Planned	**Actual**	**Cummulative Total**
Personnel (PY)			
Contract	250.0	242.5	523.3
Other O&M	70.0	77.3	115.0
Capital	138.0	169.2	197.5

OBJECTIVE: To compile a composite magnetic map of the Queen Charlotte Basin and adjacent areas by acquiring data where required and merging it with existing aeromagnetic and marine magnetic data sets.

DESCRIPTION: The resulting data sets will be interpreted paying particular attention to the distribution of the Oligocene volcanics. These volcanics separate Tertiary and Cretaceous sedimentary successions which may have hydrocarbon potential. This data will provide an additional constraint on the geological model of the basin.

SCIENTIFIC RESULTS: The compilation of the regional aeromagnetic data was completed and a preliminary interpretation of the data initiated.

OUTPUTS:
Aeromagnetic maps of the Queen Charlotte Islands, British Columbia: 1:25,000 scale, 7720G, 7721G, 7736G-7738G, 7752G, 7753G, 7762G, 7763G.
1:50,000 scale, 9434G-9456G, 9469G-9474G, 9478G-9482G, 9487G-9490G, 9495G-9499G, 9504G-9507G, 9512G-9516G, 9522G-9525G, 9531G-9533G.

FGP Project Number: WC26-490 Project Officer: B.E.B. Cameron

TITLE: Stratigraphy and Biostratigraphy of West Coast rocks.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)			
Contract	24.0	23.6	34.3
Other O&M	44.0	45.5	59.2
Capital	20.0	21.6	21.6

OBJECTIVE: To determine the geologic history of the area through detailed stratigraphic and biostratigraphic studies of the Mesozoic and Cenozoic rocks from available subaerial and

offshore exposures and from the subsurface. This research will lead to an understanding of the depositional environments of the rocks and consequently the identification of potential hydrocarbon source beds and reservoir intervals.

DESCRIPTION: During the summer 1988, studies of the Jurassic and Cretaceous rocks in the important northwest Graham Island will continue. The results of these studies will be incorporated in a publication of the Jurassic microfaunas of the Queen Charlotte Islands and their biostratigraphic importance. Completion of the Cretaceous studies will lead to the publication of a description of Cretaceous microfaunas of the Charlottes and their biostratigraphic importance..

SCIENTIFIC RESULTS: Illustration and description of Jurassic microfaunas is proceeding well and should be ready for submission in 1988. Laboratory and field work on the Cretaceous rocks of the Queen Charlotte Islands was continued. The southern part of the outcrop belt (Skidegate and Cumshewa Inlet areas) was completed. A preliminary report on the stratigraphic revisions of these Cretaceous rocks has been submitted. A manuscript on the Jurassic biostratigraphy of the Queen Charlotte Islands is in press, as are the other two papers dealing with stratigraphy and hydrocarbons of this area. Biostratigraphic studies were extended to the Cretaceous rocks of northwest Graham Island. Preliminary results indicate a variable paleodepth range from shallow marine to bathyal. The discovery of highly petroliferous Jurassic rocks in the CumshewaInlet have extended the known range of Jurassic hydrocarbon source beds from northern Graham Island, southeast towards Hecate Strait.

OUTPUTS:

CAMERON, B.E.B., TIPPER, H.W., 1986. Jurassic Stratigraphy of the Queen Charlotte Isalands, British Columbia. Geol. Sur. Can. Bulletin 365.

CARTER, B.S., 1985. Early and Middle Jurassic radiolarian biostratigraphy, Queen Charlotte Islands, British Columbia. Unpublished MSc. thesis, University of British Columbia, 306 p.

HAMILTON, T.S., and CAMERON, B.E.B., 1987. Hydrocarbon occurrences on the western margin of Queen Charlotte Basin. Can. Bull. Pet. Geol., (in press).

PESSAGNO, E.A., JR., bLOME, C.D., CARTER, E.S., MACLEOD, N., WHALEN, P.A., and YEE, Y, 1987. Preliminary radiolarian zonation for the Jurassic of North America.. Part II; Cuchman Foundation for Foraminiferal Research, Special Publication No. 23.

CAMERON, B.E.B., 1987. Significance of Lower Jurassic hydrocarbon source rocks in Cumshewa Inlet area, Queen Charlotte Islands, British Columbia. Curr. Res. Geol. Sur. Can. Paper 87-1A, pp. 925-928.

FGP Project Number: WC26-500 **Project Officer: T. Lewis**

TITLE: Geothermal measurements and thermal modelling of the Queen Charlotte Basin.

RESOURCES ($1,000's)			
	Planned	**Actual**	**Cummulative Total**
Personnel (PY)			
Contract			
Other O&M	20.0	21.3	33.1
Capital	20.0	19.9	19.9

OBJECTIVE: To obtain geothermal data to provide constraints to basin subsidence and thermal history modelling and to thermal maturation models, i.e. heat flow, heat production, thermal conductivity.

DESCRIPTION: Borehole measurements are to be made on an opportunity basis, and in boreholes drilled under other FGP projects. This will provide basic data for basin models and constraints to petroleum maturation. This project will be carried out using both contracts and in-house resources to conduct cruises, make measurements and preserve boreholes of opportunit.

SCIENTIFIC RESULTS: The first of three annual cruises to Queen Charlotte Sound measured the thermal gradients in soft muds at several widespread locations and left data loggers to monitor the bottom water temperatures. Thermal conductivities and heat gemeration were measured on samples from wells in Tofino and Queen Charlotte Basins. Boreholes were logged at Cinola on Graham Island.

OUTPUTS:

LEWIS, T.J., 1986. Measuring the thermal conductivity and heat generation of sedimentary units. Proc. Third Can-Am Conf. on Hydrogeology, Banff.

ARCTIC ISLANDS TASK TASK MANAGER: W.W. Nassichuk

SVERDRUP BASIN COMPONENT Component Manager: A.F. Embry

COMPONENT SUMMARY: R. Stephenson and A. Embry have modelled the subsidence history of the basin by integrating all available stratigraphic data with a theoretical model of lithospheric response to rifting and sediment loading and insulating effects. The Sverdrup Basin underwent a major phase of rifting and crustal extension in Carboniferous and early Permian followed by a long interval of thermal subsidence from early Permian to earliest Cretaceous. A second phase of rifting occurred in Early Cretaceous with thermal subsidence occurring in Late Cretaceous and early Tertiary. W. Nassichuk and G. Davies completed a synthesis of Carboniferous and Permian strata in the basin including lithostratigraohy, biostratigraphy, sedimentology, tectonics and geochemistry. This will serve as the general model for basin development during this time interval and will be modified by ongoing specific studies. A seismo-stratigraphic study of the upper Paleozoic strata of Sabine Peninsula contracted by G. Varney and Associates has recognized three main depositional sequences and the importance of syn-depositional faulting in basin development. Included, is a subsurface lithostratigraphic study which outlines the facies distribution of each sequence. Field studies by W. Nassichuk and B. Beauchamp on Ellesmere Island have revealed the presence of six distinct types of organic buildups within the Paleozoic succession. Some reefs are identical in composition, age, and form with oil and gas bearing reefs in the Urals. The litho-stratigraphic studies are being complemented by biostratigraphic studies by J. Utting (palynology), C. Henderson (conodonts) and B. Mamet (foraminifera). Field and subsurface lithostrat-igraphic and biostratigraphic studies of the Mesozoic succession have led to a major revision of stratigraphic nomenclature and the recognition of thirty depositional sequences. The distribution, thickness, age and facies composition of sequences are summarized by A. Embry in a regional synthesis. K. Osadetz and A. Embry have recognized four phases of Cretaceous volcanism in th eastern portion of the basin. The first three phases are early Cretaceous in age and coincided with rift activity in the basin. The fourth phase, of Late Cretaceous age, is restricted to the extreme northeastern portion of the basin and represents the landwardextension of Alpha Ridge. E. Johannesson (Statoil) and A. Embry examined all cores from the Lower Jurassic reservoir sandstones in western Sverdrup Basin. A variety of depositional facies from distributary channel to offshore bar were recognized and mapped. B. Ricketts has studied numerous surface sections of uppermost Cretaceous-Lower Tertiary Eureka

Sound Group which contains thick coal seams. Four formations have been recognized and formally named within the group. Biostratigraphic studies by D. McIntyre in combination with sedimentologic and petrographic studies by Ricketts have revealed that the uppermost formation, the Buchanan Lake, was deposited during an early phase of Eurekan Orogeny in middle Eocene. Detailed mapping (1:50,000) of the Eureka Sound Group on Axel Heiberg and Ellesmere Islands in combination with section measuring has allowed reliable coal resource estimates to be made. Thermal maturation studies are being carries out under the direction of F. Goodarzi and B. Norford. Ro values have been determined for 1436 samples from the Mesozoic succession in 33 wells in the western Sverdrup Basin. The data are being plotted and maturation zones have been mapped for the Middle Triassic interval. A broad area of mature source rocks is present in the western Sverdrup Basin. Throuh a contracted study by C. Henderson the thermal maturation of 12 sections of upper Paleozoic strata on the eastern and southern flanks of the basin have been determined using conodont alteration indicies. Two maturity maps were drawn and a fairway of favouable maturation was delineated along the basin margins. Detailed geochemical studies have been carried out on Middle-Upper Triassic bituminous shales. Five potential source rock intervals have been identified and their distribution mapped. Biomarker analysis by P. Brooks have shown that the Triassic shales are the source of the oil found in the Sverdrup Basin. The Visean Emma Fiord Formation on Grinnell Peninsula has been found to be an extremely rich "oil shale" of lacustrine origin. Regional compilation maps at scales of 1;1,000,000, 1:2,000,000, and 1:5,000,000have been compiled under the direction of A. Okulitch and are in the final stages of completion.

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FGP Project Number: AI15-070 Project Officer: B.S Norford

TITLE: Thermal Maturity of the Paleozoic Sedimentary Rocks.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.3	0.0	0.7
Contract	65.0	50.4	201.5
Other O&M	0.0	3.4	3.5
Capital	5.0	0.0	79.0

OBJECTIVE: Determination of organic maturity of rocks of Ordovician-Permian age in the Arctic Islands.

DESCRIPTION: The thermal maturity of the rocks will be established through the use of conodonts (colour alteration and fluorescence), palynology (TAI), scolecodonts and graptolites (Vitrinite Reflectance) and sediments (Vitrinite Reflectance). Radiogenic dating of the conodonts will be attempted. SCIENTIFIC RESULTS: Outside contract completed on thermal maturity of 12 Upper Carboniferous and Permian stratigraphic sequences in the Sverdrup Basin (based on conodont alteration indicies), providing a thermal isograd map for these rocks in the region. These data were combined with other new Upper Paleozoic data generated internally to upgrade preliminary maturity maps for the stratigraphic interval.

OUTPUTS: GOODARZI, F., HIGGINS, A.C., In Press. Optical properties of Scolecodonts and their use as indicators of thermal maturity, Marine and Petroleum Geology.

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FGP Project Number: AI15-080 Project Officer: A.V. Okulitch

TITLE: Geology of the Arctic Islands.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.2	0.0	0.1
Contract	38.1	33.1	119.9
Other O&M	3.4	2.8	2.8
Capital	0.0	0.0	18.8

OBJECTIVE: To provide regional summaries and assessments of geologic knowledge of the Arctic Islands through compilation of bedrock geology maps and cross-sections at 1:1,000,000 scale, geotectonic correlation charts and well data.

DESCRIPTION: The compilation will focus on the status of the data base for current models of basin analysis and for future problem areas, and will provide a concise summary for resource assessment. Cooperation and integration with industry and universities is intended. Compilation will take 4-5 years by contract personnel (A. Zolnai, P. Gann, J. Greggs) supervised by the project officer, who is also responsible for editing. Compilations at 1:1,000,000 will be used to produce regional maps at 1:2,000,000 and 1:5,000,000 scales for planning purposes and large scale tectonic syntheses. These maps will also be submitted for publication in the DNAG Arctic volume.

OUTPUTS:

MAYR, U., de FREITAS, T., OKULITCH, A.V., 1987. Geology, southwest Cardigan Strait (59A) and easternmost Prince Alfred Bay (59B) map-areas; Geol. Sur. Can. Open File #1431.

OKULITCH, A.V., and NAIRN, K.N., 1986. Microcomputer system for the Geologic Atlas of Canada; Abstracts and Program, CODATA, 1986, Ottawa, July.

OKULITCH, A.V., PACKARD, J.J., and ZOLANI, A.I., 1986. Evolution of the Boothia Uplift, Arctic Canada; Can. Jour. Earth Sci., v.23, pp. 350-358.

SMITH, G.P., and OKULITCH, A.V., 1987. The Inglefield Uplift: A Devonian tectonic element, Ellesmere Island; Bull. Cdn. Pet. Geol., v. 35, pp. 75-78.

ZOLANI, A.I., and OKULITCH, A.V., 1986. CAD/DBMS for the Geological Atlas of Canada; 15th Geochautauqua: Computers in the Petroleum Industry, "Integrated Approaches"; Program and Abstracts; Calgary, Canada.

FGP Project Number: AI15-120 Project Officer: J.A. Podruski

TITLE: Basin Analysis of Western Sverdrup.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.0	0.0	0.3
Contract	73.0	63.0	63.0
Other O&M	17.0	71.9	111.5
Capital	0.0	21.5	21.5

OBJECTIVE: Develop reports and hydrocarbon play maps for the Arctic Islands which define plays and play areas.

DESCRIPTION: The reports and play maps will be based on surface and subsurface geology, geophysics, geochemistry, heat flow and hydrodynamics. Establish research into specific petroleum geology problems in the region.

SCIENTIFIC RESULTS: Contract Work By R. Stewart (ex-Panactic Oils Ltd.,) is leading to high quality organic geochemical and organic petrographic studies of the Schei Point source facies of over a large area of the Western Sverdrup Basin. Although the work is painstaking, Stewart has demonstrated that careful study of drill cuttings is worthwhile in obtaining superior samples and results. Contract work by Dalhousie faculty and graduate students continues on Sverdrup Basin igneous rocks. Studies in progress include work on Permian volcanics and volcanoclastics, and alkaline volcanic rocks of northern Ellesmere Osland and associated intrusive rocks. These studies promise to contribute to significantly increased understanding of the subsidence behaviour and thermal history of the Sverdrup Basin, and the relationship of these characteristics to the origin of the Arctic Ocean Basin. A pilot project contract study has begun on present day stress distributions, obtained through examination of dipmeter logs, within the Arctic Islands.

OUTPUTS:
Brooks, P.W., Embry, A.F., Goodarzi, F., and Stewart, R., in press. Geochemical studies of the Sverdrup Basin (Arctic Islands) Part I. Organic geochemistry and biological marker geochemistry of the Shei Point Group (Triassic) and recovered oils; Cdn. Soc. Pet. Geol. Bull.

FGP Project Number: AI15-140 **Project Officer: W.W.Nassichuk**

TITLE: A Review of Upper Paleozoic Surface and Subsurface Stratigraphy and Carbonate Petrology in the Sverdrup Basin.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.1	0.0	1.0
Contract	0.0	71.7	91.4
Other O&M	240.0	142.9	152.9
Capital	9.3	11.1	112.1

OBJECTIVE: To correlate the upper Paleozoic subsurface stratigraphy on Melville Island with the stratigraphy elsewhere in the Sverdrup Basin and to establish a depositional and stratigraphic framework for the basin.

DESCRIPTION: The subsurface upper Paleozoic stratigraphy on Melville Island will be compared with better known surface stratigraphy elsewhere in the Sverdrup Basin, including northern Ellesmere and Axel Heiberg Islands. The depositional and stratigraphic framework will include a review of diagenesis and reef development critical to an assessment for petroleum potential.

SCIENTIFIC RESULTS: The oldest formation in the Sverdrup Basin, The Visean Emma Formation was described as an extremely rich "oil shale" of lacustrine origin. Two types of oil shale are contained in the formation; (a) alginite-rich oil shale in which the liptinite may be as high as 93% of the organic material, and (b) alginite-poor oil shale. Six distinct types of organic - constructed buildups or reefs are contained within upper

Paleozoic strata in the Sverdrup Basin. Each is characterized by the dominance of a specific organism and by the dominance (in most buildups) of pervasive syndepositional submarine cement. Some reefs are identical in composition, age and form to important oil and gas reservoirs in the northern Urals.
A preliminary complilation of seismic data and areview of subsurface stratigraphy in the western Sverdrup Basin is near completion. The apparent lack of a broad, shallow water Carboniferous to Permian limestone platform like that which exists in northeastern parts of the basin is both a response to the active extensional tectonics and siliciclastic input in the south. Also, the relatively narrow shelf is a factor in allowing greater infill by younger Permian sediments following the Melvillian disturbance.

OUTPUTS:

HIGGINS, A.C., NASSICHUK, W.W., 1986. Possible Carboniferous boundary stratotype sections in the Sverdrup Basin, Arctic Islands, Canada. Newsletter, Middle Pennsylvanian Working Group, International Union of Geological Sciences Subcommission on Carboniferous Stratigraphy, 4ms pages.
DAVIES, G.R., NASSICHUK,W.W., 1986. Carboniferous to Permian geology of the Sverdrup Basin, Canadian Arctic Archipelago. DNAG, Innuitian Vol., H.P. Trettin (ed), 30 ms pages,19 figs.
DAVIES, G.R., and NASSICHUK, W.W., in press. An Early Carboniferous (Visean) lacustrine shale in the Canadian Arctic Archipelago; Bull. Am. Ass. Pet. Geol., 25 MS p.
DAVIES, G.R., and NASSICHUK, W.W., 1986. Carboniferous and Permian reefs in the Canadian Arctic Archipelago; GEOS, v. 15, no. 4, Fall 1986, pp. 1-5.
DAVIES, G.R., and NASSICHUK, W.W., in press. Upper Carboniferous tubular algal bondstone reefs in the Otto Fiord Formation, Canadian Arctic Archipelago: in Memoir; Cdn. Soc. Pet. Geol., "Reef Symposium", 15 MS p.
DAVIES, G.R., NASSICHUK, W.W., and Beauchamp, B., in press. Upper Carboniferous Waulsortian reefs, Canadian Arctic Archipelago: in Memoir; Cdn. Soc. Pet. Geol., "Reef Symposium", 17 MS p.
DAVIES, G.R., RICHARDS, B.C., BEAUCHAMP, B., and NASSICHUK, W.W., in press. Carboniferous and Permian reefs in Canada and adjacent counties; in Memoir; Cdn. Soc. Pet. Geol., "Reef Symposium", 25 MS p.
GOODARZI, F., DAVIES, G.R., NASSICHUK, W.W., and SNOWDON, L.R., in press. Exsudatinite in carboniferous oil shales from Arctic Canada; Fuel.
NASSICHUK, W.W., DAVIES, G.R., and MAMET, B.L., 1986. Microcodiaceans in the Lower Carboniferous (Visean) Emma Fiord Formation, Devon Island, Arctic Canada; Geol. Sur. Can. Curr. Res. Paper 86-1B.

NASSICHUK, W.W., and HENDERSON, C.M., 1987. Lower Permian (Asselian) ammonoids and conodonts from the Belcher Channel Formation, southwestern Ellesmere Island; Geol. Sur. Can. Curr. Res. Paper 87-1B.

FGP Project Number: AI15-230 **Project Officer: A.C. Higgins**

TITLE: Paleozoic Biostratigraphy and Biofacies Studies.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.3	0.0	1.6
Contract	64.5	82.2	138.2
Other O&M	25.2	29.6	29.6
Capital	1.0	1.0	41.0

OBJECTIVE: Establishment and refinement of biostratigraphic zonations and correlations, and outlining of major biofacies in rocks of Ordovician to Permian age in the Arctic Islands.

DESCRIPTION: Biostratigraphic zonations will be defined on combined studies of microfaunas, palynomorphs, and macrofaunas; in support of ongoing exploration and regional geology program.

SCIENTIFIC RESULTS: E.W. Bamber continued preparation of a manuscript on the biostratigraphy and taxonomy of Upper Cretaceous and Permian corals of the Sverdrup Basin, with J. Federowski, University of Poznan, Poland. D.C. McGregor completed a manuscript on spore biostratigraphy of Melville Island based on internal reports and previously unpublished data. He also continued preparation of a Geological Survey of Canada Bulletin on the taxonomy of Middle and Upper Devonian spores of southwestern Melville Island. A.C. Higgins completed a report on the conodonts of the Nansen Formation, Ellesmere Island, as a contribution to a joint Paper with W.W. Nassichuk and B.L. Mamet (University of Montreal). A.E.H. Pedder continued work on manuscript concerning corals fron the Silurian of Ellesmere Island for publication in Paleontology, and a further manuscript on species of Devonian corals from the Arctic Islands. He also

continued co-operative work with Q. Goodbody on the Devonian of Victoria Island. T.T. Uyeno continued work on conodonts from the uppermost Ordovician through Middle Devonian sequences of central and southwestern Ellesmere Island. J. Utting continued to work on the taxonomy of Lower Permian palynomorphs for publication as a Geological Survey of Canada Bulletin. He visited the University of Silesia, Sosnowiecz, Poland, for two weeks to consult on a joint manuscript with M. Jachowicz and A. Jachowicz concerning the palynology of Lower Carboniferous oil shale deposits of Devon Island. En route in Copenhagen he consulted with S.Piasecki (Geological Survey of Greenland, Copenhagen) and R. Konieczny (Continental Shelf and Petroleum Research Institute, Trondheim) concerning a joint manuscript in preparation on the palynostratigraphic zonation of the Canadian Arctic Islands, Greenland, Svalbard, and the Barents Sea. As further support for operation Melville, conodont and spore assemblages are being studied from Devonian, Carboniferous and Permian rocks by T.T. Uyeno, D.C. McGregor, C. Henderson (University of Calgary), A.C. Higgins (BP Research, U.K.), and J. Utting. C. Henderson and J. Federowski (visiting scientist) spent two weeks on Devon Island collecting conodont and spore samples and specimens of corals from Carboniferous and Permian rocks; a large collection of corals was made from the type section of the Belcher Channel Formation. B.L. Mamet (University of Montreal) in association with Geological Survey of Canada funded Ph.D. students has provided biostratigraphic data concerning sedimentology and smaller foraminifera. A general tectonostratigraphic study including biostratigraphy was carried out of the Roadian (Lower Permian stage) by O. Rodkin.

OUTPUTS:

UTTING, J., 1986. (Abstract) Palynology of Carboniferous, Permian and Lower Triassic rocks of the Sverdrup Basin; Cdn. Soc. Pet. Geol. 1986 Convention, Calgary, Alberta.

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FGP Project Number: AI15-260 Project Officer: A.E. Foscolos

NOTE: THIS PROJECT WAS ORIGINALLY INITIATED AS WA15-260.

TITLE: Mass transfer of elements in clastic sequences.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.4	0.0	0.3
Contract	0.0	10.0	10.0
Other O&M	75.0	5.8	187.3
Capital	10.0	14.8	338.9

OBJECTIVE: To study mass transfer of elements from shales to sandstone in order to understand the processes of cementation in reservoir rocks and diagenesis of shales. This data will be used to establish mineralogical stability fields for common allogenic components in shales and sandstones.

DESCRIPTION: Detailed mineralogical and inorganic analysis of a shale on a metre by metre scale away from a sandstone contact as well as analysis of the adjacent sandstone will be necessary in order to carry out mass balance calculations and understand the process of mineral phase migration in clastic sequences. AA, XRF, SEM and ICP-MS analyses will be used to examine static conditions and thermodynamic and kinetic studies will be used to generate dynamic models.

SCIENTIFIC RESULTS: In 1985-86 two cores were taken in the Sverdrup Basin by Panarctic Ltd., for ISPG. These are Schei Point Group (Triassic) cores, and were taken in the East Drake L-06 and Skybattle M-11 wells. J.A. Podruski described and sampled these cores, and samples taken for organic anlysis by P.W. Brooks and inorganic analyses by A.E. Foscolos are keyed to the geological descriptions of Podruski. A.E. Foscolos retired from the Geological Survey of Canada in September, 1986. He plans to return during the summer of 1987 to complete this project. Accordingly , some 65 samples have been ground and analyzed by X-ray diffraction during 1986-87. These preparations will permit Foscolos to study various aspects of the project, summer, 1987. This includes total chemical analysis,

cation exchange capacity, and organic/inorganic carbon determinations, in addition to SEM work. Samplesfor organic geochemical study currently are awaiting processing in the extracts laboratory, a prerequisite for most organic geochemical work. Emphasis in the organic geochemical work is on the character and maturation level of organic-rich zones within the Schei Point, a prime hydrocarbon source facies. Related work includes organic geochemical study of cuttings of the Schei Point, being carried out by R. Stewart under contract, and P.W. Brooks, F. Goodarzi at ISPG, under project 840080.

OUTPUTS:
NORRIS, B., 1986. A petrographic investigation of the Eldridge Bay Mamber, (Shei Point Group), Lower-Middle Triassic of the Sverdrup Basin, Canadian Arctic Archipelago; Unpublished B.Sc., Thesis, University of Toronto, 38p.

FGP Project Number: AI15-270 Project Officer: F. Goodarzi

TITLE: Organic maturation and properties of kerogen and bitumen in clastic and carbonate sequences of the Sverdrup Basin and Franklinian Geosyncline.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	2.2	0.0	0.2
Contract	169.0	181.1	312.0
Other O&M	0.0	39.6	39.6
Capital	72.0	76.6	116.9

OBJECTIVE: To determine kerogen and bitumen types in clastic and carbonate sediments, to determine their properties (optical, chemical, trace element content). To classify the bitumen, its origin and to make a comparision of the bitumen from frontier areas to those occurringin the rest of Canada and major bitumen occurrences in the world. To determine the bitumen-hydrocarbon relationship and oil migration path.

DESCRIPTION: Contract work to miscellaneous companies and/or consultants will be awarded in order to collect and prepare

outcrop and/or well samples from the Arctic Islands sedimentary basins. Petrographic analyses will be carried out both in-house and on a contract basis through commercial laboratories and a PhD student working in-house. Geochemical analyses will be carried out in-house partially under contract with a PhD student. The petrographic, organic and inorganic results will be combined, compared and contrasted in several publicationsas well as a theis.

SCIENTIFIC RESULTS: 1650 samples were submitted to outside contractors (Geooptic Ltd., D.Pearson Associates Ltd., and D. Marchoni) for maturity studies. Results have been received and are being processed for publication. About 100 samples received from contractors were checked for accuracy of results.

OUTPUTS:

BROOKS, P.W., EMBRY, A.F., GOODARZI,F., and STEWART,R., in press. Geochemical studies of the Sverdrup Basin (Arctic Islands), Part I, Organic geochemistry and biological marker geochemistry of the Shei Point Group (Triassic) and recovered oils, Bull. Cdn. Pet. Geol.

GOODARZI, F., DAVIES, G.R., NASSICHUK, W.W., and SNOWDON, L.R., in press. Organic petrology and Rock Eval analysis of Lower Carboniferous Emma Fiord Formation in Sverdrup Basin, Canadian Arctic Archipelago; Marine and Petroleum Geology.

GOODARZI, F., DAVIES, G.R., NASSICHUK, W.W., and SNOWDON, L.R., in press. Exsudatinite in Carboniferous oil shale from Arctic Canada; Fuel.

GOODARZI, F., and STASIUK, V.D., 1987. Graptolite preparation for reflected light microscopy, a technical note; Geol. Sur. Can. Curr. Res. Paper 87-A, pp. 317-322.

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FGP Project Number: AI15-290 Project Officer: J.H. Wall

TITLE: Mesozoic and Teriary biostratigraphy and paleoecology.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.1	0.0	0.5
Contract	51.0	45.9	87.4
Other O&M	4.0	5.1	24.9
Capital	1.5	2.2	13.9

OBJECTIVE: To assess the assemblage composition, biochronological significance and paleoecology of Mesozoic and Teriary microfaunas (chiefly foraminifera), microfloras, ammonites and bivalves of the Sverdrup Basin in order to better define subsurface and outcrop stratigraphy.

DESCRIPTION: Comprehensive microfossil studies of outcrop and subsurface sections, including samples taken from the Ice Island, will be integrated with macrofaunal control data to determine what microfossils are sufficiently time sensitive for dating the Mesozoic and Tertiary successions. Compelmentary analyses of all ther above fossil groups will be applied toward interpretation of the depositional environments and thermal maturation of these beds. Principal goal is the generation of GSC and outside papers for establishing biostratigraphic schemes and correlations, and combining stratigraphy, sedimentology and biostratigraphy of the Mesozoic and Tertiaty successions.

SCIENTIFIC RESULTS: Comparison of Jurassic-Lower Cretaceous foraminiferal biostratigraphy of Siberia and Sverdrup Basin shows general similarity of microfaunas but discrepancies in age assignments of associated ammonites of the region. This has important implications for compilation of circum Arctic correlation charts. Foraminiferal assemblages clarified stratigraphic relationships in the Jurassic section on Sproule Peninsula. A marine Paleocene microfauna from Eureka Sound Group in Ellesmere Island is correlative with one from Moose Channel Formation of Mackenzie Delta. Manuscript on Jurassic rocks and fossils of Melville Island and western Sverdrup Basin was completed. Basin margin sequence is replete with hiatuses. A

continuous sequence of Toarcian-Aalenian interval contains a new ammonite fauna. The Pliensbachian is more widely developed than anticipated. Data on distribution of Canadian Jurassic macrofossils entered in a computer file by contract. Palnomorphs used to establish timing of Eurekan orogeny.

OUTPUTS:

JELETZKY, J.A., and POULTON, T.P., in press. A new genus and subgenus, and two new species of Latest Jurassic Oxytomid bivalves from Arctic Canada; Cdn. Jour. Earth Sci.

RICKETTS, B.D., and McINTYRE, D.J., 1986. The Eureka Sound Group of eastern Axel Heiberg Island, new data on the Eurekan Orogeny; Geol. Sur. Can. Curr. Res. Paper 86-1B, pp.405-410.

FGP Project Number: AI15-350 **Project Officer: A.F. Embry**

TITLE: Mesozoic basin analysis of Sverdrup Basin, Arctic Archipelago.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.4	0.0	0.4
Contract	0.0	10.0	10.0
Other O&M	0.0	0.8	69.9
Capital	0.0	0.0	0.0

OBJECTIVE: To determine regional stratigraphic relationships and envirnments of deposition for the Mesozoic history of the basin and to evaluate its petroleum potential.

DESCRIPTION: The objectives will be accomplished by studying and correlating surface and subsurface sections, integrating all biostratigraphic data, preparing cross-sections and maps (isopach, facies, structure, paleoecology), and integrating all geophysical and geochemical data. Lithostraigraphic studies will be performed in close consultation with workers in other disciplines.

SCIENTIFIC RESULTS: A comprehensive summary of the regional stratigraphy, sedimentology and tectonic history of the Mesozoic succession of the Arctic Islands, which includes 14 cross-sections, 14 isopach maps and 14 facies maps, was completed. A review of petroleum discoveries, potential, and source rocks of the Mesozoic was also prepared. A study of the stratigraphy and sedimentology of the Jurassic of the Melville Island area was completed. Four sequences were recognized in the succession and the facies distribution within each was determined and illustrated on maps and cross-sections. Four episodes of Cretaceous volcanism were recognized in the Sverdrup Basin. Isopah maps of volcanic units suggest that the volcanism was related to hot spot activity north of Ellesmere Island during the rifting and drifting phases of the Amerasian Basin. Potential petroleum source rocks were identified within five separate stratigraphic units of the Triassic Schei Point Group. The distribution and maturity of each were mapped. A series of isopach maps for the Upper Paleozoic-Mesozoic succession of the Sverdrup Basin was prepared and utilized in determining the tectonic subsidence history of the basin. The basin underwent rifting from the Carboniferous - Early Permian, thermal subsidence from Early Permian - earliest Cretaceous, renewed rifting during Early Cretaceous, and thermal subsidence in Late Cretaceous.

OUTPUTS:

EMBRY, A.F., 1986. Triassic Sea-Level Changes: Evidence from the Canadian Arctic Archipelago, in, Sea Level Changes: an Integrated Approach, SEPM Special Publication.

RICKETTS, B.D., EMBRY, A.F., 1986. Coal in the Canadian Arctic Archipelago. GEOS, Vol 15, pp. 16-18.

BROOKS,P.W., EMBRY, A.F., GOODARZI, F., and STEWART, R., in press. Geochemical studies of Sverdrup Basin (Arctic Islands) Part I. Organic geochemistry and biological marker geochemistry of the Schei Point Group (Triassic) and recovered oils; Bull. Cdn. Pet. Geol.

EMBRY, A.F., in press. Mesozoic history of the Arctic Islands; in Innuitian Orogen and Arctic Platform: Canada and Greenland; H.P. Trettin (ed.); Geological Survey of Canada, Geology of Canada No. 3.

EMBRY, A.F., 1986. Stratigraphic subdivision of the Blind Fiord and Bjorne Formations (Lower Triassic), Sverdrup Basin, Arctic Islands; Geol. Sur. Can. Curr. Res. Paper 86-1B, pp. 329-340.

EMBRY, A.F., 1986. Stratigraphic subdivision of the Awingak Formation (Upper Jurassic) and revision of the Hiccles Cove Formation (Middle Jurassic), Sverdrup Basin, Arctic Islands; Geol. Sur. Can. Curr. Res. Paper 86-1B, pp. 341-349.

EMBRY, A.F., 1986. (Abstract). Mesozoic Depositional Sequnces, Arctic Islands: Anatomy and Origin; in Abtracts with Programs, Geological Society of America, 99th Annual Meeting, p. 594.
EMBRY, A.F., 1986. (Abstract). Petroleum geology of the Schei Point and Blaa Mountain Groups (Middle-Upper Triassic), Canadian Arctic Islands; in Program and Abstracts, CSPG 1986 Convention, p. 43.
EMBRY, A.F., and Osadetz, K.G., in press. Stratigraphic and tectonic significance of Cretaceous volcanism in Queen Elizabeth Islands, Canadian Arctic Archipelago; Cdn. Jour. Earth Sci.
Stephenson, R.A., Embry, A.F., Nakiboglu, S.M., and Hastaoglu, M.A., in press. Rift-initiated Permian-Early Cretaceous subsidence of the Sverdrup Basin; in C. Beaumont and A. Tankard (eds.), Basins of Eastern Canada and Worldwide Analogues; Can. Soc. Pet. Geol. Mem. 12.

FGP Project Number: AI15-380 **Project Officer: R.A. Stephenson**

TITLE: Structural, tectonic and stratigraphic analysis of the Arctic Islands.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.1	0.0	0.1
Contract	1894.0	58.0	58.0
Other O&M	30.0	82.3	82.3
Capital	6.0	4.9	4.9

OBJECTIVE: To determine intermediate and deep structure of the Arctic Archipelago through application of reflection and refraction seismic techniques.

DESCRIPTION: Aseries of seismic lines across northern ELLesmere Island will permit extrapolation of reasonably well-known surface structures to depth along a regional cross-section. This project will provide data in an area where no company-devised data exist.

SCIENTIFIC RESULTS: Specifications for a contract for approximately 200 km of deep seismic reflecion profiling on

Melville Island were written up as part of a Request for Proposals ; changing logistical and budget conditions dictated withdrawal of the RFP. The existence, availability, quality, and scientific value of induatry-acquired seismic reflection data, for use in the intermediate to deep crustal studies, were comprehensively appraised. Some 800 km of seismic reflection data, acquired primarily by Panarctic but including some belonging to Texaco Canada, comprising a continuous profile from S.W. Dundas Peninsula to N. Sabine Peninsula on Melville Island and some complementary cross-lines, were chosen for reprocessing and reinterpretation with primary emphasis on Lower Paleozoic and deeper horizons. These data had been recorded to 8 seconds for the most part but processed to 5.5 seconds with no attempt to enhance deeper reflectors. As a pilot project, 83 line-km of Panarctic data were reprocessed and preliminary interpretation made by the University of Alberta under contract , with R.A. Stephenson as Scientific Authority. The general quality of the migrated and reprocessed sections is good, showing reflections to 8 or 10 seconds from within the middle of the crust and oermitting preliminary identification of several geological units and some tectonic features. A Second contract to University of Alberta to begin April 1, 1987 for continued reprocessing of the assembled seismic data and comprehensive geological and tectonic analysis of the intermediate and deep horizons was awarded. Planning of logistics and operations for a major gravity survey on Axel Heiberg and Ellesmere Islands including terrain modelling and detailed transects across Eurekan structures begun by J.B. Boyd and L. Losier of Geophysics Division in consultation with R.A. Stephenson. Regional modellingof the subsidence and basin fill of the Sverdrup Basin from Visean through Valanginian time was completed by R.A. Stephenson and A.F. Embry, and the results presented at the Basins of Eastern Canada and Worldwide Analogues Symposium in Halifax. The quantitative model shows that the geological development of the Sverdrup Basin during this period can be explained by the thermal evolution of the basin lithosphere system following a major Visean-Sakmarian event.

OUTPUTS:

KANASEWICH, E.R., and BERKES, Z., 1987. Reprocessing and preliminary interpretation of selected industry acquired regional seismic reflection data from Melville Island; DSS Contract 23294-6-0925/01-SG, Final Report, 15 p. plus plates, (unpublished).

Stephenson, R.A., Embry, A.F., Nakiboglu, S.M., and Hastaoglu, M.A., in press. Rift-initiated Permian-Early Cretaceous subsidence of the Sverdrup Basin; in C. Beaumont and A. Tankard (eds.), Basins of Eastern Canada and Worldwide Analogues; Can. Soc. Pet. Geol. Mem. 12.

STEPHENSON, R., NAKIBOGLU, S.M., HASTAOGLU, M.A., and EMBRY, A.F., 1986. (Abstract) Rift initiated subsidence and thermal evolution of the Sverdrup Basin; Program with Abstracts, Basins of Eastern Canada and Worldwide Analogues Symposium, Halifax, p. 110.

FGP Project Number: AI15-440 **Project Officer: B.D. Ricketts**

TITLE: Studies of coal deposits of western and northern Canada.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.7	0.0	0.4
Contract	0.0	19.0	19.0
Other O&M	30.0	0.8	10.3
Capital	6.0	14.6	14.6

OBJECTIVE: To develop a stratigraphic framework for the Eureka Sound Formation that will allow interpretation of the evolution of coal-bearing basins. To establish the timing and nature of different phases of Eureka deformation. Analysis of coals to determine rank, quality, and depths of burial of strata. Using this stratigraphic framework, establish the resource potential of the formation. Additional studies will be conducted on older coal-bearing formations in both the Sverdrup Basin and Franklinian Geosyncline, to provide basic data for Canada's National Coal Inventory.

DESCRIPTION: These studies will be accomplished by basic mapping, detailed measurement of stratigraphic sections. This will include critical biostratigraphic analyses of coal for rank and composition. All available drill hole data will be used.

SCIENTIFIC RESULTS: Compiled maps of Eureka Sound Group on a 1:50,00 scale in the Vesle-Canon Fiord-northern Fosheim Peninsula areas. Developed new insights into LateCretaceous-Tertiarybasin evolution in the Canadian Arctic, with the long standing concept of multiple basins being disputed, and more precise estimates of timing of Eurekan deformation. Palynological analysis continues

to be a critical component of the basin analysis. Regions of high coal resource potential are being identified. Analysis of coals by F. Goodarzi continues, to determine quality, rank, and composition.

OUTPUTS:

RICKETTS, B.R., , 1986. Eureka Sound Formation, Strathcona Fjord Map Sheet, Ellesmers Island. GSC Open File #1182.

RICKETTS, B.R., EMBRY, A.F., 1986. Coal in the Canadian Arctic Archipelago. GEOS.

RICKETTS,B.R., 1986. Delta evolution in the Eureka Sound Fromation, Western Axel Heiberg Island: the transition from wave-dominated to fluvial dominated deltas. GSC Bulletin, in press.

RICKETTS,B.R., 1986. New formations in the Eureka Sound Group, Canadian Arctic Islands; Geol. Sur. Can. Curr. Res. Paper 86-1B, pp. 363-374.

RICKETTS, B.R., and McIntyre, D.J., 1986. The Eureka Sound Group of eastern Axel Heiberg Island: new data on the Eurekan Orogeny; Geol. Sur. Can. Curr. Res. Paper 86-1B, pp. 405-410.

RICKETTS, B.R., 1986. (Abstract) Geology and coal resource potential of coal-bearing basins, Eureka Sound Group, Arctic Archipelago; Western Canada Coal Geoscience Forum, Calgary, Program and Abstracts, p. 57.

RICKETTS, B.R., 1987. Preliminary structural cross- sections across Fosheim Peninsula and Axel heiberg Island, Arctic Archipelago; Geol. Sur. Can. Curr. Res. Paper 87-1A, pp. 369-374.

RICKETTS, B.R., in press. Princess Margaret Arch: re-evaluation of an element of the Eurekan Orogen, Axel Heiberg Island; Cdn. Jour. Earth. Sci.

RICKETTS, B.R., in press. Reply to discussion by A.D. Miall, on the stratigraphy of the Eureka Sound Group, Canadian Arctic Archipelago; Geol. Sur. Can. Curr. Res. Paper 87-1B.

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PALEOZOIC PLATFORM-MIOGEOCLINE

PALEOZOIC PLATFORM -MIOGEOCLINE COMPONENT Component Manager: R.L.Christie

COMPONENT COMPONENT SUMMARY: Seismic and subsurface data from industry activity in th western platform region are available and have been studied both in house and through contract (Fox, Kanasewich). Basinal and carbonate build-up areas (Cambrian to Silurian) and a thick unit (Weatherall Formation) characterized by prominent clinoform structures were identified in the Melville Island region. Deep seismic interpretation suggests gentle deformation, overthrusting, decollements, and unconformities in a thick (reflections to 8 or 10 seconds) sedimentary section that probably includes Proterozoic, Cambrian, and younger beds. Crystalline (Archean) basement has been tentatively identified. Feild work (two seasons) towards a comprehensive report on Melville Island region is complete. This region was occupied by shale-dominated basins and carbonate-dominated platforms in early Paleozoic time; these features were overwhelmed by a thick clastic wedge in middle Paleozoic time, when shoreline deposits advanced generally southwestward over outer shelf deposits. Younger (late Paleozoic-Mesozoic) clastic and shale rocks occur as marginal deposits of the Sverdrup Basin and in faulr controlled marginal sub-basins. The stratigraphy and biostratigraphy of of lower Paleozoic (Goodbody), and upper Paleozoic (Riediger and Harrison), and Mesozoic (Poulton, Embry), beds have been described and understanding refined in a series of papers prepared for publication. Studies of graptolites (Lenz and Borre), conodonts (Uyeno), palynomorphs (McGregor), and bivalves (Johnston) have contributed to stratigraphic control and are also reported as separate papers, awaiting publication. A suspected younging of Devonian facies boundaries westward was confirmed and documented by palynological results. Jurassic marine reptiles collected in 1985 were described by D.A. Russell. Structural and tectonic analysis of Melville Island was carried out by Harrison under the guidance of staff at Rice University, Houston, Texas; some structural features proposed to account for surface and subsurface geometry include basal detachments in Ordovician evaporites and in Middle Devonian shales, a "triangle-zone" or underthrusting of the Canrobert Hills Fold Belt beneath a platformal homocline to the south, a detachment at 12 km. depth above which Melvillian cross-folds developed, and "inversion" of Carboniferous sub-basins due to a transpressional event coeval with the Melvillian Disturbance. One field season (of two projected) was completed on Grinnell Peninsula of Devon Island; the stratigraphic column of this structurally complex area has been re-described and the

stratigraphy refined. One field season (of four projected) has been completed in th northern orogenic belt; mapping and stratigraphic interpretation of Proterozoic to Upper Silurian rocks of northern Axel Heiberg Island were revised, and alkali basalts were identified as the oldest known (Namurian) volcanic rocks of Sverdrup Basin. Thermal maturation studies (Goodarzi) on organic matter in Devonian beds of Melville Island indicate numerous possible stages of oil generation and migration, with the material now at the mature and over-mature stages; the "mature" material is considered gas-prone, and the rocks may have been petroleum reservoirs in the past. Coaly material in rocks of the same age are of high volatile bituminous A rank in western parts of the Island, but are of lower rank and were probably less deeply buried in the east. The Arctic Islands and North Greenland volume (Geology of Canada, No., 3) of the DNAG series has nearly been completed., with 19 of 21 chapters submitted to the series editor and external referees. Systematic summaries of geophysical, stratigraphic, and structural features of the Canadian islands and North Greenland form a comprehensive geological and geophysical synthesis of the region - a first.

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FGP Project Number: AI25-110 Project Officer: R.L. Christie

TITLE: Structure and Stratigraphy of the Paleozoic-Mesozoic Basins of Melville and Adjacent Islands.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.2	0.0	1.6
Contract	0.0	12.0	23.9
Other O&M	30.0	62.3	260.0
Capital	2.0	0.5	0.5

OBJECTIVE: To obtain an improved understanding of the sedimentary and tectonic elements of the Franklinian and Sverdrup basins in the Melville-Bathurst Islands region, to better understand the source and migration mechanisms, and entrapment of hydrocarbons. To derive improved models of Franklinian and Sverdrup basin evolution in the context of circum-Arctic tectonics.

DESCRIPTION: These objectives will be achieved through airphoto and field study and from well and geophysical data.

SCIENTIFIC RESULTS: Seismic and subsurface data from industry activity were studied both in house (Densmore) and through contract (Kanasewich, University of Alberta). Basinal and carbonate build-up areas (Cambrian to Silurian) and a thick unit (Devonian Weatherall Formation) characterized by prominent clinoform structures were identified. The study by Kanasewich is reported on elsewhere under project 850040, but includes results relevant to this project as follows: (a) deep seismic interpretation suggests gentle deformation, overthrusting, decollements, and unconformities in a thick (reflections to 8 or 10 seconds) sedimentary section that probably includes Proterozoic, Cambrian, and younger beds, and (b) crystalline (Archean) basement has been tentatively identified. Stratigraphic and biostratigraphicdata have been reported in a group of papers prepared for a comprehensive volume (GSC Papers series)on Melville Island; (Geological reports, Melville Island, R.L. Christir , ed.) Structural features proposed by Harrison include:basal detachments in Ordovician evaporitesand in Middle Devonian shales; a "triangle zone" near the Canrobert Hills, and a detachment at 12 km depth above which Melvillian cross-folds

developed; and "tectonic inversion" of Carboniferous sub-basins due to a transpressional event coeval with the Melvillian disturbance. Thermal maturation studies (Goodarzi) on organic matter (fossils, coal) in Devonian rocks indicate mature and over-mature stages, with the "mature" material gas- prone. The rocks may have been petroleum reservoirs in the past. Coal ranks (high volatile bituminous A and lower) indicate deep burial from west to east on Melville Island.

OUTPUTS:

CHRISTIE, R.L., 1986. The Melville Project, 1984-85 progress report. Current Research, Part A, GCS Paper 86-1A, pp. 795-799.

HARRISON,J.C., GOODBODY, Q.H., CHRISTIE, R.L., 1985. Stratigraphic and structural studies on Melville Island, District of Franklin. Current Research, Part A, GSC Paper 85-1A, pp. 629-637.

ROBSON, M.J., 1985. Lower Paleozoic stratigraphy of northwestern Melville Island, District of Franklin. Current Research, Part B, GSC Paper 85-1B, pp. 281-284.

UTTING, J., 1985. Preliminary palynological results from the Permian and lowermost Triassic of Sabine Peninsula, Melville Island, Canadian Arctic archipelago. Current Research, Part B, GSC Paper 85-1B, pp. 231-238.

EDLUND, S.A., 1986. Vegetation-geology-climate relationships of western Melville Island; Geol. Sur. Can. Curr. Res. Paper 86-1A, pp.719-726.

GOODBODY,Q.H., 1986. Spectacular exposures of fluvial, delta plain, and shoreline to shelf edge deposits on Melville Island, Arctic Canada; GAC/MAC Program with Absracts, v.11, pp.75-76.

FGP Project Number: AI25-280 Project Officer: U. Mayr

TITLE: Investigation of stratigraphy and tectonic development of lower Paleozoic Platform-Miogeocline margin zone.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	2.8	0.0	0.1
Contract	100.0	0.0	0.0
Other O&M	83.5	33.9	44.0
Capital	40.0	34.3	34.3

OBJECTIVE: To describe and understand significant facies and thickness changes in terrigenous and carbonate formations in the lower Paleozoic platform Miogeocline margin zone. To describe and understand deformation related to intersecting Silurian and Devonian fold belts on Grinnell Peninsula. To describe and understand Tertiary transverse faults in the Mackinson Inlet region and to interpret their relationship, if any, to seafloor spreading in Baffin Bay.

DESCRIPTION: The margin zone is to be investigated on Devon Island (Grinnell Peninsula and adjacent areas). Significant facies changes and thickness increases of terrigenous and carbonate formations occur in this zone. Additionally, in the Grinnell area Silurian and Devonian fold belts intersect, while the Mackinson Inlet area contains Tertiary continental transform faults probably connected to seafloor spreading in Baffin Bay.
SCIENTIFIC RESULTS: One field season completed; northern Devon Island east of Arther Fiord was mapped and the Ordovician to Devonian stratigraphic succession was traced westward as far as the cornwallis fold belt.

OUTPUTS:
MAYR,U., de Freitas, T., and Okulitch, A.V., 1987. Geological map, 1:125,000 scale, Cardigan Strait (59A), southwestern part; Prince Alfred Bay (59B), southwestern part; Geol. Sur. Can. Open File # 1431.

FGP Project Number: AI25-460 **Project Officer:** N.J. McMillan

TITLE: Analysis of Arctic Platform rocks - Proterozoic,Cambrian, Ordovician, Silurian.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.1	1.5	1.5
Contract	50.0	34.6	34.6
Other O&M	0.0	0.0	0.0
Capital	0.0	0.0	0.0

NOTE:This project terminated March 31, 1986.

OBJECTIVE: To determine the distribution of organic matter in Proterozoic and lower Paleozoic rocks of the Arctic Platform. To assess these rocks as sources for hydrocarbons and to provide input into heat regime modelling.

DESCRIPTION: This work will be done in liason with contractors and Canadian Universities. Subsidence models will be made to understand hydrodynamics, heat regimes and maturation.

SCIENTIFIC RESULTS: Resposibilities for this project were transferred to Project # AI15-120 in fiscal 1986-87.

OUTPUTS:
MACAULEY, G., 1985. Geochemistry of the Ordovician Boas oil shale, Southampton Island, N.W.T. Geol. Sur. Can. Open File #1285.

FGP Project Number: AI25-560 Project Officer:J.C. Harrison

TITLE: Structure and tectonics of Prince Patrick and adjacent islands.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.0	0.0	0.0
Contract	41.3	41.3	41.3
Other O&M	44.0	8.2	8.2
Capital	0.0	0.0	0.0

OBJECTIVE: (1) Productions of 1:250,000 scale geological maps, (2) structural and tectonic analysis, (3) assessment of hydrocarbon and mineral resource potential.

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DESCRIPTION: Field: Helicopter supported geological mapping. Extensive use of air photo interpretation . Field comparison with northern Alaska in cooperation with Rice University staff. Field comparisons with WrangeL Island through Canada/Russia exchange. Office: Preparation of maps and construction of balanced cross-sections incorporating exploration well and seismic data. Preparation of report(s) on structural and tectonic analysis.

SCIENTIFIC RESULTS: Harrison has carried out preliminary literature research in preparation for the first field season in 1987. Through participation in a Canada/Russia exchange Harrison carried out field work on Wrangel Island (with Cecile and Russian hosts) enabling direct comparison with Arctic Island geology. A paper on Devonian to Permian tectonics of Melville Island was presented at the Canadian Society of Petroleum Geologists annual convention, Calgary. A geophysical and geological study of Upper Paleozoic strata on Melville Island was carried out by G.R. Varney and associates under contract. A number of isopach and structure-contour maps of key units have been compiled from seismic data acquired from Panarctic Oils Ltd. The contract is scheduled for completion at the end of May, 1987.

OUTPUTS:

CECILE, M.P., and HARRISON, J.C., 1986. A visit to the Soviet Arctic; Episodes. vol. 9, no. 4, pp. 240-241.

HARRISON, J.C., OLDOW, J.S., and AVE'LALLEMONT, H.E., 1986. Devonian to Permian tevtonics on th esouthern margin of the Sverdrup Basin, Melville Island, Canadian Rctic Islands, (abstract and oral presentation); Canadian Society of Petroleum Geologists Annual Convention, Calgary.

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FGP Project Number: AI25-570 Project Officer: H.P. Trettin

TITLE: Stratigraphic - structural analysis of Proterozoic to Devonian rocks, northern Ellesmere and Axel Heiberg Islands.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.4	0.0	0.0
Contract	0.0	0.0	0.0
Other O&M	22.0	10.8	10.8
Capital	0.0	0.0	0.0

OBJECTIVE: To improve our knowledge of the geological history and economic mineral potential of the region.

DESCRIPTION: Field: Four seasons of detailed field work (mapping at 1:100,000 or more detailed, stratigraphy, sampling) specific years for given years determined by availability of helicopter support from PCSP and other GSC operations. Laboratory:Optical petrography, X-ray diffraction, SEM and probe work at Calgary; chemical analysesand isotopic age determinations from Ottawa laboratories. Office: Compilation of GSC reports and maps (Bulletins, Papers) and outside papers.

SCIENTIFIC RESULTS: One season of field work was completed. Proterozoic to Upper Silurian stratigraphy of northern Axel Heiberg were revised (Trettin 1987 B); the oldest known volcanic rocks (alkalai basalt, Namurian) of the Sverdrup Basin were discovered; and pre-Carboniferous rocks of northern Axel Heiberg Island were remapped. Nineteen out of 21 chapters of the volume "Innuitian Orogen and Arctic Platform: Canada and Greenland" (Geology of Canada No. 3) were submitted to the series editors and two external referees. Prepared by some thirty Canadian and European authors, this is the first comprehensive geological and geophysical synthesis that includes both the Canadian Arctic Islands and North Greenland. A unified and partly revised tevtonic framework is based on systematic summaries of the geophysical characteristics and stratigraphic and structural record of the region. The account is rounded off by chapters of exploration, landscapes and resources (petroleum, coal, metals).

OUTPUTS:

TRETTIN, H.P., 1987a. Pearya: A composite terrane with Caledonian affinities in northern Ellesmere Island; Can. Jour. Earth Sci.,v. 24, pp. 224-245.

TRETTIN, H.P., 1987b. Investigation of Paleozoic geology, northern Axel Heiberg and northwestern Ellesmere Islands; Geol. Sur. Can, Curr. Res. Paper 87-1A, pp. 357-367.

TRETTIN, H.P., and PARRISH, R., 1987. Late Cretaceous bimodal magmatism, northern Ellesmere Island: isotopic age and origin; Can. Jour. Earth Sci.,v. 24, pp. 257-265.

TRETTIN, H.P., PARRISH, R., and LOVERIDGE, W.D., 1987. U-Pb age determinations on Proterozoic to Devonian rocks from northern Ellesmere Island, Arctic Canada; Can. Jour. Earth Sci., v. 24, pp. 246-256.

FGP Project Number: AI25-580 **Project Officer: R. Thorsteinsson**

TITLE: Baumann Fiord (49C0, Vendom Fiord (49D) and Strathcona Fiord (49E).

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.0	0.0	0.0
Contract	0.0	0.0	0.0
Other O&M	0.0	0.0	0.0
Capital	0.0	0.0	0.0

OBJECTIVE: To produce 1:250,000 geological maps and geological reports on the above map areas; and to conduct a detailed stratigraphic and sedimentological study of the Upper Ordovician to Lower Devonian transition from shelf type carbonates to deep-water basinal clastic sediments. Prior to field investigations: Production of geological maps , as working hypotheses, based on the interpretation of aerial photographs and all published and unpublished information on these areas.

DESCRIPTION: Field investigations: Traversing in helicopter in order to accately determine and map formational contacts and structural features; study the lithological characteristics of the various formations; collect lithological samples anf fossil

faunas; and establish small subsidiary field camps from which a Ph.D. candidate and his assitant will conduct detailed geological studies. After completion of field investigations: Process and study of field data and collections in order to produce final geological maps and report.

SCIENTIFIC RESULTS: Research of existing literature and interpretation of air photographs.

CONTINENTAL SHELF COMPONENT Component Manager: A.F. Embry

COMPONENT SUMMARY: Planning for the seismic refraction program began in 1984 under the direction of D. Forsyth and R. Jackson. The refraction program was carried out in April and early May of 1985 in the region north of Nansen Sound and Axel Heiberg Island. The survey consisted of a 180 km reversed line along the outer shelf, a 60 km line along the inner shelf, and a 60 km line perpendicular to the margin which linked the two margin-parallel lines. The obtained data have been resduced and preliminary crustal models formulated. High velocity basement rocks (Lower Paleozoic, Precambrian) are covered by a thin veneer of Tertiary to Quaternary strata on the inner shelf. On th outer shelf the crust is only 22-25 km thick and the basement rocks are overlain by a thick sedimentary package which is divided into two successions. The lower interval, which has velocities of 3.5 to 4.5 km/sec, is up to 5 km thick. The strata appear to be moderately deformed and are interpreted to be Cretaceous and Paleogene clastics and volcanics. This interval is overlain by an undeformed low velocity (2.2 km/sec) wedge of sediments which is up to 2 km thick. These strata are most likely of Neogene age. In April 1986, a second refraction program was shot north of Axel Heiberg Island and Sverdrup Channel. The following reversed lines were recorded: a 120 km line along the continental slope, a 180 km line along the inner shelf which extended the 1985 line southwestward to Meighen Island area, a 120 km line which linked the slope line with the inner shelf line and a 60 km line which linked the slope line with the 1985 outer shelf line. The 1986 data are presently being reduced and preliminary crustal models for the four lines will be generated in the next few months. The two refraction surveys completed so far have resulted in an excellent regional grid on the continental shelf between Nansen Sound and Sverdrup Channel Gravity measurements were made in connection with the seismic refraction experiments under the leadership of L. Sobczak and H. Weber. Further gravity data are presently being obtained on the shelf north of Axel Heiberg Island in connection with a hydrographic survey. These data will result in a regional grid which will be integrated with the refraction data in the formulation of crustal models. All available aeromagnetic data on the shelf have been compiled by D. Forsyth into regional maps along the extent of the shelf. These data are presently being interpreted by Forsyth and Embry. The seismic reflection group is led by A. Overton who devised a method of obtaining CDP data on the randomly moving Ice Island. A cross array of geophones has been set up along the length anf breadth of the Ice Island and thirteen shot holes were drilled through the 40 m thick ice. A series of continuous profiles was obtained along the path of the island during July and August 1985 as it drifted southwestward. The data have been

processed by Vertitas under the direction of Z. Hajnal, University of Saskatchewan. The area surveyed is underlain by high velocity, highly deformed, Lower Paleozoic-Precambrian rocks and only one relector at about 1.5 sec has been identified on the records. In July and August 1986 seismic reflection profiles were again shot but unfortunately the Ice island only moved a short distance. These data are presently being processed. The bottom sampling program is under the direction of P. Mudie. During 1985 and 1986 special sampling and high resolution seismic systems were installed on the Ice Island. About 200 surface samples and 300 km of high resolution seismic profiles show that the area of the shelf traversed is covered by a thin (10-20 cm) layer of carbonate-rich Holocene mud. Unique reef-like sileceous sponges thrive in total darkness at depths of 90-150 m. The thickness of Late Quaternary glaciomarine sediments varies from 2.5 m in Nansen and Sverdrup troughs to less than 1 m on the intervening banks. Below the soft sediment on the banks is a semi-consolidated layer of terrigenous mudstone and conglomerate with common mafic pebbles and abundant woody plant debris. Maastrichtian-Paleogene palymorphs within this unit suggest it represents an offshore extension of the Eureka Sound Formation.

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FGP Project Number: AI34-550 Project Officer: P.J. Mudie

TITLE: Ice Island sampling and investigation of sediments.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.3	0.3	0.3
Contract	58.0	38.0	65.4
Other O&M	130.0	147.0	264.2
Capital	0.0	2.0	3.0

NOTE: FGP resources are supplementary to other resources assigned to this project by AGC.

OBJECTIVE: To determine the spatial distribution of microfossils, sediment texture, mineralogy and geotechnical properties of the sediment cover on the continental margin of Canada Basin; to define, map and interpret surficial lithofacies on this margin where conditions are probably analagous to glacial stage environments off Eastern Canada; to conduct high resolution biostratigraphic and stable isotope studies of the High Arctic shelf sediments in areas of high sedimentation rates; to correlate paleoenvironmental data from a Canadian Basin Margin with CESAR data from the central Arctic Ocean; to construct a sediment budget for the Arctic Ocean margin.

DESCRIPTION: The Ice Island will be used as base for sample collection, to obtain and interpret geological information on the surface and near-surface seabed materials of the Arctic Continental Shelf.

SCIENTIFIC RESULTS: About one month of the two-month field season was spent repairing existing wet-lab facilities on the Ice Island, including structures and faulty equipment; in maintaining the camp during summer melt season, and in attempting to install a sparker seismic system. Twenty-six cores and fifty grab samples have been analyzed for lithological correlation and paleoenvironmental interpretation. The sedimentological studies indicate a shallow Pleistocene cover of glaciogenic and hemipelagic sediment (less than 2m thick on most of the central

shelf) which is underlain by Tertiary bedrock that crops out on ridges. Fault structures indicate recent tectonic activity Bottom photographs, grab and dredge samples show a unique siliceous sponge reef community living under the perennial ice pack at 95-140m water depth. The structure and composition of the arctic reef is similar to that in Permian strata on Ellesmere Island, which was formerly thought to indicate subtropical climatic conditions. Geochemical studies of planktic foraminifera (O-18) and organic matter (C-13, N-15, C:N) and palynological studies of sediment cores show that fully marine conditions have only existed on Axel Heiberg Shelf during the past ca 8Ka. Low carbon content of Holocene sediments reflects low productivity and strong oxidation. More organic carbon was deposited during Wisconsinian interval due to redeposition of lignites eroded from the Beaufort and/or Eureka Sound Formation; these glacial-stage sediments are barren of Quaternary microfossils.

OUTPUTS:

MUDIE, P.J., MOSHER,D.C., VANWAGONER,N.A., AKSU, A.E., MACKO,S.A., 1986 ISIS Field Report 1985 BIO Internal Report
JACKSON, H.R., 1986 Ice Island lab shows petroleum potential GEOS vol 15, no 2, pp 1-4.

FGP Project Number: AI35-090 Project Officer: A.F. Embry

TITLE: Stratigraphy and Structure of Arctic Continental Shelf.

RESOURCES ($1,000's)

	Planned	Actual	Cummulative Total
Personnel (PY)	0.3	0.3	0.4
Contract	542.0	785.2	785.2
Other O&M	850.0	69.1	495.4
Capital	50.0	265.2	716.6

OBJECTIVE: To determine the crustal structure of the continental shelf with emphasis on the Phanerozoic portion, and to evaluate its petroleum potential.

DESCRIPTION: These objectives will be accomplished by: shooting and interpreting seismic refraction lines on the shelf and adjacent slope (R. Jackson, AGC and D. Forsyth, EPB, co-leaders); shooting and interpreting seismic reflection profiles along and near the path of an ice island which is drifting southwestward along the shelf (A. Overton, RGG, leader); integrating all geophysical data with known geology and geophysics of adjacent Arctic Islands (A. Embry, ISPG, leader).

SCIENTIFIC RESULTS: In April 1986, a refraction program was shot north of Axel Heiberg Island and Sverdrup Channel. The following reversed lines were recorded: a 120 km line along the continental slope, a 180 km line along the inner shelf which extended the 1985 line southwestward to the Meighen Island area, a 120 km line which linked the slope line with the inner shelf line and a 60km line which linked the slope line with the 1985 outer shelf line. The 1986 data are presently being reduced and preliminary crustal models for the four lines will be generated in the next few months. In July and August 1986 seismic reflection profiles were shot along the path of the Ice Island but unfortunately the island only moved a short distance. These data are presently being processed. The 1985 seismic reflection data have been processed by Veritas under the direction of Z. Hajnal, University of Saskatchewan. The area surveyed is underlain by high velocity, highly deformed Lower Paleozoic - Precambrian rocks and only one reflector a t about 1.5 seconds has been identified on the records. All available aeromagnetic data on the shelf have been compiled into regional maps along the extent of the shelf by D. Forsyth. These data are presently being interpreted by Forsyth and Embry.

OUTPUTS:

Asudeh, I., Forsyth, D.A., Jackson, H.R., Stephenson, R., and White, D., 1985. 1985 Ice Island refraction survey, phase I report. GSC Open File Report #1196.

HAJNAL, Z., and OVERTON, A., 1986. Reflection experiment on a floating sice platform; Geoph. Jour., Royal Ast. Soc., v.89, pp. 201-208.

WESTERN ARCTIC TASK TASK MANAGER: W.W. Nassichuk

MACKENZIE DELTA-BEAUFORT SEA COMPONENT Component Manager: D.K. Norris

COMPONENT SUMMARY: The data collected to date and its interpretation reflect the multi-disciplinary approach to understanding the Beaufort-Mackenzie area. Two deep seismic reflection lines, using vibro-seis, were undertaken in 1986. The lines consisted of a long NW-SE line from just south of Inuvik to the edge of the Mackenzie Delta and a short east-west tie line across the southern edge of the long line. A preliminary interpretation of the deep reflection lines has been completed. Some preliminary results include, (a) depth to crystalline basement near Inuvik estimated at 18 km, (b) a depth to Moho near Inuvik estimated as 39 km, (c) recognition of a thick, thrust faulted Proterozoic section in the Eskimo Lakes Arch, (d) recognition of the Eskimo Lakes Fault zone as a series of listric normal faults that probably sole-out deep within Proterozoic strata and, (e) a 12 km thick section of Mesozoic and Tertiary strata under the outer part of Mackenzie Delta. Industry-derived reflection seismic was examined from the NW Anderson Plains to obtain stratigraphic and structural data in Proterozoic strata. This data will be related to the identified Proterozoic section in the deep reflection seismic lines Aeromagnetic data were collected in 1985; an initial map was produced and some preliminary interpretations proposed, comparing magnetic response to known or extraplolated geological features. However, there were some problems with compatability of two different data-sets on the map which have to be resolved before a comprehensive interpretation is undertaken. A Seismic refraction survey was conducted in March, 1987 during which data for twenty-two preliminary seismic sections were obtained. Velocity data from a shot point approximately 100 km north of Mackenzie Delta indicates the possibility of oceanic crust under the sedimentay column. Cintinuous monitoring of earthquakes has been undertaken under the FGP program and the data collected will be used to derive sense-of-motion between large-scale tectonic elements in the area. Locations, magnitudes and epicentre locations of earthquakes have been published on a quarterly basis. Much of the stratigraphic and biostratigraphic framework for Mesozoic anf Tertiary strata has been completed at a regional scale using relection seismic, well data and outcrop studies. Many thousands of kilometres of reflection seismic and up to 200 wells are available for study. Preliminary work on Paleozoic and Proterozoic stratigraphy in the subsurface of Tuktoyaktuk Peninsula was started in 1986 under a contract agreement. A NE-trending core of Proterozoic strata in the Eskimo Lakes Arch

and north-trending structures in Lower Paleozoic strata on the northern flank of the arch were recognized. These studies were integrated with the interpretation of the deep reflection data. Distribution of structures or structural tends affecting Paleozoic through Tertiary strata have been mapped, principally through the interpretation of reflection seismic. Special emphasis was placed on the geological interpretation of the west Beaufort Sea during 1986 and depositional sequences and structures were identified and mapped. The west Beaufort study formed the basis for a petroleum evaluation of the disputedboundary area. Geological and geochemical studies have provided the framework on which petroleum assessment of the Beaufort-Mackenzie Basin is based. A petroleum resource evaluation of the disputed Alaska-Canada offshore border was done in 1986. A petrological study, principally of potential reservoir sands, was initiated in 1986 under a contract agreement, in which material from 328 sample points were examined from nine wells and three outcrop areas. Preliminary conclusions are that the weakly cemented offshore succession has undergone normal compaction, some cementation and then subjected to dissolution of cements and decompaction. An initial study of heat flow was contracted out and a report produced in which it was recognized that the southern margin of the Beaufort-Mackenzie Basin and the Rapid Depression have low heat flow, presumably due to the rapidly deposited, thick sediment cover. Monitoring of earthquake activity using local stations has resulted in the more accurate measurement of earthquake locations, epicentres and magnitudes in the Beaufort area. the uninterpreted data have been published requlary, on a quarterly basis. Earthquake probability data will be important to engineers in their plans for construction of oil production structures on the Beaufort Sea.

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FGP Project Number: WA15-100 Project Officer: D.G. Cook

TITLE: Structural Geology and Tectonic and Stratigraphic Analyses, Northern Mainland and Adjacent Continental Shelf.

RESOURCES ($1,000's)

	Planned	Actual	Cummulative Total
Personnel (PY)	1.1	0.3	0.3
Contract	1205.0	886.8	919.4
Other O&M	0.0	75.6	396.7
Capital	100.0	105.7	105.7

OBJECTIVE: To determine the geometry, sequential development, temporal and genetic relationships of normal faults and diapiric structures; establishing the basic structural geometry and seismostratigaphy of the lower part of the supracrustal wedge and subjacent lithosphere from the northern mainland across the continental shelf to the southern edge of the Canada basin.

DESCRIPTION: Aeromagnetic and deep seismic data will be used to complement geological data to determine the geometry and development of the Canada Basin.

SCIENTIFIC RESULTS: Processing of the Inuvil-Mackenzie Delta seismic reflection line continuea, supervised by F. Cook (University of Calgary). Preliminary interpretations are well advanced, and a manuscript describing the geometry of seismic structures, and crustal models are in preparation. L. Lane, J. Dietrich and J. Dixon have interpreted the Mesozoic and Cenozoic seismic stratigraphy in the Inuvik-Mackenzie Delta seismic line, and have contributed to the interpretation of structural geometry under Campbell Uplift and Mackenzie Delta. L. Lane is contributing to preparation of manuscripts describing these interpretations. Initail results include: (a) depth-to-crystalline basement near Inuvik estimated at 18 km; (b) depth-to-Moho near Inuvik estimated at 39 km; (c) recognition of a thick succession of thrust faulted Proterozoic strata in the core of Eskimo Lake Arch; (d) recognition of the Eskimo Lake Fault Zone as a series of listric normal faults that appear to sole-out deep within Proterozoic strata; and (e) recognition of up to 12 km of Mesozoic strata at the outer edge of the Mackenzie

Delta. Locations and technical requirements for a marine deep seismic reflection line across the Beaufort continental margin have been finalized, and contract documents are in preparation, supervised by F. Cook. L. Lane has prepared a pre-Mesozoic map covering NTS 117A-D, 116N-P and parts of 106M and 107B, from published surface maps and well data. Distribution of Paleozoic facies boundaries preclude many kilometers of right-lateral displacement on the Kaltag-Yukon fault system. Also, the eastern erosional zero-edge of Permian strata in the area is controlled by the Eskimo Lakes-Treeless Creek fault system. M. Cecile, F. Cook and R. Ellis, (UBC) received submissions from geoscientists interested in contributing to the Lithoprobe Dempster Highway proposal. These submissions will be used in preparation of the final proposal the the Lithoprobe Steering Committee. In November 1986,M. Cecile passed to L. Lane responsibility for the GSC component of the proposal. A seismic refraction program supervised by R. Stephenson was completed at the end of March, and preliminary interpretation is underway. Data were obtained for three regional seismic lines, 1000 km long in total. Broadside profiling was done along 2 of those lines. An initial observation is that oceanic crust may underlie the sediment column at a shot point located about 100 km north of the delta. Regional gravity coverage was extended to north of 64 deg. N., in north Yukon at a station spacing of 10 km. The data has been reviewed and added to the regional data base.

FGP Project Number: WA15-240 **Project Officer: D.H. Weichert**

TITLE: Beaufort Earthquake Station Array - Seismicity and Inferred Faults, Deep Structure and Tectonic Processes.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.0	0.0	0.0
Contract	0.0	24.6	24.6
Other O&M	60.0	50.6	61.0
Capital	0.0	15.0	15.0

OBJECTIVE: To reactivate existing stations with data collection at the EPB standard station at Inuvik. To operate the earthquake station array along the coast of the Beaufort Sea and adjacent

areas to continuously monitor and record earthquakes in the region, particularly the offshore concentration.

DESCRIPTION: Collected data will be processed to determine earthquake parameters; i.e., locations, depths, magnitudes, mechanisms (for larger events) and statistics. SCIENTIFIC RESULTS: Data collection continued from four statiuons in the area: Komakuk Beach; Shingle Point; Dawson; Sachs Harbour and Fort Simpson, supplemented by the standard stations at Inuvik, Mould Bay and Yellowknife. No earthquakes were recorded from the Beaufort Sea during 1986. The first two stations are telemtered to Inuvik where they are recorded on paper, under contract. The other three are regional station packages recording locally and operated by contract. The Komakuk seismometer was repaired during the reporting period. A new vault had to be installed and the station recalibrated. Shingle Point and Sachs Harbour were also recalibrated. The Inuvik recording equipment was given an overhaul and a timing problem eliminated. Seismogram reading and epicenter-magnitude determination contiues at the Pacific Geoscience Centre. The Fort Simpson ststion was decommissioned on March 31,1987, because the seismic activity at the south end of the Beaufort-Mackenzie belt has subsided. Several strong motion recorders are still operational in the area.

OUTPUTS:

WEICHERT, D.H., 1986. Quarterly Bulletin of Canadian Earthquakes. April - June - September - December.

WEICHERT, D.H., WETTMULLER< R.J., and MUNRO, P., 1986. Vertical earthquake acceleration exceeding 2g?; Bull. Seis. Soc. Am., v. 76, pp. 1473-1478.

FGP Annual Report 1986-87

FGP Project Number: WA15-320 Project Officer: D.H. McNeil

TITLE: Cretaceous-Tertiary biostratigraphy and paleoecology, palynomorphs and microfossils.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.3	1.2	1.2
Contract	43.4	16.6	16.6
Other O&M	5.0	4.8	4.8
Capital	40.0	27.5	27.5

OBJECTIVE: Establishment, refinement, and application of microfaunal and microfloral zonations in onshore and offshore subsurface successions of Late Cretaceous and Tertiary age in the Mackenzie Delta and Beaufort Sea.

DESCRIPTION: The objectives are to be attained by detailed description of microfaunal and microfloral assemblages and analysis of their paleoecological, correlative, and chronostratigraphic significance. Data will be derived from outcrop and subsurface sources. Computer processing of data and quantitative analysis will be utilized where appropriate. Outcrop sequences, especially type sections, will provide important standards for subsurface correlations. A field component will be considered where logistical support is available.

SCIENTIFIC RESULTS: Samples were processed from several surface and subsurface sections (including those done under contract). Biostratigraphic reports and correlations were completed for Aklavik A-37, Ogruknang M-31, Ogeogeoq J-06, Parsons A-44, Parsons F-09, Siku A-12 and Edlok N-56. Cretaceous microfossils from outcrop samples were identified for J. Dixon under a contract.

OUTPUTS:

McNEIL, D.H., 1986. Micropaleontoloogical report on Paleocene to Jurassic strata in six wells in the Mackenzie Delta, Northwest Territories: Geol. Sur. Can. Internal Rpt., 7-DHM-1986.

McNEIL, D.H., 1986. Foraminiferal zonation in Tertiary strata in the Beaufort-Mackenzie Basin; an. Soc. Pet. Geol. 1986 Convention, Program and Abstracts, p. 65.
McNEIL, D.H., 1987. Micropaleontology report on one core sample from the Shell Unak L-28 well (NTS 107B), Mackenzie Delta, District of Mackenzie; Geol. Sur. Can. Internal Rpt., 1-DHM-1987.
McNEIL, D.H., 1986. Report on palynology of 45 samples from Yukon Territory (NTS 116J, 116O and 117A) and Northwest Territories (NTS 107B); Geol. Sur. Can. Internal Rpt., 3-DJM-1986.
McNEIL, D.H., 1986. Report on palynology of 33 samples from Yukon Territory and Northwest Territories (NTS 116G,H,and I, 97C and 117A); Geol. Sur. Can. Internal Rpt., 2-DJM-1986.

FGP Project Number: WA15-410 **Project Officer: N.J. McMillan**

TITLE: Hydrocarbon potential in stratigraphic and unconformity related traps - siesmic stratigraphy.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.3	0.0	0.0
Contract	40.0	39.9	39.9
Other O&M	0.0	0.0	0.0
Capital	0.0	0.0	0.0

OBJECTIVE: To evaluate the details of subsurface stratigraphy within parts of the Mackenzie-Beaufort.

DESCRIPTION: Models for the deltas in the Mackenzie/Beaufort allow growth faults, erosion intervals, delta plains, slopes, fronts, turbidites. Some of these environments (and combinations of them), are more ideal than others for hydrocarbon entrapment. Accordingly it is essential to use seismic lithostratigraphy in finding and describing these fovoured zones.

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FGP Project Number: WA15-420 Project Officer: N.J. McMillan

TITLE: Geological nature of abnormal pressure zones of Mackenzie Delta-Beaufort Sea.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.5	0.5	0.5
Contract	65.0	48.2	48.2
Other O&M	0.0	0.0	0.0
Capital	0.0	0.0	0.0

NOTE: THIS PROJECT WAS TERMINATED MARCH 31, 1987.

OBJECTIVE: Conduct a petrographic, petrologic, chemical study of the overpressured zones and normal zones in wells drilled.

DESCRIPTION: Initiate contracts with consultants and possibly research groups in oil companies. A complete literature review will be made and a critical path of research established. Between 1985 and 1989 ISPG will, in collaboration with the Alberta Research Council and other government/non-government agencies, produce maps of pressure zones. Subsequently these zones will be subjected to petrographic, chemical, geochemical studies to learn of the origin of zones of geopressure.

SCIENTIFIC RESULTS: The stratigraphic framework which has evolved for the area involves stratigraphy, reflection seismic studies, sedimentology and paleontology and is being used to acquire and study the hydrogeological and other aspects of abnormal pressures. The work is contracted through the Alberta Geological Survey, with the study divided into three phases. Phases one and two have involved data gathering and processing, and a full report of this activity has been received. Phase three is planned for 1986-87, will involve synthesis of all data collected.

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FGP Project Number: WA15-450 Project Officer: A.C. Higgins

TITLE: Thermal maturity studies of the Paleozoic of the northern mainland and Tertiary of the Beaufort Sea/Mackenzie Delta.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.1	0.1	0.1
Contract	20.0	39.8	39.8
Other O&M	0.0	30.0	30.0
Capital	5.0	0.0	0.0

OBJECTIVE: Determination of organic maturity of rocks of Paleozoic and Tertiary age by the use of conodonts, palynology, scolecodonts, graptolites and sediments to determine burial and erosional history.

DESCRIPTION: Colour assessments of conodonts (CAI) and palynomorphs (TAI) vitrinite reflectance measurements on palynomorph residues, grptolites and scolecodonts, and fluorescence measurements on conodonts to determine thermal maturity as an aid to hydrocarbon and mineral exploration. This project will complement Mesozoic thermal maturity studies. Samples will be collected from Arctic wells, outcrop and existing ISPG collections. Field component includes Paleozoic and Tertiary sampling on the northern mainland and Mackenzie Delta. Study of modern heat flow will be carried out by the Earth Physics Branch.

SCIENTIFIC RESULTS: Samples from subsurface and suface sections were processed (including contracted processing) and many of the samples were examined and measured for orhanic maturity. Completion of the measurements and collation of data was delayed by the resignation of the original project leader (A. Higgins). Tertiary strata from thr Issungnak O-61 well were processed and examined and low thermal maturity recognized (well below that normally required to generate hydrocarbons).

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FGP Project Number: WA15-590 Project Officer: J.R. Dietrich

TITLE: Petroleum geology of Tertiary, Mesozoic and Paleozoic north of 68 deg. N. on the N.W.T. and Yukon mainland and offshore.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.0	0.0	0.0
Contract	0.0	0.0	0.0
Other O&M	225.0		
Capital	0.0	0.0	0.0

OBJECTIVE: To study and document the regional and local structure and stratigraphy of sedimentary strata within the Beaufort-Mackenzie basin, with emphasis on aspects of petroleum geology and resource potential.

DESCRIPTION: The objectives will be accomplished through the interpretation and integration of geological, geophysical, paleontological and geochemical data from boreholes, surface sections and seismic and potential field surveys.

SCIENTIFIC RESULTS: Completion of a geological/petroleum resource evaluation for the Alaska-Canada border in the Beaufort Sea. Presentation of the geological results at the CSPG's June annual conference in Calgary; co-authored with J. Dixon. Integration of well data released in 1986 into the stratigraphic scheme for the basin. The following contracts were undertaken under this project: Study of geopressures by the Alberta Research Council - this was phase 3 of the study and involved data gathering and entry into a data base. A petrological study of Tertiary sandstones by V. Schmidt - samples for thin sections, SEM examination and XRD analysis were collected and examined from a south-north transect across the basin, from outcrop areas to the Koakoak O-22 well. Sandstone composition was documented, diagenetic alterationsnoted and recorded types and amounts of porosity observed. A report listing the observations and computed data, photomicrographs of selected rocks and initial conclusions and recommendationswas submitted. Initial conclusions are that the Upper Cretaceous to Miocene succession

underwent normal compaction and cementation followed by decementation and decompaction. A study of pre-Mesozoic stratigraphy along Tuktoyaktuk Peninsula was done by H. Wielans - in order to better understand the pre-Mesozoic stratigraphy and apply the knowledge to the interpretation of deep reflection seismic. An initial report was produced and the distribution of pre-Mesozoic strata at the sub-Mesozoic unconformity mapped. A NE trending core of Proterozoic strata was recongnized in the Eskimo Lakes Arch and north trending stryctures in Lower Paleozoic strata were identified on the northwest flank of the arch. A review of the availability and quality of reflection seismic in NW Anderson Plains was done by R. Mayers. The deep reflection seismic revealed a thick Proterozoic succession under the southern Tuk Peninsula and control points penetrating such strata are in Anderson Plains. Coseqently a study to link the two data areas was udertaken. A contracted study of borehole temperature data from wells along two profiles in the northern Yukon and adjacent NWT was initiated. Heat flows were calculated. Results show low heat flow from the platform areas and higher heat flows from the folded terrain of the Ogilvie Mountains and northeast of Aklavik on the Mackenzie Delta. These variations may result from deep convective heat flow, non-uniform thermal conductivity, or from transient fluid-flow effects. Low heat flow was noted in the Rapid Depression and Kugmallit Trough, presumably because of the rapidly deposited , thick, sediment column. Reprocessing of some seismic data by GSI produced better quality data for selected seismic lines in the western Beaufort Sea. These were used in the study of the disputed border area. R. Peach was contracted to enter well information into the ISPG's SWELLS database and to retrieve and manipulate data at the request of ISPG personnel. The database for the Beafort-Mackenzie area was brought up-to-date with all publically accessible well data.

OUTPUTS:

ALBERTA RESEARCH COUNCIL, 1987. Hydrogeology and abnormal pressures in the Beaufort-Mackenzie sedimentary basin, Phase III; Progress Report. Internal ISPG contract report.

DIETRICH, J.R., 1986. Geology and petroleum evaluation of the Alaska-Canada border dispute area, Beaufort Sea; Internal ISPG report for the Petroleum Secretariat.

DIETRICH, J. R., and DIXON, J., 1986. Geology of the Beadort Sea continental margin near the Canada-USA border. Can. Soc. Pet. Geol. Annual Convention, Reserves 21, Program and Abstracts, p. 39. SCHMIDT, V., 1987. Petrological/diagenetic studies of Upper Cretaceous and Tertiary strata, Beaufort-Mackenzie Basin, Phase I; Internal ISPG contract report.

TEMPEST GEOPHYSICAL CONSULTANTS LTD., 1987. Analysis of temperature 36 FGP ANNUAL REPORT, 1985-86 data from the Mackenzie Delta and offshore Beaufort Sea area of the Northwest Territories/Yukon Territory; Internal ISPG contract report.
WIELANS, J.B.W., 1987. Study of pre-Mesozoic stratigraphy and structure, Tuktoyaktuk Peninsula, Phase I; Internal ISPG contract report.

INTERIOR PLAINS COMPONENT Component Manager: D.G. Cook

COMPONENT SUMMARY: Assessment of deep structural aspects of Proterozoic strata and their controls on younger basins and structures was undertaken on two fronts. The first was a follow up study of recently published inferences into the nature of deep structural controls from re-examination of their surface geological expression and available geophysical data. To this end a theoretical procedure for balancing basement-controlled structural features was developed and tested against better known structures in the Wyoming structural province (Cook, in press). The second approach was to assess what geophysical data was now available through government agencies, as well as approaches to industry for donation or purchase of geophysical data. Through the solicitations of M.P. Cecile, about 1800 km of seismic data distributed over the area between 129 deg long., and the edge of Paleozoic cover was aquired for the cost of reproduction paper and mylar copies. In addition a contract was let, through a Mackenzie-Beaufort project to do a complete survey of what geophysical data was available from COGLA, to assess the quality of this data, to establish if copies are, or are not, available in the GSC, and if not to acquire this data. This contract is underway. A second phase of interpretation of selected parts of this massive data base is planned. Another useful tool in understanding deep controls on basins and structures is through magnetic and gravity maps. One of our most complex and difficult areas is the northern Yukon, which essentially is the geological framework within which the Mackenzie Delta "basin" developed. Through the FGP initiative large parts of the areas have been flown to produce detailed magnetic and gravity anomaly maps, and these data are now being refined and standardized for final publication. Studies of the internal geology, paleogeography, biostratigraphy and regional correlations involves a large number of projects and disciplines, including subsurface and surface stratigraphy, structural and map studies. Two subsurface studies of the lower and middle Paleozoic miogeoclinal succession were initiated. The first of these was through contract to P.C. Pugh. His report is a regional stratigraphic survey of the northern half of the Interior Plains Component. This report includes all the important wells and will give explorationists an excellent reference for evaluating their existing data, and for planning future activities. The second project is an in-house study known as the "Mackenzie Corridor" project. This project was initiated along with other FGP programs but carried under A-base because no special funding was required. Since its inception the "Mackenzie Corridor" project has produced numerous reports in the last three years. The Williams (1987) report will be an important guide to future hydrocarbon exploration in the prospective lower clastic part of the miogeoclinal succession

because it defines some major Cambrian depo-centres which are "down dip" of known gas fields. In the northern part of the Interior Plains these deeper successions appear to have significant hydrocarbon potential. A surface stratigraphic and facies study was initiated in the Ogilvie and Wernecke Mountains, and studies of important Devonian carbonate strata in the southern Mackenzie mountains were continued. Two important results of these studies are: the recognition of the reservoir potential of the Devonian Ogilvie carbonate in its transition-to-basin facies in the Eagle Plains area (Dubord et al, 1986); and hypothesis on the origin of gas-bearing Manetoe facies in the southern Mackenzie Mountains (Morrow and Cummings, in press). A synthesis of the paleogeography and geological history of the Ordovician and Silurian part of the miogeolclinal succession was prepared for the Decade of North American Geology, Western Canada Volume (Cecile and Norford, in press). Another new initiative is the study of the stratigraphy and structure of the Devono-Mississippian foredeep succession in the western part of the Northern Cordillera. A set of seven 1:50,000 geological maps with an extensive and comprehensive description of stratigraphic units have been produced (Cecile, 1985, 1986). This and previously collected data show this area to have been tectonically active during deposition resulting in a complex stratigraphy. Detailed mapping and analysis of the stratigraphy and extensive biostratigraphic support allows for correlation of these units across both component areas. A project was undertaken to study Jurassic-Cretaceous strata in the northern Yukon to provide correlation between surface exposures with hydrocarbon-rich units in the Mackenzie Delta area, and a complete northern Cordilleran framework for facies analysis. This work is now near completion and one important synthesis-type publication is complete (Dixon, 1986). Another significant product of this activity and similar activity in the Mackenzie-Beaufort Component is a short course given by Dixon et al (1986) on the geology, biostratigraphy, and organic geochemistry of Jurassic to Pleistocene strata of the Beaufort-Mackenzie and adjacent areas. An important component of all geological and stratigraphic studies is high level of sophisticated biostratigraphic support. Three major projects were organized to provide improved regional correlations. One concerns Paleozoic biostratigraphy and two concern Mesozoic-Tertiary stratigraphy. All three group projects have made significant advances towards establishing new and improved circum-polar and western North Aerican correlations. In addition to establishing Canadian standards for Mesozoic and Tertiary strata of the northern Cordillera and Mackenzie Beaufort (e.g. McNeil, 1986), scientists involved with this project have consulted with and been consulted by industry specialists, U.S. scientists working in Alaska and are participating in an exchange with their Soviet counterparts who are working in similar strata

of the soviet Arctic. In the Interior Plains an important focus of biostratigraphic studies has been the "Brackett Basin" southeast of Norman Wells. Upper Cretaceous and Tertiary palynomorphs in this area are intermediate between assemblages found in Alberta and midcontinental U.S. and the Arctic region (Nichols and Sweet, 1987). These intermediate assemblages will provide a framework for isolation species whose range changes with latitude and thus a more reliable North American faunal zonation. In addition, physical techniques of correlation are being applied to the same sequences using magnetostratigraphy and geochemistry. If successful they may establish a worldwide perspective on the entire Upper Cretaceous-Tertiary biostratigraphic zonation scheme. Paleozoic biostratigraphers have also produced significant results in regional correlation and improved standards. A.E.H. Pedder has completed visits to both Germany and the Soviet Union to review Devonian coral collections and is now in a position to complete the systematics of several poorly known Canadian Arctic coral genera. In addition various scientists are completing Carboniferous and Permian palynomorphs and invertebrate microfossil studies that are providing new information on relationships between floras of the northern Yukon, Arctic Islands, and Alaska. In addition a number of specific stratigraphic studies in the area have been produced. The Geological Survey of Canada has established a world-class capability for studies of the hydrocarbon potential of sedimentary strata. Prior to new FGP initiatives only scattered bits of data were available in the public domain on the organic characteristics of strata in the Northern Cordillera and Interior Plains. With the FGP initiative several projects were undertaken to produce critical information on key areas, or regional information on prospective units. Reports on th Canol Fm. as a source rock for Norman Wells (Snowdon et al) and on the organic geochemistry of Cambrian to Proterozoic sediments in the Colville Hills area (Cambrian gas fields here may have a Proterozoic source, Macauley), are both in press. Regional surveys include: the petroleum potential and level of maturation of all Cambrian and Proterozoic rocks in the Interior Plains area (Snowdon and Williams, 1986); a cross-section study along the Dempster Highway corridor (Bustin and Link, 1987). With the FGP initiative a project was undertaken to study the character of, and manner in which, major coal deposits are found across the Northern Cordillera and Interior Plains. Numerous coal occurrences have been visisted, sampled and evaluated. One area of focus has been the Brackett Basin where a relatively thorough evaluation of occurrences has been completed (Cameron et al, 1986). In the northern Yukon a 5 m thick seam of low ash, low sulphur,anthracite coal was discovered during execution of this project (Cameron et al, 1986). One of the biggest constraints on exploration and exploitation in the Arctic is permafrost. Changes introduced by man can result in either the increase or

decrease in the size of the permafrost zone. In 1978 an important study of ice wedge growth, through experimental draining of a lake was initiated in the Mackenzie Delta area. It was decided the best way to meet the FGP initiative, in the area of hazards and constraints, was to support this project through a contract to the University of British Columbia. This study has provided an enhanced understanding of the processes involved in the growth, development and decay of perennial ground ice (MacKay, 1986). Soon after the FGP initiative was launched a major earthquake in the central Mackenzie Mountains triggered a large rock avalanche. Some funds were diverted to support immediate studies of the earthquake and rock avalanche.

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FGP Project Number: WA25-250 Project Officer: L.R. Snowdon

TITLE: Oil source correlation for northern interior plains crudes.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.2	0.2	0.2
Contract	18.0		
Other O&M	2.0	7.1	7.1
Capital	0.0	0.0	0.0

OBJECTIVE: Acquire and analyze oil, condensate and possible source rock samples to make hydrocarbon/source correlations in the Northern Interior Plains. Map probale source distributions once source beds have been identified in order to predict location of possible undiscovered reserves.

DESCRIPTION: Oil and rock samples will be collected and preparation and analysis will be carried out under contract to an organic geochemist. Geochemical and geological data will be merged and published as maps and cross-sections in open file reports and refereed journals. This project will be carried out as series of one year contracts to identify probale source rocks in the Northern Interior Plains, collect sample and analyze, then make oil/source correlations. The character of the source rocks will also be investigated.

SCIENTIFIC RESULTS: S. Feinstein began participation in this project Jan/87 and has already assembled data for preparation of maturation maps, and initiated a number of projects to acquire new maturation data.

OUTPUTS:

KALDI,J., 1987. Core/petrographic study of the Kee Scarp Formation, Norman Wells, N.W.T.; Geol. Sur. Can. Internal Report.

MACAULEY, G., 1987. Organic geochemistry of some Cambrian to Proterozoic sediments, Coleville Hills area, N.W.T.; Geol. Sur. Can. Open File # 1498.

SNOWDON, L. R., and WILLIAMS, G.K., 1986. Thermal maturation and petroleum source potential of Cambrian and Proterozoic rocks in the Mackenzie Corridor; Geol. Sur. Can. Open File # 1367.
SNOWDON, L.R., BROOKS, P.W., WILLIAMS, G. L., and GOODARZI, F., in press. Correlation of the Canol Formation source rock with oil from Norman Wells; Oganic Geochemistry.

FGP Project Number: WA25-330 **Project Officer: A.R. Sweet**

TITLE: Macropaleontology, micropaleontology and palynology of Devonian, Cretaceous and Tertiary rocks of the Interior Plains.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.7	1.8	1.8
Contract	0.0	0.0	0.0
Other O&M	26.7	15.7	15.7
Capital	5.0		

OBJECTIVE: To establish and refine biostratigraphic zonations utilzing Cretaceous and Tertiary palynomorphs, Cretaceous ammonoids and bivalves, and Devonian brachiopods, corals and conodonys and apply these to resolving stratigraphic problems arising from energy inventory and regional geological studies within the Interior Plains.

DESCRIPTION: By developing a detailed understanding of morphological changes within the groups studied, expressed within a formal taxonomic framework, and interrelating this to paleoecological influences on occurrences, a logical basis for limiting the ranges of individual taxa will be provided. Fossils will be obtained from outcrops through field programs integrated with regional studies and subsurface sources. Study will involve both light and scanning electron microscopy. Data handling will be assisted by computer processing. In addition to library research, direct examination of macro and microfaunas and floras from other biogeographic provinces will be necessary ti identify specimens and establish continuity with internationally recognized time scales. Consultation with other researchers in North America and abroad will ensure this study is placed within

an international geological and geographical framework.

SCIENTIFIC RESULTS: For the Cretaceous and Tertiary palynomorphs progress has been made towards the accomplishment of objectives, in part through the collaboration with J.D. Nichols of the USGS. By comparing the sequence of palynofloral assemblages from the Brackett Coal Basin with those from Alberta and midcontinental United States and through this process isolating species whose range changes with latitude, a more reliable zonation for the entire midcontinental region can be achieved. The ongoing integration of biostratigraphic techniques with magnetostratigraphy and the identification of geochemical anomalies continued through cooperation with J.F. Lerbekmo, University of Alberta. The detailed study of assemblages present in the youger strata than those mentioned above allows the recognition of phylogenetic lineages which place rational limits on the ranges of individual species, such has been done within the genus Pesavis, providing a firhter basis for refining biostratigraphic zonations. The applied part of this research is directed to the recognition and zonation of individual coal within the Brackett Basin and this has been accomplished by the detailed study of sections within the Tertiary Hills and along the Mackenzie River. Manuscripts in Preparation: Kalgutkar, R.M., and Sweet, A.R. The morphology, taxonomy and phylogeny of the fossil genus Pesavis from northwestern Canada, Conributions to Canadian Paleontology, Geological Survey of Canada,1987. Norris, A.W., Uyeno, T.T., and Sartenaer, P. Brachipod and conodont faunas of the bitumous shale and limestone of the Pine Point Formation (Middle Devonian), south side of Great Slave Lake District of Mackenzie, Geological Survey of Canada Bulletin, 1988. Ricketts, B.D., Norris, D.K., and Sweet, A.R. Structural setting,sedimentology and palynological zonation of the Late Cretaceous and Tertiary of the Bracketts Coal Basin, Geological Survey of Canada Bulletin, 1988.

OUTPUTS:

CAMERON, A.R., NORRIS, D.K., RICKETTS,B.D., and SWEET, A.R., 1986. Geology and coal resource potential, Summit Creek Formation, Fort Norman area, N.W.T. (Abs); Can. Soc. Pet. Geol. Program amd Abstracts, Reserves 21 Meeting, p. 31.

NICHOLS, D.J., and SWEET, A.R., 1897. Biostratigraphy of Upper Cretaceous nonmarine palynofloras in a north-south transect of the Western Interior Basin; (Abs), Geol. Assoc. Can., Program with Abstracts, v. 12, p.77.

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FGP Project Number: WA25-370 Project Officer: D.G. Cook

TITLE: Stratigraphy and structure of northern Franklin Mountains and adjacent plains.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.1	0.1	0.1
Contract	25.0	27.5	27.5
Other O&M	0.0	0.0	0.0
Capital	0.0	0.0	0.0

OBJECTIVE: To carry out stratigraphic and structural studies of the Northern Interior Plains including Franklin Mountains and Coleville Hills in order to gain a better understanding of the Proterozoic framework underlying the Phanerozoic basins, Phanerozoic depositional sequences and relationships to tectonic controls, and subsequent deformational geometry and mechanism. To evaluate the potential for source rockd and trapping conditions for hydrocarbons.

DESCRIPTION: Work will be managed by D.G. Cook, but carried out initially under contract (stratigraphic studies by D.C. Pugh, gravity studies by the University of Calgary), and later by a recruit subsurface stratigrapher, in cooperation with a geophysicist.

SCIENTIFIC RESULTS: Through the solicitations of M.P. Cecile, approximately 1800 km of seismic data were donated to the Survey by Petrocanada for the cost of reproducing paper and mylar copies. These data cover the area between Great Bear Lake and 129 deg. west longitude. Also through extension of another FGP project to J. Dietrich, Beaufort-Mackenzie Component, a contract was let out to assess and acquire geophysical data, mostly west of 129 deg.

OUTPUTS:
PUGH, D.C., 1986. Stratigraphic cross-sections of the northern interior plains. Geol. Sur. Can. Open File #1176.

COOK, D.G.,in press. Balancing basement-cored folds of Wyoming Province; in Interaction of the Rocky Mountain Foreland and Cordilleran Thrust Belt, Geol. Soc. Am. Special Paper.

FGP Project Number: WA25-510 **Project Officer:J.A. Heginbottom**

TITLE: Modelling of ground ice regimes.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.0	0.0	0.0
Contract	80.0	54.6	54.6
Other O&M	0.0	0.0	0.0
Capital	0.0	0.0	0.0

OBJECTIVE: To develop conceptual and mathematical models of the growth, development and decay of perennial ground ice,so as to enhance understanding of the processes involved and of the implications for man's activities, and to improve ability to provide advice to other government departments and industry.

DESCRIPTION: The work will be done by a combination of field observation and sampling, field experiments, laboratory testing and analysis, and theoretical studies and analysis. The results will be published in the open, scientific literature. The project will be undertaken mainly by means of contract research; some in-house research may be appropriate.

SCIENTIFIC RESULTS: A contract was arranged with J.R. MacKay to continue the ice-wedge study. He undertook field work in June, July, August and Noovember New aerial photographs of the Nahanni rock slide were taken during the summer, and field work was completed on the slide itself.

OUTPUTS:

BASHAM, P.W., WETMILLER, R.J., WEICHERT, D.H., and EVANS, S.G., in press. The 1985 Nahanni earthquakes: problems for seismic hazard estimates in the northeastern Canadian Cordillera; Seis. Soc. Am., Program with Abstracts, Annual Meeting, Santa Barbara, Ca.

EVANS, S.G., AITKEN, J.D., WETMILLER,R.J., and HORNER, R.B., 1987. A rock avalanche triggered by the October 1985 north Nahanni earthquake, District of Mackenzie, N.W.T.; Can. Jour. Earth Sci., v. 24, pp. 176-184.

MACKAY, R.J., in press. Some mechanical aspects of pingo growth and failure, Western Arctic Coast, Arctic Canada; Can. Jour. Earth Sci.

MACKAY, R.J., in press. Pingos of the Western Arctic Coast, Canada; Ymer, v. 87.

MACKAY, R.J., 1986. Growyh of Ibyuk Pingo, Western Arctic Coast, Canada, and some implications for environmental reconstruction; Quat. Res., v. 26, pp. 68-80.

MACKAY, R.J., 1986. The first 7 years (1978-1985) of ice-growth, Illisarvik experimental drained lake site, Western Arctic Coast; Can. Jour. Earth Sci., v. 23, pp. 1782-1795.

MACKAY, R.J., and LESLIE, R.V., 1987. A simple probe for the measurement of frost heave in a permafrost environment; Geol. Sur. Can. Curr. Res. Paper 87-1A, pp.37-41.

WETMILLER, R.J., BASHAM, P.W., WEICHERT, D.H., and EVANS, S.G., in press. The 1985 Nahanni earthquakes: problems for seismic hazard estimates in the northeast Canadian Cordillera; Procceedings, Fifth Canadian Conference on Earthquake Engineering.

NORTHERN CORDILLERA COMPONENT Component Manager: M.P. Cecile

COMPONENT SUMMARY: This component has been merged with the Interior Plains Component and is reported for there. However, the original numbering of projects has been retained.

FGP Annual Report 1986-87

FGP Project Number: WA35-300 Project Officer: D.H. McNeil

TITLE: Macropaleontology, micropaleontology and palynology of the Mesozoic and Lower Tertiary of the northern Yukon and western District of Mackenzie.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.1	0.7	0.7
Contract	18.5	4.4	4.4
Other O&M	7.5	1.3	1.3
Capital	0.0	0.0	0.0

OBJECTIVE: To apply and expand existing biostratigraphic zonations in macropaleontology (ammonoids and bivalves) and micropaleontology (Foramanifera) and palynology; relationships of these zonations to onshore Mackenzie Delta and Interior Plains sequences as part of an integrated regional study.

DESCRIPTION: The objectives are to be attained by detailed description of molluscan, foramaniferal, and palynological assemblages and analysis of their paleoecological, correlative and chronostratigraphic significance. Data will be derived from outcrop and subsurface sources. Computer processing of data and quantitative analysis will be utilized where appropriate. Outcrop sequences, especially type sections, will provide important standards for subsurface correlations. Afield component will be considered where logistical support is available.

SCIENTIFIC RESULTS: Field work was undertaken on Upper Cretaceous outcrops to the east and west of the Mackenzie Delta during July, 1985. Palynological collections were made from the Boundary Creek and Smoking Hills Formations, both potential source rocks for oils in the Beaufort-Mackenzie Basin. A data file for all Jurassic macrofossils collected from northern Yukon and adjacent District of Mackenzie was completed. Work on a paper on the foraminifera of the Maastrichtian-Paleocene Tent Island and Lower Moose Channel Formations of the Yukon Coastal Plain is now in progress. A contract to S. Fowler for a report on Neocomian foraminifera of the northern Yukon and adjacent

western District of Mackenzie was completed during the past year. A manuscript describing Lower Jurassic and Aalenian ammonites and bivalves from the northern Yukon and adjacent N.W.T. is in progress.

OUTPUTS:

FOWLER, S., 1986. A report on the micropaleontology of 49 outcrop samples from Upper Jurassic - Lower Cretaceous sections, Richardson and Barn Mountains. Internal report submitted to the Paleontology subdivision of ISPG, GSC, Calgary.

FOWLER, S., 1986. Micropaleontology of 33 outcrop samples from Jurassic and Cretaceous sections, Richardson, Ogilvie mountains and Eagle and Horton River plains areas. Internal report submitted to the Paleontology subdivision, ISPG, GSC, Calgary.

McNeil, D.H., 1986. Biostratigraphy of the Beaufort Mackenzie Basin; In, Dixon et al, Geology, biostratigraphy and organic geochemistry of Jurassic to Pleistocene strata, Beaufort Mackenzie area, N.W.T. Notes for Short Course, published by the Canadian Society of Petroleum Geologists.

MacKintyre, D.J., 1986. Palynology; In, Dixon et al, Geology, biostratigraphy and organic geochemistry of Jurassic to Pleistocene strata, Beaufort Mackenzie area, N.W.T. Notes for short course, published by the Canadian Society of Petroleum Geologists.

Poulton, T.P., 1986. Internal GSC fossil report on Jurassic Ammonites, northern Alaska; GSC Paleontological Report J1-TPP-1985.

FGP Project Number: WA35-310 Project Officer: E.W. Bamber

TITLE: Micropaleontology, palynology and macropaleontology of the surface and subsurface Paleozoic of the northern Yukon and western District of Mackenzie.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.2	1.0	1.0
Contract	5.0	8.3	8.3
Other O&M	27.0	5.3	5.3
Capital	0.0	0.0	0.0

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OBJECTIVE: To establish and extend biostratigraphic zonations for the following fossil groups: palynomorphs Carboniferous-/Permian), conodonts (Upper Paleozoic), corals Devonian-/Carboniferous), brachiopods (Devonian) and Lower Paleozoic macrofauna.

DESCRIPTION: Collections of Paleozoic fossil groups listed above will be obtained through field work on surface sections, and from available subsurface cores. Taxonomic description and biostratigraphic and paleoecological analysis of these faunas and floras will be undertaken with the purpose of establishing one or more comprehensive, integrated biostratigraphic schemes for the area and determining the paleoenvironmental significance of the fossil assemblages. Where appropriate, studies of minor groups will be carried out by outside specialists under contract.

SCIENTIFIC RESULTS: An outside contract on the "Biostratigraphy of Carboniferous and Permian palynomorphs from the Eagle Plain - Ogilvie Mountains area, Yukon" has been completed and submitted to Paleontology section of the ISPG. A.E.H. Pedder completed compilation of literature of Silurian and Devonian corals of the USSR. As part of the Canada/USSR Arctic Science project, two weeks were spent at the All Union Institute for Geology and Mineral Resources of the World's Oceans in Leningrad. Data was assembled for preliminary correlation tables for the Devonian of Canada and the USSR. Laboratory and literature searches for two manuscripts were completed. The first on Pridolian rugose corals from Ellesmere Island; and the second on Taimyrophyllum (Devonian Rugosa), Yukon and Canadian Arctic.

OUTPUTS:

JERZYKIEWICZ, J., 1986. Biostratigraphy of Carboniferous and Permian palynomorphs from the Eagle Plain - Ogilvie Mountains area, Yukon. Internal report submitted to the Paleontology subdivision of ISPG, GSC, Calgary.

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FGP Project Number: WA35-340 Project Officer: M.P. Cecile

TITLE: Stratigraphic and structural analysis of Late Paleozoic strata in the northern Mackenzie and Selwyn Mountains.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.6	0.6	0.6
Contract	0.0	0.0	0.0
Other O&M	40.0	31.4	31.4
Capital	7.0		

OBJECTIVE: Late Paleozoic rocks in the northern Canadian Cordillera formed a large foredeep basin that provided the source and host strata for the Norman Wells oil. This project combines mapping, stratigraphic, paleontological and organic geochemical studies in the western part of this foredeep basin (NTS 105-O, 106-A,B). The objectives are to unravel its very complex stratigraphy and establish data on the basin characteristics in this area.

DESCRIPTION: Field work, foot traverses, and section measuring, will be carried out using casual helicopter charters during the 1985 and 1987 field seasons. Paleontological and organic geochemical studies will be carried out using ISPG facilities.

SCIENTIFIC RESULTS: Geological mapping at 1:50,000 scale was completed for the two map sheets in the Niddery Lake (1050) map-area. Including mapping of three sheets by G. Abbott of DIAND, the entire Niddery Lake map area has now been completed. On the basis of this work an Open File report on the Geology of the Central Macmillan fold belt was released in 1986. The report consists of a geological map and legend which features Late Paleozoic stratigraphy and illustrates local Devonian growth faulting. The area is on a trend with and in the same facies position as two large Zn-Pb-Ag deposits found in the Macmillan Pass area Y.T. An important highlight of this summers activity was recognition that a peculiar and highly shortened structural package characteristic of most of the Niddery Lake map-area (Niddery Decollement Sheet) continues to the south through the Sheldon Lake map-area. Abrupt curvatures in fold trends within

this belt are coincidental with (wrap-around) peculiar east-west trending fold belt (Macmillan Fold Belt) which features two large east-west trending grabens filled with chert pebble conglomerate. It would appear that the conglomerates have partly acted as buttresses during emplacement of this far traveled structural package. A second important highlight is that stratigraphic and biostratigraphic studies on Devonian-Mississippian stratigraphy are now complete. With this and previous work we can now correlate this complex package of rocks from the Selwyn Basin into the Northern Interior Plains. Additional samples of Devonian shales were collected from the mountain front near the Arctic Red and Gayna Rivers for organic geochemical maturation analysis. A manuscript on "Ordovician and Silurian of western Canada" was completed, reviewed, corrected and submitted for publication to DNAG editors. An abstract was published and paper presented at the Calgary Geological Survey of Canada Oil and Gas Forum on "Lower Paleozoic Embayments, Troughs, and Arches, Northern Canadian Cordillera". The implication of these features for petroleum exploration was reviewed.

OUTPUTS:

Cecile, M.P., 1986. Geology of the central MacMillan Fold Belt (NTS 1050 - 3). Geol. Sur. Can. Open File #1242.

Cecile, M.P., 1986. (Abstract), Lower Paleozoic embayments, troughs and arches, Northern Canadian Cordillera; Geological Survey of Canada. Abstracts for forum on "Oil and Gas in Canada", p. 5.

Cecile, M.P., and Norford, B.S., 1985. Ordovician and Silurian paleogeographic maps and cross-sections for western and northwestern Canada. Geol. Sur. Can. Open File #1137.

Cecile, M.P., and Norford, B.S., in press. Ordovician and Silurian of western Canada. Western Canada Volume, Decade of North American Geology, Geological Survey of Canada Publication.

Cecile, M.P., and Norford, B.S., in press. Ordovician and Silurian of western Canada. Canadian Cordilleran Volume, Decade of North American Geology, Geological Survey of Canada Publication.

Potter, A.W., and Cecile, M.P., 1985. (Abstract) Paleogeographic significance of two Late Ordovician brachiopod faunules from the Misty Creek Embayment, Selwyn Basin, Northwest Territories, Canada. Geol. Soc. Am., Abstracts with Program v. 17, p. 401.

Cecile, M.P., and Norford, B.S., 1985. (Abstract), The Ordovician and Silurian of Western Canada. Geol. Soc. Am., Abstracts with Program v. 17, p. 347.

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FGP Project Number: WA35-360 Project Officer: J. Dixon

TITLE: Stratigraphy and sedimentology of Jurassic - Cretaceous strata, northern Cordillera.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.3	0.3	0.3
Contract	0.0	0.0	0.0
Other O&M	25.0	32.2	32.2
Capital	10.0		

OBJECTIVE: To evaluate the present stratigraphic scheme and to undertake detailed facies analysis of Jurassic-Cretaceous strata. To establish an understanding of the on-shore Jurassic-Cretaceous geology and to project that into the offshore Beaufort Sea.

DESCRIPTION: Helicopter supported stratigraphic-sedimentologic field studies will be carried out. Understanding the Jurassic-Cretaceous geology onshore will permit projecting the geology into the offshore Beaufort Sea. This in turn will allow for some well-based speculation on the deep geology in the offshore and aid in the evaluation of petroleum potential of the deeper strata.

SCIENTIFIC RESULTS: Examination of Jurassic-Cretaceous strata in the Keele Range, northern Y.T., was undertaken in 1985. Newly identified exposures of Albian strata were examined and compared with the Albian Sharp Mountain Fm. Sedimentological data from these Albian units indicate a deep-water origin, rather than the shallow water marine origin originally suggested. On the basis of this research a manuscript titled "Comments on the stratigraphy, sedimentology and distribution of the Albian Sharp Mountain Fm., northern Y.T.", has been submitted for publication in GSC's Current Research.

OUTPUTS:
DIXON,J., DIETRICH, J.R., MCNEIL, D.H., MCINTYRE, D.J., SNOWDON, L.R., BROOKS, P., 1986. Geology, biostratigraphy, and organic geochemistry of Jurassic to Pleistocene strata, Beaufort-Mackenzie area, northwest Canada. Notes. Short course published by Can. Soc. Pet. Geologists.
Dixon, J., in press. Cretaceous to Pleistocene stratigraphy and paleogeography. Can. Soc. Pet. Geologists Bull.

FGP Project Number: WA35-390 **Project Officer: D.W. Morrow**

TITLE: Lower Paleozoic stratigraphy and facies relationships in the Wernecke, Ogilvie and Mackenzie Mountains.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.8	0.4	0.4
Contract	0.0	0.0	0.0
Other O&M	10.0	9.7	9.7
Capital	0.0	0.0	0.0

OBJECTIVE: To determine the spatial relationships between the lower Paleozoic formations and unnamed map units in the Wernecke and Ogilvie Mountains of the Yukon Territory ans in the Mackenzie Mountains in the Northwest Territories and to identify the major facies within these formations; to outline their sedimentologic-tectonic settings and post-depositional diagenetic changes that have affected them; to highlight regions that contain abrupt interfaces such as shelf-to-basin transitions between shelf and margin facies and shelf interior deposits that commonly influence diagenetic patterns and tha emplacement of hydrocarbons and mineral deposits.

DESCRIPTION: Stratigraphic sections measured during field work in 1985 and 1986 in conjunction with previously acquired, unpublished stratigraphic sections will be the primary data source.

SCIENTIFIC RESULTS: Stratigraphic field work on the southernmost exposures of the Kutchin and Ogilvie Formations adjacent to shales of the Selwyn basin was completed in the central Nash Creek map-area, 106D. This field work showed that large but discontinuous patch reefs are present in the Ogilvie Fm., at the southern limits of the Ogilvie Platform. Similar strata, in a comparable facies position, are extensive in the subsurface of the northern Interior Plains and thus are excellent potential hydrocarbon exploration targets.

OUTPUTS:

MORROW, D. W., 1986. Shelf-to-basin transition of the Ogilvie Formation, Hart River Y.T. Geol. Sur. Can. Curr. Res. Paper 86-1B (in press).

Morrow, D.W., and Cummings, G.L., in press. The Gas Bearing Manetoe Facies, Yukon and Northwest Territories. Geol. Sur. Can. Bull.

FGP Project Number: WA35-400 Project Officer: A.R. Cameron

TITLE: Coal - Paleozoic, Mesozoic and Tertiary, western District of Mackenzie and northern Yukon Territory.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.6	0.5	0.5
Contract	0.0	0.0	0.0
Other O&M	40.0	27.6	27.6
Capital	0.0	0.0	0.0

OBJECTIVE: To examine the structural framework, burial history, stratigraphy quality, composition and areal distribution of Upper Devonian 52 FGP ANNUAL REPORT, 1985-86 (Frasnian), Lower Carboniferous (Visean), Lower Cretaceous (Neocomian), Upper Cretaceous (Maastrichtian) and Lower Teriary (Paleocene to Oligocene) coal seams in the northern Cordillera and contiguous Interior Platform. The results will have immediate application to the National Coal Inventory and to hydrocarbon exploration.

DESCRIPTION: Fiscal year 1985/86 will be the first of a two-year project and will include sampling of coal seams on a regional

basis.The work will be carried out in Brackett Basin with helicopter support from Norman Wells, by car and helicopter from Inuvik and by helicopter from Komakuk Beach.

SCIENTIFIC RESULTS: During the summer of 1985, three weeks were spent examining and collecting from coal seams in Devonian to Oligocene rocks of the Fort Norman, Inuvik and British Mountains areas. This and subsequent laboratory work defined an occurrence of massive bitumen near Rengleng River N.W.T. and a high quality anthracite bed (5m) south of the Barn Mountains, Y.T. Conodonts in these rocks indicate a maturation beyond the oil window.

OUTPUTS:
NORRIS, D.K., 1986. Lower Devonian Road River Formation on the north flank of the Romanzof Uplift, northern Yukon Territitory. Geol. Sur. Can. Curr. Res. Paper 86-1A.
NORRIS, D.K., CAMERON, A.R., 1986. An occurrence of bitumen in the interior platform near Rengleng River, District of Mackenzie. Geol. Sur. Can. Curr. Res. Paper 86-1A.

FGP Project Number: WA35-430 Project Officer: R.W. Macqueen

TITLE: Dempster Highway vitrinite reflectance/geochemistry cross-section - Northern Cordillera.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	0.2	0.2	0.2
Contract	20.0	17.1	17.1
Other O&M	0.0	0.0	0.0
Capital	0.0	0.0	0.0

OBJECTIVE: To investigate the maturation profiles of Paleozoic and Mesozoic sedimentary rocks in the northern Yukon in order to better understand their tectonic setting and the mantle/lithosphere relationships in the northern Cordillera.

DESCRIPTION: The work will be performed by University of British Columbia staff and students. Coaly and organic samples will be

collected along the Dempster Highway and analyzed (including vitrinite reflectance), to determine their maturation.

SCIENTIFIC RESULTS: Samples of all available outcrops of Paleozoic and Mesozoic rocks between Dawson and Aklavik have been collected and are in process of having their vitrinite refectance determined.

OUTPUTS:

LINK, C., 1985. An investigation of sedimentary rock maturation - profile in northern Yukon and N,W.T. Internal report submitted to Petroleum subdivision, ISPG, GSC, Calgary.

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SUPPORT R&D TASK TASK MANAGER: J.G. Fyles

FGP Project Number: SR11-540 Project Officer: J.G. Fyles

TITLE: R&D support to various FGP projects.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	(4.0)		
Contract	0.0		
Other O&M	0.0		
Capital	91.0		

OBJECTIVE: To facilitate the attainment of particular FGP research objectives by supplementing the funds and person-years allocated to selected FGP projects.

DESCRIPTION: Supplementary funding will be provided to selected projects in which the anticipated results will have a bearing on, and contribution to, a wide range of projects within a component or task. Of the O&M resources asigned to the Task, $300k per year has been trannsferred to supplement the West Coast Task, (subsequently reduced through expenditure reductions), and the remaining $360k per year has been assigned to ODP. The 4 PY associated with the Task have been transferred to CPM (Pat Bay), (2) and ISPG (2). $91k capital is being held in reserve.

LOGISTIC SUPPORT TASK TASK MANAGER: G.D. Hobson

LOGISTICS-ARCTIC ISLANDS COMPONENT Component Manager: G.D Hobson

COMPONENT SUMMARY

Logistic support, navigation facilities and room and board were provided as necessary for activities on and from the Ice Island as well as projects on the Arctic Islands.

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FGP Project Number: LS11-530 Project Officer: D.D Picklyk

TITLE: Program Administration

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)	1.0	1.0	2.0
Contract	0.0	1287.1	1291.6
Other O&M	10.0	0.0	0.0
Capital	0.0	100.0	147.9

NOTE: The large apparent overexpenditures within the project are due to the the incorrect coding of centrally administered logistic charges that would normally have been accounted for within projects LS13-170 and LS13-180. A separate central project should have been created to accomadate the charges Charges include rental of fixed and rotary winged aircraft as well as salaries.

OBJECTIVE: To provide effective management of the Frontier Geoscience Program.

DESCRIPTION: To provide effective management of the Frontier Geoscience Program by maintaining relevant program records and planning documents and providing administrative support by the maintenance of management committee minutes and the production of special reports as required.

SCIENTIFIC RESULTS: None. Administrative documentation was maintained as necessary.

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FGP Project Number: LS13-170 Project Officer:G.D. Hobson

TITLE: Logistic Support Arctic Islands.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)			
Contract	553.0	242.4	1292.2
Other O&M	0.0	169.9	169.9
Capital	0.0	15.5	15.5

NOTE: PCSP has contributed an additional $452,672.18 (in fiscal 85/86 to this project which is not included in the above total.

OBJECTIVE: To provide logistic support, including transportation and communications to the FGP as required to meet hostile working conditions in the Arctic Islands.

DESCRIPTION: Services will be arranged through PCSP or directly by the Arctic Islands Task Manager. The annual budget will be established by consultation between PCSP and the Arctic Islands Task Manager. These services will include air transportation, radio communications, and mobilization costs for seismic surveys and geological sampling programs. Part of the operating expenses of a scientific base camp on the "Ice Island" will be included in the annual budgets in those years in which the camp may be stategically situated and functional.

SCIENTIFIC RESULTS: None, scientific results are reported separately within the relevant scientific project. Expenditures incurred are related to mobilization and set-up of the base camp on the Ice Island.

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FGP Project Number: LS13-180 Project Officer: J Popelar

TITLE: Logistic Support Navigation

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY)			
Contract			
Other O&M	0.0	200.0	200.0
Capital	0.0	200.0	200.0

OBJECTIVE: To provide navigation services to the FGP as required from the ice island or from onshore stations in the Arctic Islands or Western Arctic.

DESCRIPTION: Services will be arranged through PCSP This navigation service will be used for geophysical surveys and geological sampling programs System development for ice island navigation will be carried out with collaboration of Geodetic Survey, S&MB, and will provide position orientation and related base station services for ice island projects.

SCIENTIFIC RESULTS: None, scientific results are reported in the relevant scientific projects. Resources to maintain the necessary facilities are accounted for within the various scientific projects using them.

LOGISTICS WESTERN ARCTIC COMPONENT Component Manager: G.D. Hobson

COMPONENT SUMMARY: Logistic support and navigation facilities were provided as necessary for projects within the Beaufort Sea and northern mainland areas.

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FGP Project Number: LS23-150 Project Officer: G.D Hobson

TITLE: Logistic support Western Arctic.

RESOURCES ($1,000's)			
	Planned	Actual	Cummulative Total
Personnel (PY) Contract Other O&M Capital	0.0	325.0	325.0

OBJECTIVE: To provide logistic support including transportation and communications to the FGP as required to meet hostile working conditions in the Western Arctic. Services will be arranged through PCSP or directly by the Western Arctic Task Manager.

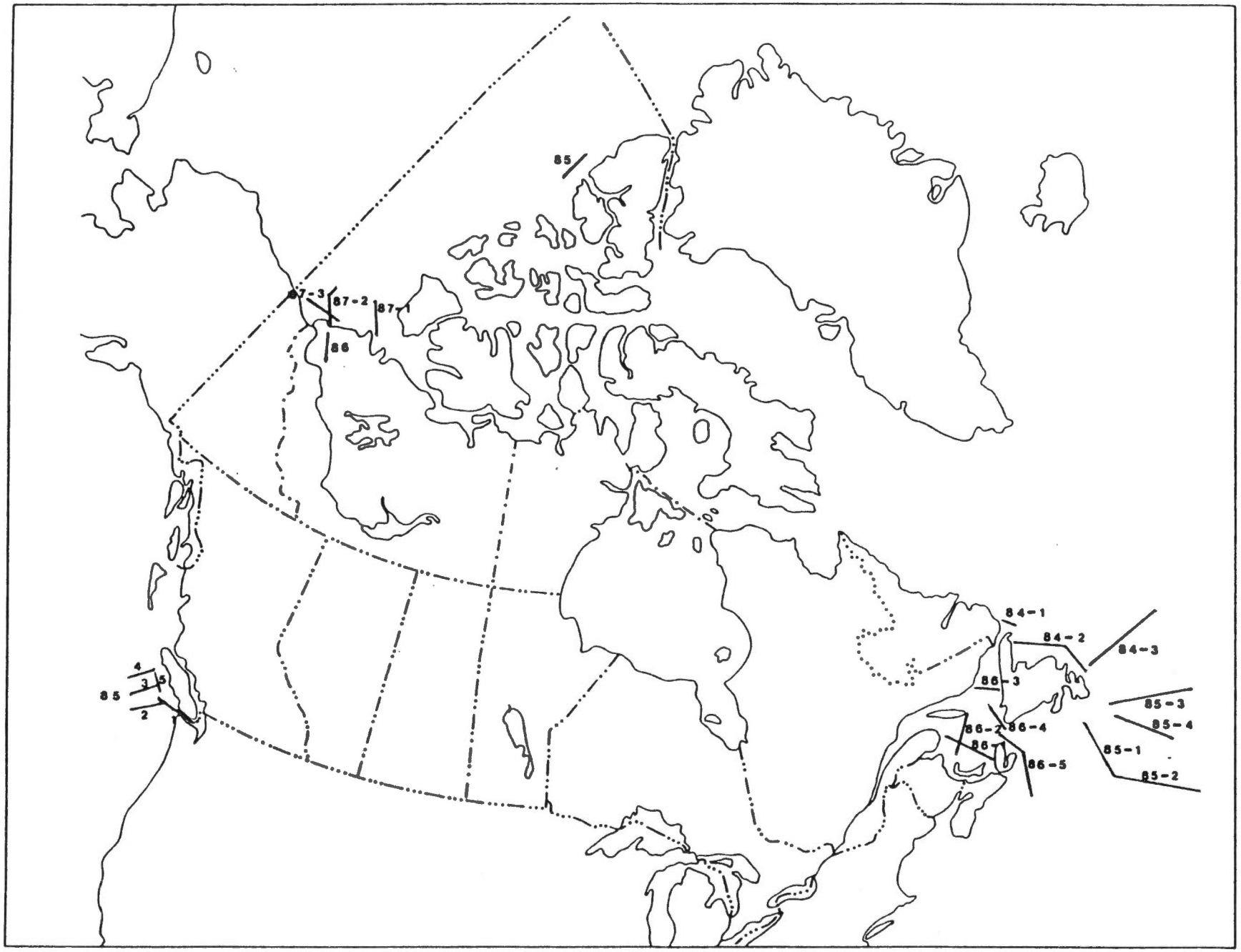
DESCRIPTION: The annual budget will be established by consultation between PCSP and the Western Arctic Task Manager. These services will include air transportation, radio communications and mobilization costs for the scientific projects,

SCIENTIFIC RESULTS: None, scientific results are reported in the relevant scientific projects. Resources are accounted for in the various projects utilizing the provided services.

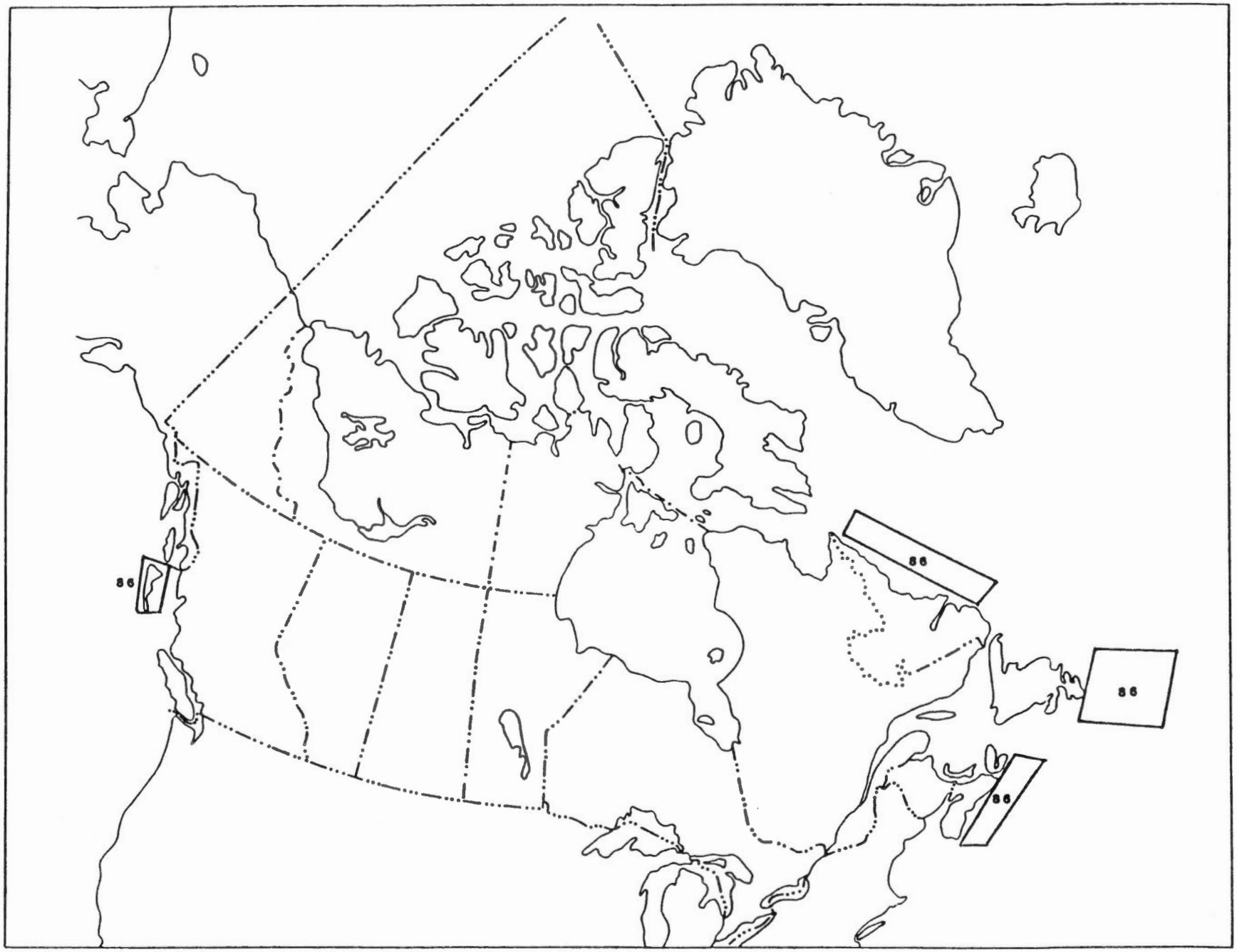
Appendix I

Major Survey Locations

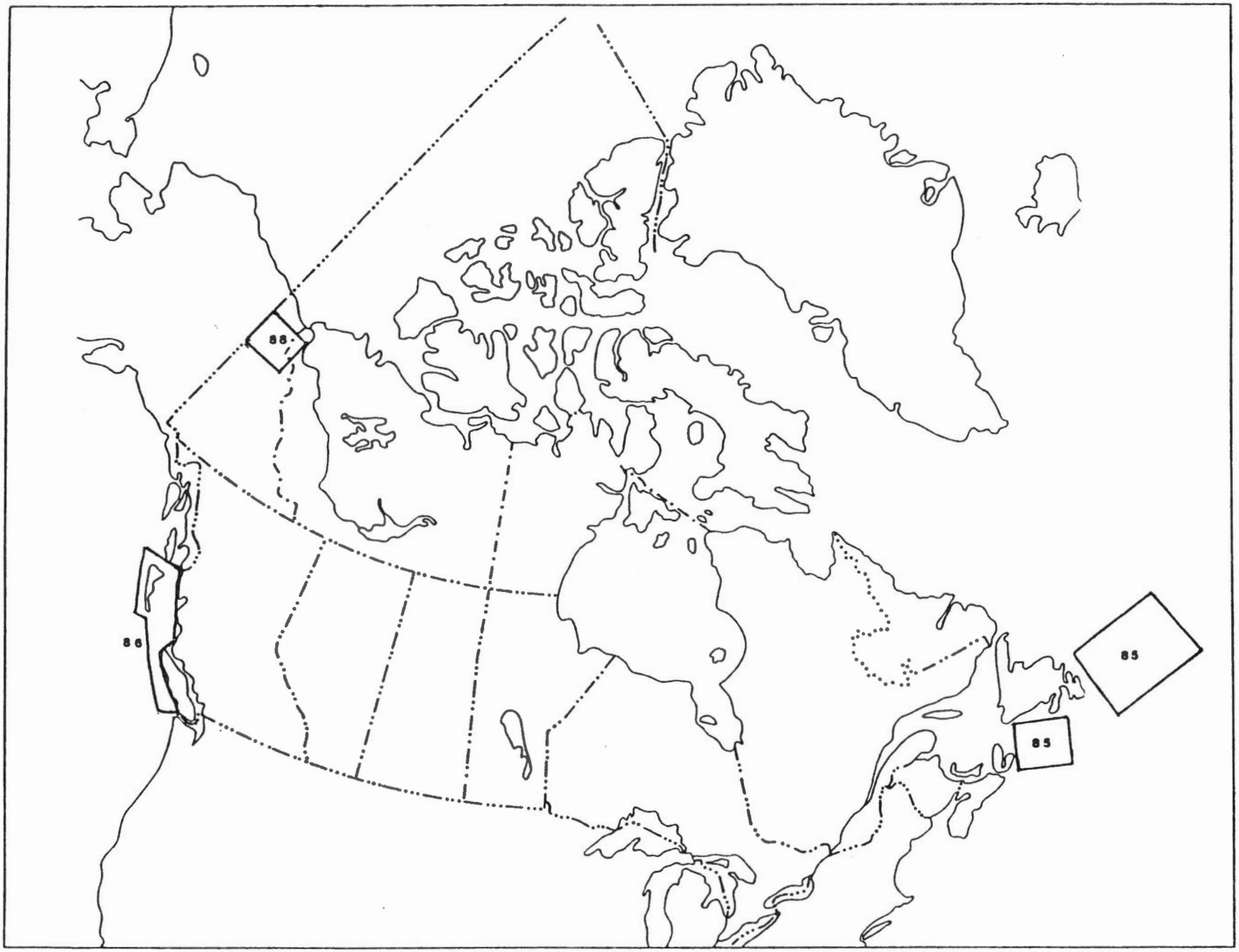
Seismic Refraction Surveys / Études de réfraction séismique



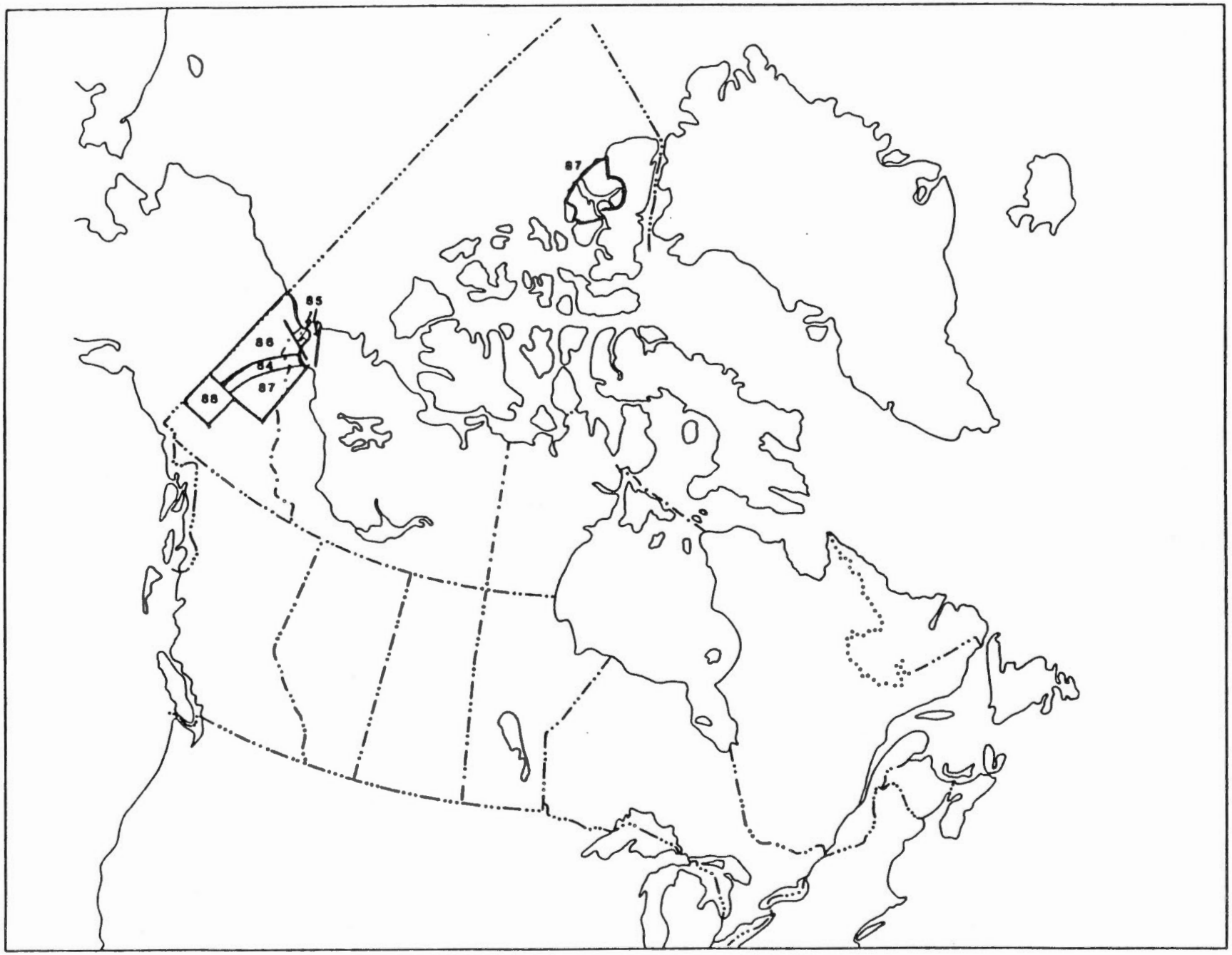
Seismic Reflection Surveys / Études de réflexion séismique



Biostratigraphic Studies / Études biostratigraphiques



Aeromagnetic Surveys / Études aéromagnétiques



Gravity Surveys / Études gravimétriques